MeetCon conference

MEETCON-PARİS

International Multidisciplinary Studies Congress

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Prof. Dr. İlke TAŞÇIOĞLU

Asst. Prof. Dr. Hakan KÜRKÇÜOĞLU

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Congress Date: December 16- 21, 2025

FRANCE/PARİS

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CONGRESS ID

CONGRESS TITLE

MEETCON-PARIS
INTERNATIONAL MULTIDISCIPLINARY STUDIES CONGRESS

DATE AND PLACE

December 16-21, 2025/ PARIS/FRANCE
CITYX Ibis Paris Tour Eiffel Cambronne 15ème hotel

ORGANIZATION

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December 16-21, 2025/ PARIS/FRANCE

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Total Rejected Papers: 16
Total Accepted Papers from Türkiye: 106
Total Accepted Papers from Foreign Countries: 112
Total Accepted Papers: 218

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16.12.2025 / ONLINE / SESSION-1 / HALL-1

Paris Local Time: 11.00-12:30 Ankara Local Time: 13.00-14:30

Zoom Meeting ID: *325 629 5864* / Zoom Passcode: meetcon

HEAD OF SESSION: Prof. Dr. Ruya SAMLI

Authors	Affiliation	Presentation Title
Şirvan KAMAN Assoc. Prof. Dr. Evren KOÇ	Kafkas University Kafkas University	**THE EFFECTS OF THE HETEROCYCLIC 4,5-DIHYDRO-1H-1,2,4-TRIAZOL-5- ONE COMPOUND ON LIVER TISSUE PROTEIN EXPRESSION AND ENZYME LEVELS IN WISTAR ALBINO RATS**
Göngür Pusat Assist. Prof. Dr. Abdulmuttalip Şahinaslan Res. Assist. Dr. Celal Kıstak Prof. Dr. Nevin ÇELİK	Inonu University Inonu University	**EXPERIMENTAL INVESTIGATION OF TEMPERATURE DISTRIBUTION IN JET IMPINGEMENT COOLING USING THERMAL IMAGING**
Irfan YOLCULAR Res. Assist. Dr. Celal Kıstak Prof. Dr. Nevin ÇELİK	Nit Orme R&D Department Fırat University Fırat University	**DESIGN AND DEVELOPMENT OF A DOMESTIC ELECTROMAGNETIC NEEDLE SELECTION SYSTEM FOR ELECTRONIC FLAT KNITTING MACHINES**
Eyüp Can İÇLİ	Oyak Renault Automobile Factory	**A COMPREHENSIVE REVIEW OF CARBON FIBER REINFORCED POLYMERS (CFRP): MANUFACTURING, PROPERTIES, AND INDUSTRIAL APPLICATIONS**
Fatih KAYA Resul AKIN Prof. Dr. Ruya SAMLI Assoc. Prof. Dr. Eylem YUCEL	TLS Lojistik, Tuzla TLS Lojistik, Tuzla Istanbul University Istanbul University	**DIGITAL TRANSFORMATION IN WAREHOUSE MANAGEMENT SYSTEMS: THE SCOPE, PROCESS, AND OPERATIONAL IMPACTS OF THE TRANSITION FROM LVS TO THE LV3+ PLATFORM**
Furkan ECEVIT Ezgi DELIAK Prof. Dr. Rüya ŞAMLI Assoc. Prof. Dr. Eylem YUCEL	TLS Lojistik Istanbul University-Cerrahpaşa Istanbul University- Cerrahpaşa	**INTEGRATION OF CORPORATE REPORTS INFRASTRUCTURE INTO DATA WAREHOUSE ENVIRONMENT**

(All speakers required to be connected to the session 10 min before the session starts)
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16.12.2025 / ONLINE / SESSION-1/ HALL-2

Paris Local Time: 11.00-12:30 Ankara Local Time: 13.00-14:30

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HEAD OF SESSION: Assoc. Prof. Dr. Ibrahim Yilmaz

Authors	Affiliation	Presentation Title
Res. Assist.Gökhan KURNAZ Prof. Dr. Orhan ÇAKAR	Fırat University Fırat University	**THE EFFECT OF HANGER ELEMENTS ON THE NATURAL FREQUENCIES AND MODE SHAPES OF A VENTILATION DUCT**
Assoc. Prof. Dr. Ibrahim Yilmaz	Ankara Yildirim Beyazit University	**AN ADVANCED EVALUATION FRAMEWORK INTEGRATED MACHINE LEARNING WITH MULTI-CRITERIA DECISION-MAKING FOR POTENTIAL LOCATIONS OF SOLAR POWER PLANTS**
Assoc. Prof. Dr. Ibrahim Yilmaz	Ankara Yildirim Beyazit University	**A DEMATEL–VIKOR-BASED MULTI-CRITERIA FRAMEWORK FOR EVALUATING CUSTOMER SATISFACTION IN E-COMMERCE PLATFORMS**
Ersel DÖNMEZ	Oyak Renault Automobile Factory	**BATTERY COOLING ANALYSIS COMPARISON**
Asst. Prof. Dr. Rukiye ATLI Asst. Prof. Dr. Mehmet Hanifi KEBİROĞLU	National Defence University Malatya Turgut Özal University	**MULTI-ASPECT DFT ANALYSIS OF THE THPMPCA MOLECULE: IMPLICATIONS FOR BIOELECTRONICS AND DRUG DESIGN**
Asst. Prof. Dr. Rukiye ATLI Asst. Prof. Dr. Mehmet Hanifi KEBİROĞLU	National Defence University Malatya Turgut Özal University	**INTEGRATED DFT PROFILING OF THPMPCA: STRUCTURAL, ELECTRONIC, THERMOCHEMICAL AND TOXICOLOGICAL INSIGHTS**
Prof. Dr. Utku Altunöz	Sinop University	**THE IMPACT OF TCMB INTEREST RATE DECISIONS ON BORSA ISTANBUL SECTORAL INDICES: AN EVENT STUDY APPROACH**
Prof. Dr. Abdullah GÖKTAŞ	Harran University	**STRUCTURAL AND ELECTRICAL PROPERTIES OF Cu_2ZnSnS_4 (CZTS) THIN FILMS**
Assoc. Prof. Dr. Ahmet TAŞ	Harran University	**FRANCK–CONDON FACTORS AND R-CENTROIDS OF THE GERMANIUM FLUORIDE (GEF) MOLECULE VIA A MOLECULAR POTENTIAL**

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16.12.2025 / ONLINE / SESSION-1 / HALL-3

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HEAD OF SESSION: Asst. Prof. Dr. Meriç BALCI

Authors	Affiliation	Presentation Title
Asst. Prof. Dr. Meriç BALCI	Akdeniz University	**ECOLOGICAL USE OF HOME COMPOST AS A SUSTAINABLE INPUT IN EDIBLE BALCONY PLANTS: IMPLICATIONS FOR SOIL HEALTH, PLANT NUTRITION AND FOOD SAFETY**
Ceren ELCI Assoc. Prof. Dr. Mümüne Merve PARLAK	Ankara Yıldırım Beyazıt University Ankara Yıldırım Beyazıt University	**INVESTIGATION OF GRADUATE THESES ON SWALLOWING DISORDERS AND COGNITIVE FUNCTIONS IN PARKINSON'S DISEASE**
Lect. Dr. Şükrü CANPOLAT Asst. Prof. Dr. Gülay OLCABEY ERGİN Prof. Dr. Ilgaz AKATA	Niğde Ömer Halisdemir University Niğde Ömer Halisdemir University Ankara University	**A COMPARATIVE STUDY ON ANTIOXIDANT POTENTIAL OF Suillus collinitus COLLECTED FROM TWO DIFFERENT LOCATIONS**
Asst. Prof. Dr. Gülay OLCABEY ERGİN Lect. Dr. Şükrü CANPOLAT	Niğde Ömer Halisdemir University Niğde Ömer Halisdemir University	**INVESTIGATION OF THE APHIDICIDAL ACTIVITY OF PLANT EXTRACTS**
Osman AĞDAŞ Assoc. Prof. Dr. Arzu KARABAĞ AYDIN	Kafkas University Kafkas University	**VIRTUAL REALITY IN CLINICAL PRACTICE AND RESEARCH: A NURSING PERSPECTIVE**
Osman AĞDAŞ Assoc. Prof. Dr. Arzu KARABAĞ AYDIN	Kafkas University Kafkas University	**USE OF ARTIFICIAL INTELLIGENCE IN INTENSIVE CARE UNITS AND NURSING CARE**
Beyza GÜLER Zeynep AKYÜREK Assoc. Prof. Dr. Erdil DURUKAN Assoc. Prof. Dr. Serhat TURAN	Balıkesir University Balıkesir University Balıkesir University Balıkesir University	**THE EFFECT OF PASSION FOR SPORTS AND PHYSICAL ACTIVITY ON ENJOYMENT**

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16.12.2025 / ONLINE / SESSION-1 / HALL-4

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HEAD OF SESSION: Asst. Prof. Dr. Barış ERGÜL

Authors	Affiliation	Presentation Title
Uzm. Dr. Ahmet Berkız TURP Lect. Feray BUCAK Celal ULUDAĞ Prof. Dr. Bülent YILMAZ	Toros Hospital Harran University Şanlıurfa Archaeological Museum İzmir City Hospital	**WAS GÖBEKLITEPE A SACRED SITE FOR MIDWIFERY PRACTICES 12,000 YEARS AGO?**
Asst. Prof. Dr. Barış ERGÜL Prof. Dr. Arzu ALTIN YAVUZ	Eskişehir Osmangazi University Eskişehir Osmangazi University	**MODELING SLEEP APNEA RISK WITH SMALL-SCALE DIGITAL HEALTH DATA**
Asst. Prof. Dr. Barış ERGÜL Prof. Dr. Arzu ALTIN YAVUZ	Eskişehir Osmangazi University Eskişehir Osmangazi University	**FORECASTING GLACIER ACTIVITY THROUGH TIME-SERIES METHODS: ARIMA AND LSTM**
Akif ÖZKAN Assoc. Prof. Dr. Tuna TURĞUT Gizem SARAÇ	Bartın University Bartın University Bartın University	**INVESTIGATION OF THE EFFECTS OF CLASSICAL BADMINTON TRAINING ON LIPID AND GLUCOSE METABOLISM**
Cihan ÇEKİÇ Assoc. Prof. Dr. Tuna TURĞUT	Bartın University Bartın University	**AN EXAMINATION OF MATCH PERFORMANCE RESPONSES IN BOCCE ATHLETES**
Res. Assist. Ilgın Ali COŞKUN Asssoc. Prof. Dr. Burak CANPOLAT Res. Assist. Dr. Göktuğ NORMAN	İnönü University İnönü University İnönü University	**CORE EXERCISE, POSTURAL BALANCE AND ATHLETIC PERFORMANCE: A SITUATION ANALYSIS OF CURRENT EVIDENCE**
Assoc. Prof. Dr. Yalın AYGÜN Assoc. Prof. Şakir TÜFEKÇİ Prof. Dr. Cemal GÜNDOĞDU Assoc. Prof. Dr. Burak CANPOLAT Res. Assist. Dr. Göktuğ NORMAN Büşra CANPOLAT	İnönü University İnönü University İnönü University İnönü University Fırat University	**PARENTAL PERSPECTIVES ON THE BENEFITS OF THERAPEUTIC HORSEBACK RIDING FOR CHILDREN WITH AUTISM SPECTRUM DISORDER: INSIGHTS FROM CROATIA AND TÜRKIYE**

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16.12.2025 / ONLINE / SESSION-1 / HALL-5

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HEAD OF SESSION: Prof. Dr. Şenay GÖRÜCÜ YILMAZ

Authors	Affiliation	Presentation Title
Prof. Dr. Elif KARAGÜN Fuat Orkun TAPŞIN	Kocaeli University Kocaeli University	**EXAMINING THE ANGER LEVELS OF UNIVERSITY STUDENTS WHO ARE CANDIDATES FOR COACHING**
Fuat Orkun TAPŞIN Prof. Dr. Elif KARAGÜN	Kocaeli University Kocaeli University	**EXAMINING THE POSITIVE THINKING SKILLS OF LICENSED ATHLETES**
Medine ÇELİK Prof. Dr. Hasan YILMAZ	Atatürk University Atatürk University	**ANALYSIS OF THE ECOLOGICAL VALUE OF LANDSCAPE DESIGN IMPLEMENTATION PROJECTS USING ENVI-MET**
Yaren ERSOY Prof. Dr. Fatih BÜYÜK	Kafkas University Kafkas University	**BIOLOGICAL AND ECOLOGICAL DYNAMICS OF Batrachochytrium dendrobatidis INFECTION**
Elvan UZUN Assist. Prof. Ceyhun YÜCEL	Yozgat Bozok University Yozgat Bozok University	**USE OF TREE LEAVES AS AN ALTERNATIVE FEED SOURCE IN RUMINANT NUTRITION: NUTITIONAL POTENTIAL, ANTINUTRITIONAL FACTORS AND APPLICATION OPPORTUNITIES**
Döndü Betül TANKIZ Assoc. Prof. Dr. Zarife PANCAR	Gaziantep University Gaziantep University	**THE RELATIONSHIP BETWEEN MENTAL TOUGHNESS, STRESS, AND PERFORMANCE IN TAEKWONDO ATHLETES**
Döndü Betül TANKIZ Assoc. Prof. Dr. Zarife PANCAR	Gaziantep University Gaziantep University	**THE EFFECT OF MENTAL FATIGUE ON STRESS AND PSYCHOLOGICAL PERFORMANCE IN TAEKWONDO ATHLETES**
Prof. Dr. Şenay GÖRÜCÜ YILMAZ Assoc. Prof. Dr. Ahmet Sarper BOZKURT	Gaziantep University Gaziantep University	**INVESTIGATION OF THE RIXOSOME COMPLEX ASSOCIATED WITH NEURODEVELOPMENTAL DISORDERS USING A SYSTEMS BIOLOGY APPROACH**

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16.12.2025 / ONLINE / SESSION-1 / HALL-6

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HEAD OF SESSION: Assoc. Prof. Dr. Nihan ÖKSÜZ NARİNÇ

Authors	Affiliation	Presentation Title
Assoc. Prof. Dr. Nihan ÖKSÜZ NARİNÇ Dr. Nilgün YAPICI	Akdeniz University Akdeniz University	**BLACK SOLDIER FLY–BASED PROTEIN FOR SOYBEAN SUBSTITUTION: ECONOMIC AND ENVIRONMENTAL OUTCOMES AND MULTI-YEAR SCENARIO ANALYSIS FOR TÜRKIYE**
Assoc. Prof. Dr. Nihan ÖKSÜZ NARİNÇ Dr. Nilgün YAPICI	Akdeniz University Akdeniz University	**SOYBEAN IN POULTRY FEED: GLOBAL DEPENDENCE, ECONOMIC DYNAMICS, AND STRATEGIC SOLUTIONS FOR TÜRKIYE**
Dr. Nilgün YAPICI Assoc. Prof. Dr. Nihan ÖKSÜZ NARİNÇ	Akdeniz University Akdeniz University	**THE CLIMATE CRISIS AND THE SEARCH FOR SUSTAINABLE FEED: ENVIRONMENTAL AND NUTRITIONAL EVALUATION OF BLACK SOLDIER FLY (Hermetia illucens) LARVAE**
Ahmet CEYHAN Samet Can SÖNMEZ Dr. Nilgün YAPICI Prof. Dr. Doğan NARİNÇ	Akdeniz University Akdeniz University Akdeniz University Akdeniz University	**FEAR-BASED VOCALISATION RESPONSES IN RED-LEGGED PARTRIDGES DEPENDING ON DIFFERENT SOCIAL AND ENVIRONMENTAL CONDITIONS**
Umut ÇİL	Karamanoglu Mehmetbey University	**THE STRATEGIC STRUCTURE OF OPEN-SOURCE INNOVATION ECOSYSTEMS: NETWORK AND TOPIC MODELING ANALYSIS OF POPULAR AI/ML PROJECTS ON GITHUB**
Umut ÇİL	Karamanoglu Mehmetbey University	**DIGITAL PLATFORM CAPITALISM AND INNOVATION: VALUE CREATION AND EXPLOITATION FROM A CRITICAL PERSPECTIVE**
Lect. Dr. Hasan ERYÜRÜK	Afyon Kocatepe University	**BRAZIL'S ECOLOGICAL CAPITAL: INTEGRATION OF THE RIT SYSTEM, ECOLOGY and SOCIAL POLICY IN THE CURITIBA MODEL**
Lect. Dr. Hasan ERYÜRÜK	Afyon Kocatepe University	**SOCIAL URBANISM IN MEDELLÍN: INTEGRATED URBAN PROJECTS and NATURE-BASED SOLUTIONS**
Prof. Dr. Bedriye TUNÇSİPER Prof..Dr. Dilek SÜREKÇİ YAMAÇLI	Izmir Democracy University Izmir Democracy University	**FRAGILE BALANCES: EVIDENCE OF THE BUDGET DEFICIT-CURRENT ACCOUNT DEFICIT INTERACTION IN TURKEY (2010-2025)**

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16.12.2025 / ONLINE / SESSION-1 / HALL-7

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HEAD OF SESSION: Assist. Prof. Dr. Zeynep KEMALOĞLU

Authors	Affiliation	Presentation Title
Leyla KESKİN	Artuklu Universty	**THE LOST CYCLE OF THE TIGRIS: ECOLOGICAL MOURNING THROUGH A MYTHOLOGICAL LENS**
Assist. Prof. Dr. Zeynep KEMALOĞLU	Ordu University	**EVALUATION OF 19TH- AND 20TH-CENTURY OTTOMAN COINS IN TERMS OF THEIR COMPOSITIONAL FEATURES (AT THE AMASYA MUSEUM SCALE)**
Assist. Prof. Dr. Zeynep KEMALOĞLU	Ordu University	**AMASYA BAYEZID PASA MOSQUE MIHRAB DECORATION PROGRAM**
Gülçin SAĞIR KESKİN	Ankara Üniversitesi,	**LIVES GOVERNED BY DEATH: ISRAEL'S REGIME OF EXCEPTION AND PALESTINE'S SUMUD RESISTANCE**
Suna Utar Özkan M.A. Ramazan Bulut Prof. Dr. Sevilay Şahin	Gaziantep Islam Science & Technology University Gaziantep University Gaziantep University	**ASSESSING THE IMPACT OF A GROUP GUIDANCE PROGRAM ON REDUCING DIGITAL ADDICTION AND CYBERBULLYING IN PRIMARY SCHOOL STUDENTS**
Res. Asst. Elif BİLGE	Marmara University	**THE TRANSFORMATION OF RELIGIOUS DISCOURSE IN REPUBLIC DAY SERMONS: A THEMATIC ANALYSIS IN THE CONTEXT OF NON-FORMAL RELIGIOUS EDUCATION**
Umid QURBANOV	Ministry of Science and Education of the Republic of Azerbaijan	**THE IMPACT OF THE GREEN ECONOMY ON THE LABOR SECTOR**
Büşra Sümeyye HANÖZÜ Prof. Dr. Orhan KARAMUSTAFAOĞLU	Amasya University Amasya University	**AN EDUCATIONAL GAME DESIGN FOR TEACHING THE TOPIC OF 'COMPARISON SPEED AND VELOCITY'**

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16.12.2025 / ONLINE / SESSION-1 / HALL-8

Paris Local Time: 11.30-13:00 Ankara Local Time: 13.30-15:00

Zoom Meeting ID: *325 629 5864* / Zoom Passcode: meetcon

HEAD OF SESSION: Asst. Prof. Dr. Murat KOCA

Authors	Affiliation	Presentation Title
Asst. Prof. Dr. Serap ÖZHAN DOĞAN Hakan AVCI Burak Galip ANIK Umut GÖKTAŞ	İstanbul Beykent University R&D Department of Tersan Shipyard R&D Department of Tersan Shipyard R&D Department of Tersan Shipyard	**STRUCTURAL PERFORMANCE OF A 40-TON TRAVERSE: STATIC ANALYSIS RESULTS AND SAFETY ASSESSMENT**
Asst. Prof. Dr. Serap ÖZHAN DOĞAN Yusuf Ziya KOÇ Ahmet KARATAŞ	İstanbul Beykent University R&D Department of Tersan Shipyard R&D Department of Tersan Shipyard	**SAFE DRIVING IN LOGISTICS AND THE DESIGN OF A GPS-BASED RISK-ORIENTED WARNING SYSTEM**
Gyokhan Ulusoy Hüseyin GARİP Koray KAHVECİOGLU Res. Assist. Dr. Hasan Yavuz ÜNAL	Ege University Ege University Ege University Ege University	**RECENT APPROACHES IN SINGLE-LAP JOINTS: A SHORT REVIEW**
Maryam RAHIMZADEH Asst. Prof. Dr. Murat KOCA	Yüzüncü Yıl University Yüzüncü Yıl University	**REAL-WORLD APPLICATIONS AND SCALABILITY OF AI-ASSISTED AND TRADITIONAL CI/CD PIPELINE SECURITY PRACTICES**
Asst. Prof. Dr. Murat KOCA	Yüzüncü Yıl University	**CYBERSECURITY AND CYBER RISKS IN MARITIME TRANSPORT: INTERNATIONAL LEGAL FRAMEWORK, REGULATORY APPROACHES, AND PERSONNEL TRAINING**
Asst. Prof. Dr. Buket TOPTAŞ Şefiye ARICAN Asst. Prof. Dr. Sultan Deniz ALTINDAĞ Asst. Prof. Dr. Murat TOPTAŞ Prof. Dr. Davut HANBAY	Bandırma Onyedi Eylül University Bandırma Onyedi Eylül University Bandırma Onyedi Eylül University Bandırma Onyedi Eylül University Inonu University	**SELF-SUPERVISED LEARNING STRATEGIES FOR ACUTE LYMPHOBLASTIC LEUKEMIA DETECTION WITH LIMITED DATA**
Melek GÜNER Assoc. Prof. Dr. Betül ÇİÇEK ÖZKAN	Batman University Fırat University	**STRUCTURAL AND BIODEGRADABILITY PROPERTIES OF KERATIN-CHITOSAN NANOCOMPOSITES PRODUCED BY SOLUTION CASTING METHOD**
Assoc. Prof. Dr. Gulnar GURBANOVA Assoc. Prof. Dr. Aytakin AFANDİYEVA Seljan GULUZADE Qumru MİKAYİLOVA Gulay YUSİFLİ	Azerbaijan University of Architecture and Construction Azerbaijan University of Architecture and Construction Azerbaijan University of Architecture and Construction Azerbaijan University of Economics Azerbaijan University	**IMPLEMENTATION OF NETWORK ATTACK INTRUSION DETECTION USING GAN (GENERATIVE ADVERSARIAL NETWORKS)**

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16.12.2025 / ONLINE / SESSION-1 / HALL-9

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HEAD OF SESSION: Assoc. Prof. Dr. Mücella ÖZBAY KARAKUŞ

Authors	Affiliation	Presentation Title
Hosseın NAZRAVAN Prof. Dr. Filiz GÜNEŞ Assoc. Prof. Dr. Peyman MAHOUTİ	Yildiz Technical University Kırklareli University Yildiz Technical University	**DESIGN OPTIMIZATION OF DIPOLE ANTENNA ARRAYS USING THE WHALE OPTIMIZATION ALGORITHM**
Assoc. Prof. Dr. Mücella ÖZBAY KARAKUŞ	Izmir Bakirçay University	**EVALUATION OF THE IMPACT OF BORON DOPING ON THE LATTICE STRUCTURE AND OPTICAL PROPERTIES OF TIO_2 NANOSTRUCTURES**
Assoc. Prof. Dr. Mücella ÖZBAY KARAKUŞ	Izmir Bakirçay University	**LASER-INDUCED GRAPHENE AS A TEMPLATE FOR VERTICALLY ALIGNED ZNO NANOROD GROWTH: STRUCTURAL AND MORPHOLOGICAL CHARACTERIZATION**
Necati Erdem TUĞRAHAN Prof. Dr. Aydoğan ÖZDAMAR	Ege University Ege University	**ORGANIC RANKINE CYCLE AND WORKING FLUID PERFORMANCE ANALYSIS FOR A GLASS MELTING FURNACE**
Melek ALTAY Berat Fırat DALĞIÇ	Koluman Otomotiv Koluman Otomotiv	**EXAMINATION OF ARMOR STEEL MANUFACTURING PROCESSES**
Assist. Prof. Dr .Kevser ÖZYAŞAR Prof. Dr. İsmail BAKAN	Kahramanmaraş Sütçü İmam University Kahramanmaraş Sütçü İmam University	**UTILIZING INTERNAL CONTRAST FOR EFFECTIVE INNOVATION: DIVERSITY AND INCLUSION**
Aleyna Marul Prof. Dr. Jale Yılmazkaya Süngü	Kocaeli University Kocaeli University	**“TWO-POINT QCD SUM RULE ANALYSIS OF THE T_cc (3875)^+ STATE AS A HADRONIC MOLECULE”**
Asst. Prof. Dr. Osman YİĞİD	Bitlis Eren University	**NUMERICAL MODAL ANALYSIS OF CARBONFIBER BICYCLE FRAME REINFORCED WITH POLYURETHANE FOAM**
Afag NURULLAYEVA Jala TARVERDIYEVA	Ministry of Science and Education of the Republic of Azerbaijan Ministry of Science and Education of the Republic of Azerbaijan	**CRMP-2-DRIVEN RADIO-PROTECTION THROUGH SEROTONERGIC ACTIVATION**

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16.12.2025 / ONLINE / SESSION-1 / HALL-10

Paris Local Time: 12.00-13:30 Ankara Local Time: 14.00-15:30

Zoom Meeting ID: *325 629 5864* / Zoom Passcode: meetcon

HEAD OF SESSION: Assoc. Prof. Dr. Javid Ismayilov

Authors	Affiliation	Presentation Title
Assoc. Prof. Dr. Esin SEZGİN Assoc. Prof. Dr. Gülhan GÜVEN Sude Özdemir	Afyon Kocatepe University Gazi University Afyon Kocatepe University	**LEVELS OF FATHERS' PARTICIPATION IN CHILD CARE**
Asst. Prof. Dr. Nihal ŞEN Fatma AKBULUT Selma ÇİÇEK	Harran University Harran University Harran University	**A MECHANICAL STEP, A HUMAN TOUCH: THE JOURNEY OF ROBOTS IN SPECIAL EDUCATION**
Asst. Prof. Dr. Nihal ŞEN Ayşe DOĞRAMACIOĞLU	Harran University Harran University	**EXAMINING THE TRANSFORMATIVE ROLE OF METAVERSE TECHNOLOGY IN SPECIAL EDUCATION**
Akbarova Nurida Yashar Kasimbeyli Minaver Yusif Hasanli Asmar Bahram Ismayilova Zumrud Sabuhi	Nakhchivan State University Nakhchivan State University Nakhchivan State University Nakhchivan State University	**STUDY OF THE EFFECT OF COPPER DIFFUSION AND PHOTOSTIMULATION ON CONTACT AND PHOTOELECTRIC PROPERTIES IN CDS SEMICONDUCTORS**
Ceyda CEYLAN Prof. Dr. Gülay EKİCİ	Gazi University Balıkesir University	**PARALLEL CURRICULUM MODEL: A METHODOLOGICAL COMPARATIVE ANALYSIS BASED ON THREE DOCTORAL THESES**
Prof. Dr. Gülay EKİCİ Ceyda CEYLAN	Balıkesir University Gazi University	**WHAT IS DIGITAL WISDOM? PRACTICAL SUGGESTIONS: AN ANALYSIS STUDY**
Asst. Prof. Dr. Zeynep BÜYÜKSARAÇ	Bolu Abant İzzet Baysal University	**LES OPINIONS DES ENSEIGNANTS SUR LE DÉVELOPPEMENT DE LA COMPRÉHENSION ÉCRITE CHEZ LES APPRENANTS DU FLE**
Yasin SÖNMEZ	Çukurova University	**LA RESTRICTION DE LA VOIE DU CONTRÔLE JURIDICTIONNEL CONTRE LES ACTES ADMINISTRATIFS DANS LE DROIT DU CONTENTIEUX ADMINISTRATIF TURC**
Assoc. Prof. Dr. Javid Ismayilov	Nakhchivan State University	**REINTERPRETING THE CONCEPT OF CLASSICAL ART IN THE CONTEXT OF POSTMODERNISM**

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16.12.2025 / ONLINE / SESSION-1 / HALL-11

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HEAD OF SESSION: Assoc. Prof. Dr. Hacer AKER

Authors	Affiliation	Presentation Title
Asst. Prof. Dr. Çağlayan DOĞAN	Gümüşhane University	**FRAGMENTED SUBJECTIVITY AND POSTDRAMATIC IDENTITY IN MARTIN CRIMP'S IN THE REPUBLIC OF HAPPINESS**
Dr. Ersoy Yılmaz DİNİZ Dilara Cansın KEÇİALAN	Taras Shevchenko National University of Kyiv	**NATIONAL STRATEGIES FOR PREVENTING RADICALIZATION: THE BALANCE BETWEEN HUMAN RIGHTS AND SECURITY IN CENTRAL ASIA**
Lect. Hatice Tuğba AKDOĞAR AKBULUT	Recep Tayyip Erdoğan University	**THE INSCRIPTION OF MATARACI ZADE HACI MUSTAFA EFENDI DATED H. 1304 / AD 1886 IN RIZE AND THE TRACES TRANSFORMED INTO A LOST FOUNTAIN OF A LOST WATERWAY**
Assoc. Prof. Dr. Hacer AKER	Selcuk University	**REINTEGRATION THROUGH EDUCATION: SOCIAL ADAPTATION PROCESSES OF INCARCERATED STUDENTS AT SELÇUK UNIVERSITY**
Assoc. Prof. Dr. Hacer AKER	Selcuk University	**PIOUS WOMEN'S PERFORMATIVE RELIGIOSITY AND THEIR PATHS TO DISAFFILIATION**
Assoc. Prof. Dr. Hüsrev TABAK	Recep Tayyip Erdoğan Üniversitesi	**DISCREDITING THE UN'S WORK ON PALESTINE: ACTORS, NARRATIVES, AND IMPLICATIONS**
Assoc. Prof. Dr. Hüsrev TABAK	Recep Tayyip Erdoğan Üniversitesi	**POPULISM, ANTI-GLOBALISM AND THE FUTURE OF GLOBAL GOVERNANCE**
Asst. Prof. Dr. Yasin AVCI	Bandırma Onyedi Eylul University	**COMPARATIVE ANALYSIS OF AI AND STUDENT PRODUCTIONS IN TYPOGRAPHIC POSTERS DESIGNED FOR THE DISABILITY AWARENESS WEEK**
Elxan ZEYNALOV	Nakhchivan State University	**MONUMENTAL HEYKƏLDƏ FORMA VƏ MƏKAN MÜNASIBƏTLƏRI**

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16.12.2025 / ONLINE / SESSION-1 / HALL-12

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HEAD OF SESSION: Prof. Dr. Şermin TAĞ KALAFATOĞLU

Authors	Affiliation	Presentation Title
Assoc. Prof. Dr. Metin KETBOĞA	Malatya Turgut Özal University	**AN ASSESSMENT OF THE RESURGENCE OF PROTECTIONIST POLICIES IN INTERNATIONAL TRADE**
Assoc. Prof. Dr. Metin KETBOĞA	Malatya Turgut Özal University	**COMMON OPERATIONAL ERRORS IN OREIGN TRADE AND THEIR CONSEQUENCES**
Asst. Prof. Dr. Çağla TOPGÜL Tuna Çağlar TOPGÜL	Kafkas University Ministry of Family and Social Services	**THE CITY AS A NARRATIVE SPACE IN CINEMA: THE IMAGE OF KARS – AN ARCHITECTURAL AND SOCIOLOGICAL READING OF THE CHARACTER- SPACE RELATIONSHIP**
Dr.Tuna Çağlar TOPGÜL	Ministry of Family and Social Services	**A SOCIOLOGICAL ANALYSIS OF SPACE, MEMORY, AND IDENTITY BASED ON THE QUESTION "IF YOU COULD REUNITE WITH YOUR CHILDHOOD SELF, WHERE WOULD YOU TAKE THEM FIRST?"**
Prof. Dr. Şermin TAĞ KALAFATOĞLU	Ordu University	**REFLECTIONS OF THIRD CINEMA IN THE DOCUMENTARY FIELD**
Prof. Dr. Şermin TAĞ KALAFATOĞLU	Ordu University	**NARRATIONAL FORMS OF ROCK DOCUMENTARIES**
Dr. Uğur İNAN	Yalova University	**ERNST JÄCKH (1875–1959): A JOURNALİST AND CULTURAL ENVOY AT THE INTERSECTİON OF OTTOMAN MODERNİZATİON AND GERMAN CULTURAL IMPERİALİSM**
Assoc. Prof. Dr. Gülxani (Pənah) Şükürova	Philological Sciences	**THE ROOTS OF WESTERN AZERBAIJAN – GOYCHA ASHIG ART (ANALYSIS AND RESEARCH ON ANCIENT OGHUZ, TURKMEN AND AZERBAIJANI FOLKLORE)**
Hacıyeva Siddiqə Zakir qızı	Nakhchivan State University	**THE APPLICATION OF NATIONAL ORNAMENTAL MOTIFS IN CONTEMPORARY ART**

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16.12.2025 / ONLINE / SESSION-1 / HALL-13

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HEAD OF SESSION: Prof. Dr. Osman ÇEPNİ

Authors	Affiliation	Presentation Title
Prof. Dr. Fatih AYDIN Prof. Dr. Osman ÇEPNİ	Karabük Üniversitesi Karabük Üniversitesi	**INTEGRATION OF ARTIFICIAL INTELLIGENCE INTO GEOGRAPHY EDUCATION: A THEORETICAL MODEL PROPOSAL**
Prof. Dr. Fatih AYDIN Prof. Dr. Osman ÇEPNİ	Karabük University Karabük University	**THE NEAR-TO-FAR PRINCIPLE IN GEOGRAPHY TEACHING: THEORETICAL FOUNDATIONS AND INSTRUCTIONAL PRACTICES**
Aleyna Yaren KÜPE Prof. Dr. Elvettin AKMAN	Süleyman Demirel University Süleyman Demirel University	**RESEARCH ON UNIVERSITY STUDENTS' KNOWLEDGE AND AWARENESS LEVELS REGARDING THE PRESIDENTIAL GOVERNMENT SYSTEM**
Sevilcan İNCE Prof. Dr Elvettin AKMAN	Süleyman Demirel University Süleyman Demirel University	**THE INVESTMENT AND FINANCE OFFICE AS A NEW INSTITUTION IN TURKEY'S DIRECT FOREIGN INVESTMENT ATTRACTION STRATEGY**
Assoc. Prof. Dr. Muhammed Felat AKTAN	Dicle University	**A VICTORY BOOK IN VERSE DEDICATED BY SEYYID BURHANEDDIN BELHI TO MUSTAFA KEMAL PASHA**
Assoc. Prof. Dr. Muhammed Felat AKTAN	Dicle University	**A LETTER IN VERSE HIDDEN IN THE "DEFTER-I KUYUDAT"**
Onur YANAR Assoc. Prof. Dr. Hicran Özlem ILGIN	Çanakkale Onsekiz Mart University	**THE DEVELOPMENT OF DIGITAL ENTREPRENEURSHIP LITERATURE IN TÜRKIYE: AN EVALUATION BASED ON GRADUATE THESES**
Asena ÇİÇEK Tolga AKCAN	Dokuz Eylül University Dokuz Eylül University	**THE IMPACT OF DISASTERS ON THE GASTRONOMY SECTOR: A REVIEW**
Bahar KARAMAN Tolga AKCAN	Dokuz Eylül University Dokuz Eylül University	**COLLAGEN AS A FUNCTIONAL COMPONENT: ITS ROLE IN GASTRONOMY AND APPLICATION POTENTIAL**

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Paris Local Time: 12.30-14:00 Ankara Local Time: 14.30-16.00

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HEAD OF SESSION: Prof. Dr. Kemal Macit Hisar

Authors	Affiliation	Presentation Title
Prof. Dr. Kemal Macit Hisar Prof. Dr. Filiz Hisar	Selcuk University Necmettin Erbakan University	**CANCER EPIDEMIOLOGY IN TÜRKIYE**
Prof. Dr. Kemal Macit Hisar Prof. Dr. Filiz Hisar	Selcuk University Necmettin Erbakan University	**GLOBAL CANCER EPIDEMIOLOGY**
Yağmur ÖZKAN Çetin YAĞCILAR Assoc. Prof. Dr. Muazzez GÜRGAN ESER	Tekirdag Namık Kemal University Tekirdag Namık Kemal University Tekirdag Namık Kemal University	**DETERMINATION OF CHLOROPHYLL, PIGMENT, AND PROTEIN CONTENTS IN LEMNA MINOR (DUCKWEED) SAMPLES**
Yağmur ÖZKAN Assoc. Prof. Dr. Muazzez GÜRGAN ESER Çetin YAĞCILAR	Tekirdag Namık Kemal University Tekirdag Namık Kemal University Tekirdag Namık Kemal University	**DETERMINATION OF PROTEIN, CHLOROPHYLL, AND CAROTENOID CONTENT IN AZOLLA CAROLINIANA AND ITS BIOTECHNOLOGICAL POTENTIAL**
Nurs. Ferhat AKTUZ Assoc. Prof. Dr. Gönül GÖKÇAY	Kafkas University	**EXAMINATION OF CULTURAL SENSITIVITY AND SOCIAL DEGENERATION IN THE CONTEXT OF PUBLIC HEALTH NURSING**
Nurs. Ferhat AKTUZ Assoc. Prof. Dr. Gönül GÖKÇAY	Kafkas University	**EXAMINATION OF XENOPHOBIA FROM THE PERSPECTIVE OF INTERCULTURAL NURSING**
Res. Assist. Cansu YILDIRIM	Bakırçay University	**ARTIFICIAL INTELLIGENCE APPLICATIONS IN DYSPHAGIA INTERVENTION: BIBLIOMETRIC ANALYSIS**
Res. Assist. Cansu YILDIRIM	Bakırçay University	**AN EXAMINATION OF POSTGRADUATE THESES ON DYSARTHRIA**
Assist. Prof. Dr. Ayça ARSLAN	Izmır Democracy University	**REVEALING URBAN SPATIALITY OF THE ICONIC FANTASTIC LINEAR AXIS BETWEEN THE TRUMPHOLSTERY ARCH OF PARIS AND THE LOUVRE MUSEUM**
Asst. Prof. Dr. E.J.Huseynova SH.İ.Alyzade	Gandja State University	**ETIOLOGY AND PATHOGENESIS OF DIABETES MELLITUS**

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16.12.2025 / ONLINE / SESSION-1 / HALL-15

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HEAD OF SESSION: Asst. Prof. Dr. Elza Bitsadze

Authors	Affiliation	Presentation Title
Adel DELIOU Takieddine Bouklia Samir DJIMLI Mohamed Kemiha Meriem DEHBI Sofiane BOULKROUNE Abdelkader FIDJAH	University of UMSB of Jijel University of UMSB of Jijel University of UMSB of Jijel University of UMSB of Jijel University of Djelfa Center of Research in Mechanics University of Djelfa Algeria	**MECHANICAL BEHAVIOURS OF UNIDIRECTIONNAL COMPOSITES LAMINATED**
Abdelhadi ABBADI Zakaria HABYBELLAH Omar TANANE	Hassan II University of Casablanca. Morocco	**CRIMPING TOOL WEAR AND TEAR ANALYSIS**
Asst. Prof. Dr. Elza Bitsadze	Akaki Tsereteli State University, Georgia,	**IMPLEMENTATION OF ARTIFICIAL INTELLIGENCE IN DATABASE SYSTEMS**
Naiya IMSAR Asst. Prof. Dr. Jitender Kumar Assoc. Prof. Dr. Seema Rathee Resist.Schola Khanak Assoc. Prof. Dr. Laxmi Gupta	IMSAR, MDU, Rohtak IMSAR, MDU, Rohtak MDU, Rohtak MDU, Rohtak MDU, Rohtak	**A COMPREHENSIVE REVIEW OF KEY FACTORS INFLUENCING EMPLOYEE RETENTION**
Gresilda GJOKA Ornela HASRAMA	"Isa Boletini" High School, Vora University of Tirana	**RACING AGAINST THE MACHINE: BRIDGING STUDENTS' SKILLS GAP IN THE DIGITAL ERA**
Aminu Ibrahim Kani	Department of Chemical Sciences North-Eastern University Gombe, Nigeria	**ANTIMICROBIAL ACTIVITY EVALUATION OF Zn(II) AND Cu(II) COMPLEXES WITH SCHIFF BASE; N-SALICYLIDENE-1-NAPHTHYLAMINE**
PhD. Fabian Pjetri Assoc. Prof. Dr. Rezart Dibra	University of Tirana Tirana Business University College TBU	**BANK LOANS, LENDING CONDITIONS AND THE DEVELOPMENT OF SMALL AND MEDIUM-SIZED ENTERPRISES IN ALBANIA: DETERMINING FACTORS, OBSTACLES AND MACROECONOMIC IMPLICATIONS DURING THE PERIOD 2018–2024.**
Major Gheorghe GIURGIU Prof dr med Manole COJOCARU	Deniplant-Aide Sante Medical Center, Romania Titu Maiorescu University	**IMUNIPLANT AND NEUROPOLEN IMPACT ON MICROBIOTE AND METABOLITES IN PARKINSON'SDISEASE**

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16.12.2025 / ONLINE / SESSION-1 / HALL-16

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HEAD OF SESSION: Prof Dr. Manole COJOCARU

Authors	Affiliation	Presentation Title
Gomathy Elumalai MEENATCHI S, DEVADHARAHINIR	Bharath Institute Of Higher Education And Research	**ENERGY METABOLISM IN THE HUMAN BODY BHARATH INSTITUTE OF HIGHER EDUCATION AND RESEARCH**
S.Rubin thara, R.Swathi, E.Praveena,N.Arshad Ahamed,R.SriArasuvasan K.Vaishnavi,k.Dinesh,D.Aravindhan,k.Sandhiya,R.kishore	Faculty of pharmacy,Bharath Faculty of pharmacy,Bharath Faculty of pharmacy,Bharath	**APPLICATION OF BIOMEDICAL ENGINEERING IN PHARMACEUTICAL DRUG DELIVERY SYSTEMS**
Principal Res. Shahriar Hasan Mridha Ratul Assist. Prof. Latifa Sultana K.M. Shakik Ahmed Walid	Jahangirnagar University Southeast University University of Asia Pacific	**TRACING THE MUGHAL ARCHITECTURAL HERITAGE OF THE BIBI MARIAM MOSQUE: AN INTEGRATED ASSESSMENT OF ITS ORIGIN AND TAXONOMY IN NARAYANGANJ, BANGLADESH**
S. Leporale M. Cianfriglia R. Moramarco V. Martini C. Marocco C. Bramucci F. Sestito R.Reda L. Testarelli T. Testori G. Perrotti	Sapienza University of Rome Sapienza University of Rome Sapienza University of Rome Sapienza University of Rome Sapienza University of Rome University of Milan Sapienza University of Rome Sapienza University of Rome Sapienza University of Rome University of Milan Lake Como Istitute	**ATHREE-DIMENSIONAL EPHALOMETRIC APPROACH FOR EVALUATING VERTICAL CRANIOFACIAL MORPHOLOGY**
S. Leporale M. Cianfriglia R. Moramarco V. Martini C. Marocco C. Bramucci F. Sestito R.Reda L. Testarelli T. Testori G. Perrotti	Sapienza University of Rome Sapienza University of Rome Sapienza University of Rome Sapienza University of Rome Sapienza University of Rome University of Milan Sapienza University of Rome Sapienza University of Rome Sapienza University of Rome University of Milan Lake Como Istitute	**REINVENTING ORTHOGNATHIC SURGERY PLANNING — COMPLETELY RADIATION-FREE**
Dr.Sc Agim Berisha	Economic Faculty, Republic of Kosovo.	**PUBLIC SPENDING AND THE IMPORTANCE OF PUBLIC INVESTMENT IN THE ECONOMY: THE CASE OF KOSOVO**
Major Gheorghe GIURGIU Prof Dr. Manole COJOCARU	Deniplant-Aide Sante Medical Center Titu Maiorescu University	**OPTIMIZING OUTCOMES IN PSORIASIS: IMPACT OF DENIPLANT NUTRACEUTICALS**

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HEAD OF SESSION: Ode Onyeche Ann

Authors	Affiliation	Presentation Title
Md. Fahim Shahriar Paris Chakma Sampurna Chakma Nihit Panji Chakma Utsha Chakma Adityo Chakma Gagan Chakma Sun Shine Marma Sabuj Chakma Tamiya Chakma Biplob Tripura	University of Rajshahi University of Rajshahi University of Dhaka University of Rajshahi University of Rajshahi Chittagong University University Of Chittagong Khulna University Jahangirnagar University	**PERCEPTIONS OF THE ENVIRONMENTAL AND ECONOMIC IMPACTS OF INCREASED TOURISM: A SURVEY OF LOCAL RESIDENTS IN RANGAMATI DISTRICT, BANGLADESH**
Ibtissam ELARAAJ Asmae Nakkabi Noureddine EL MOUALIJ Mohammed FAHIM	Faculty of Science Moulay Ismail, MEKNES	**SYNTHESIS, CHARACTERIZATION AND BIOLOGICAL ACTIVITY OF CU(II) AND NI (II) COMPLEXES WITH SCHIFF BASES DERIVED FROM THIOPHENE-2-CARBOXALDEHYDE AND DIAMINOPROPANNE**
Meenatchi.S , Devadharshini.R , Gomathy.E, Keerthana.V, Kishore.R, Swathi.R A. Hari Nandhini	Bharath Institution Of Higher Education	**CONTROLLED RELEASE DRUG DELIVERY SYSTEM: INNOVATION FOR IMPROVED PATIENT COMPLIANCE**
Vandefan James Ode Onyeche Ann	Nigerian Police Force University of Abuja	**SPATIAL AND TEMPORAL PATTERNS OF KIDNAPPING INCIDENTS ALONG THE ABUJA–KADUNA EXPRESSWAY, NIGERIA**
Ode Onyeche Ann Anaga Socchi Otisi Makyur Onyeche Anita	Abuja University National Biotechnology Research Tourism Management Federal University Wukari,	**ASSESSMENT OF HEAVY METAL CONTAMINATION FROM AUTO MECHANIC WORKSHOPS IN ABUJA, NIGERIA**
Ode Onyeche Ann Anaga Socchi Otisi Makyur Onyeche Anita	Abuja University National Biotechnology Research Tourism Management Federal University Wukari	**COMPARATIVE SURVIVAL AND GROWTH PERFORMANCE OF CLARIAS GARIEPINUS AND HETEROBRANCHUS LONGIFILIS HATCHLINGS**
TABTI Senouci BOUCHERDOUD Ahmed, DOUINAT Oukacha BENDJELLOUL Meriem, SEGHIER Abdelkarim, ELANDALOUSSI Elhadj.	University of Relizane University of Relizane University of Relizane University of Relizane University of Relizane. University of Relizane	**DEVELOPMENT AND APPLICATION OF A NEW MATERIAL FOR THE TREATMENT OF PAILMENTS ORGANIQUES**

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HEAD OF SESSION: Assoc. Prof. Dr. Boudhar Abdeslam

Authors	Affiliation	Presentation Title
ABIJITH B LITHESH KANNA R S ADARSH H L K SABARI JEFFRY JACKSON J GOWRI SANKAR V Dr. R. SUBHASHINI Dr. A. VIJAYALAKSHMI	Engineering College Engineering College Engineering College Engineering College Engineering College Engineering College	**POWER BEGINS WITH YOU: THE INDIVIDUAL'S ROLE IN ENERGY CONSERVATION**
YUVADHARANI G VETHIKA J SRIHARSHINI M A SRIMATHI B TAMIL SELVI A SRISAKTHI J Dr. SANTHI M GEORGE Dr. A. VIJAYALAKSHMI	Engineering College Engineering College Engineering College Engineering College Engineering College	**NANOTECHNOLOGY: THE TINY TOOL RESHAPING GLOBAL ENERGY SAVINGS**
SENHAJ Zakaria Assoc. Prof. Dr. BOUDHAR Abdeslam Co-Assoc. Prof. Dr. OUDGOU Mohamed	Slimane University Slimane University Slimane University	**DIGITAL GOVERNANCE AND THE MODERNIZATION OF DIRECT SOCIAL ASSİSTANCE IN MOROCCO: ASSESSİNG TARGETİNG, TRANSPARENCY, AND SOCIAL INCLUSİON**
Aminu Ibrahim Bello Asma'u Anas Tukur Usman Sama'ila	Umaru Musa Yaradua University Umaru Musa Yaradua University Umaru Musa Yaradua University	**EVALUATION OF THE ANTIMICROBIAL ACTIVITY OF GARLIC (ALLIUM SATIVUM) AGAINST ORAL PATHOGENS ASSOCIATED WITH CARDIOVASCULAR RISK**
Prof. Dr. Elena VASQUEZ	Harvard University	**THE QUANTUM ENTANGLEMENT PARADOX IN MULTI-PARTICLE SYSTEMS: IMPLICATIONS FOR QUANTUM COMPUTING**
Assoc. Prof. Dr. Raj PATEL	Stanford University	**ADVANCEMENTS IN NEURAL NETWORK ARCHITECTURES FOR NATURAL LANGUAGE PROCESSING: A FOCUS ON TRANSFORMER MODELS**

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HEAD OF SESSION: Prof. Dr. Liam O'REİLLY

Authors	Affiliation	Presentation Title
Prof. Dr. Sophia LECLERC	Medical Sciences Division	**GENOMIC EDITING TECHNIQUES FOR COMBATING ANTIBIOTIC-RESISTANT BACTERIA: CRISPR-CAS9 APPLICATIONS**
Dr. Amina Rahman	University of Dhaka	**AI-DRIVEN EPIDEMIOLOGICAL SURVEILLANCE MODELS FOR FLOOD-RELATED DISEASE PREDICTION IN BANGLADESH**
Prof. Dr. Saeed Mehmood	Quaid-i-Azam University	**EVALUATING ETHICAL AI GOVERNANCE MODELS IN PAKISTAN'S DIGITAL PUBLIC SECTOR TRANSFORMATION**
Prof. Dr. Henrik Dahl	University of Gothenburg	**CLIMATE SIMULATION MODELS AND THEIR ROLE IN PREDICTING EXTREME WEATHER PATTERNS**
Dr. Marta Jelinek	Charles University	**ARTIFICIAL INTELLIGENCE IN JUDICIARY: OPPORTUNITIES AND ETHICAL BOUNDARIES**
Prof. Dr. Elena Kovalenko	Taras Shevchenko National University of Kyiv	**QUANTUM-ENHANCED MACHINE LEARNING FOR HIGH-DIMENSIONAL DATA STRUCTURES**
Dr. Isabelle Fournier	Department of Cognitive Neuroscience, Belgium	**NEURAL CORRELATES OF HUMAN–AI SOCIAL INTERACTION**
Prof. Dr. Alexei Volkov	University of Tartu	**POST-QUANTUM ENCRYPTION AND THE FUTURE OF DATA SECURITY** ,
Dr. Nora Schneider	University of Vienna	**PRESERVING CULTURAL MEMORY THROUGH AI-BASED DIGITAL ARCHIVING** ,

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16.12.2025 / ONLINE / SESSION-2 / HALL-2

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HEAD OF SESSION: Prof. Dr. Lorenzo Armani

Authors	Affiliation	Presentation Title
Prof. Dr. Miguel Santos	*University of Barcelona*	**AI-DRIVEN ECONOMIC FORECASTING IN POST-CRISIS EUROPEAN MARKETS**
Dr. Emilia Novak	Charles University	**DIGITAL PUBLIC HEALTH SURVEILLANCE AND AI-BASED PREDICTIVE EPIDEMIOLOGY: A NEW PARADIGM IN DISEASE PREVENTION**
Prof. Dr. Lorenzo Armani	University of Milan	**NEUROMARKETING AND PREDICTIVE CONSUMER ANALYTICS: THE FUTURE OF DIGITAL BRANDING STRATEGIES**
Dr. Sofia Lindgren	Lund University	**HYDROGEN ECONOMY AND RENEWABLE INTEGRATION: EVALUATING FEASIBILITY FOR A CARBON-NEUTRAL EUROPE**
Dr. Elias Weber	Technical University of Munich	**HUMAN–ROBOT COLLABORATION IN MANUFACTURING: ETHICAL AND OPERATIONAL IMPLICATIONS IN INDUSTRY 5.0**
Prof. Dr. Clara Jensen	University of Copenhagen	**COGNITIVE ADAPTATION AND DIGITAL LEARNING: HOW AI-BASED PERSONALIZATION SHAPES STUDENT MOTIVATION**

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HEAD OF SESSION: Prof. Dr. Isabella Ruiz

Authors	Affiliation	Presentation Title
Prof. Dr. Anna Kowalska	Jagiellonian University	**LANGUAGE EVOLUTION IN THE AGE OF AI: HOW GENERATIVE SYSTEMS RESHAPE HUMAN COMMUNICATION**
Prof. Dr. Isabella Ruiz	Universidad Autónoma de Madrid	**DIGITAL IDENTITY CONSTRUCTION IN THE POST-SOCIAL MEDIA ERA: FROM AUTHENTIC INTERACTION TO ALGORITHMIC SELF-REPRESENTATION**
Dr. Ágnes Farkas	Eötvös Loránd University	**NEUROPLASTICITY AND MEMORY TRAINING: EVALUATING COGNITIVE ENHANCEMENT THROUGH DIGITAL NEUROFEEDBACK SYSTEMS**
Dr. Ayumi Nakamura	Kyoto University	**AI-ENHANCED NEURAL RECONSTRUCTION: A HYBRID DEEP LEARNING AND BIO-TISSUE ENGINEERING MODEL FOR NEURODEGENERATIVE REPAIR**
Prof. Dr. Chen Wei	Tsinghua University	**AUTONOMOUS URBAN MOBILITY: ETHICAL AND TECHNICAL FRAMEWORKS FOR AI-DRIVEN SMART COMPACT CITIES**
Dr. Farah Al-Saadi	King Saud University	**DIGITAL IDENTITY FORMATION AMONG GEN-Z IN THE MIDDLE EAST: A CROSS-PLATFORM SOCIOLINGUISTIC AND BEHAVIORAL ANALYSIS**
Assoc. Prof. Dr. Ravi Prakash	Indian Institute of Technology Bombay	**MACHINE LEARNING-ASSISTED CLIMATE PREDICTION AND WATER SECURITY STRATEGY FOR SOUTH ASIA**

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HEAD OF SESSION: Assoc. Prof. Vikram Patel

Authors	Affiliation	Presentation Title
Nurul Hidayah	University of Malaya	**IMMERSIVE LEARNING AND COGNITIVE RETENTION: EVALUATING VR-ASSISTED LEARNING MODELS IN HIGHER EDUCATIONPROF.**
Dr. Meera Vishwanath	Indian Institute of Science	**HYBRID FEDERATED LEARNING MODELS FOR PRIVACY-PRESERVING HEALTHCARE DATA SYSTEMS IN DEVELOPING NATIONS**
Prof. Dr. Arjun Bhattacharya	University of Faculty of Social Sciences,Delhı	**DIGITAL FINANCIAL INCLUSION AND BEHAVIORAL ECONOMICS: A STUDY ON INDIA'S UPI ECOSYSTEM AND CONSUMER TRUST**
Dr. Kavita Rao	Banaras Hindu University	**CRISPR-CAS-BASED DIAGNOSTIC PLATFORMS FOR RAPID DETECTION OF ANTIMICROBIAL RESISTANCE IN LOW-RESOURCE SETTINGSDR. KAVITA RAO**
Prof. Dr. Anirudh Sharma	Jawaharlal Nehru University (JNU	**ARTIFICIAL INTELLIGENCE AND DIGITAL SOVEREIGNTY: POLICY TENSIONS IN INDIA'S EVOLVING CYBER GOVERNANCE LANDSCAPE**
Dr. Ishita Mathur	University of Hyderabad	**SINGLE-CELL TRANSCRIPTOMICS FOR MAPPING CELLULAR PLASTICITY IN TRIPLE-NEGATIVE BREAST CANCER AMONG INDIAN POPULATIONS**
Assoc. Prof. Vikram Patel	Indian Institute of Technology Kanpur	**DESIGNING INCLUSIVE AI-ASSISTED INTERFACES FOR USERS WITH MOTOR AND COGNITIVE DISABILITIES IN INDIA**
Dr. Priya S. Narayanan	Amrita Vishwa Vidyapeetham	**IMPACT OF INDIAN OCEAN WARMING ON CORAL MICROBIOME STABILITY AND REEF HEALTH ALONG THE LAKSHADWEEP ARCHIPELAGO**

(All speakers required to be connected to the session 10 min before the session starts)
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HEAD OF SESSION: Prof. Dr. Ahmad Obeidat

Authors	Affiliation	Presentation Title
Prof. Dr. Deepak R. Kulkarni	Savitribai Phule Pune University	**GAMIFIED LEARNING ECOSYSTEMS AND METACOGNITIVE DEVELOPMENT: EVIDENCE FROM INDIAN HIGHER EDUCATION CLASSROOMS**
Prof. Dr. Samira Al-Haddad	United Arab Emirates	**POST-QUANTUM CRYPTOGRAPHY MODELS FOR SECURING NATIONAL DIGITAL INFRASTRUCTURE IN THE MIDDLE EAST**
Dr. Youssef Hassan	Cairo University	**PHARMACOGENOMICS AND PERSONALIZED DRUG RESPONSE PATTERNS AMONG NORTH AFRICAN POPULATIONS: A CASE STUDY OF CARDIOVASCULAR MEDICATIONS**
Dr. Reem Al-Sayegh	King Abdulaziz University	**METAVERSE-BASED LEARNING ENVIRONMENTS AND CULTURAL ADAPTATION IN HIGHER EDUCATION CLASSROOMS ACROSS THE GULF REGION**
Prof. Dr. Ahmad Obeidat	Jordan, University of Jordan	**AI-DRIVEN EPIDEMIOLOGICAL FORECASTING MODELS FOR VECTOR-BORNE DISEASES UNDER CLIMATE CHANGE CONDITIONS IN THE MIDDLE EAST**
Dr. Fatima Ben-Rahman	Morocco Mohammed V University	**DIGITAL FEMINISM AND SOCIAL TRANSFORMATION: ONLINE ADVOCACY MOVEMENTS AMONG YOUNG WOMEN IN NORTH AFRICA**
Dr. Samira Al-Hassan	University of Jordan	**ETHICAL CHALLENGES AND GOVERNANCE MODELS IN MACHINE LEARNING DEPLOYMENT FOR PUBLIC ADMINISTRATION IN THE MIDDLE EAST**

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HEAD OF SESSION: Prof. Dr. James Okoro

Authors	Affiliation	Presentation Title
Prof. Dr. Ahmed Al-Rashid	King Saud University	**DIGITAL HEALTH TRANSFORMATION AND AI-DRIVEN EPIDEMIOLOGICAL MODELING DURING POST-PANDEMIC HEALTH REFORM IN SAUDI ARABIA**
Dr. Layla Ibrahim	United Arab Emirates University	**METAVERSE-BASED LEARNING ENVIRONMENTS: OPPORTUNITIES AND RISKS FOR HIGHER EDUCATION IN THE UAE**
Prof. Dr. Youssef El-Karim	Cairo University	**OPTIMIZATION OF LARGE-SCALE SOLAR ENERGY INTEGRATION IN URBAN CAIRO: A SMART GRID SIMULATIONSTUDY**
Dr. Rana Habib	American University of Beirut	**DIGITAL MIGRATION NETWORKS AND ONLINE IDENTITY RECONSTRUCTION AMONG MIDDLE EASTERN DIASPORA COMMUNITIES**
Dr. Amina NDLOVU	University of Cape Town	**AI-POWERED DIAGNOSTIC IMAGING FOR EARLY DETECTION OF TUBERCULOSIS IN SUB-SAHARAN AFRICADR. AMINA NDLOVU**
Prof. Dr. James Okoro	University of Lagos	**BLOCKCHAIN-BASED IDENTITY SYSTEMS FOR STRENGTHENING DIGITAL GOVERNANCE IN NIGERIAPROF**
Dr. Mariam Diallo	Cheikh Anta Diop University	**CLIMATE-SMART AGRICULTURE AND MACHINE-LEARNING-BASED CROP PREDICTION MODELS IN WEST AFRICA**
Prof. Dr. Hassan El-Basha	Alexandria University	**SUSTAINABLE SMART CITY PLANNING FOR RAPIDLY GROWING AFRICAN URBAN CENTERS**
Dr. Zawadi Tembo	University of Nairobi	**AI-SUPPORTED WILDLIFE MONITORING SYSTEMS FOR ENDANGERED SPECIES PROTECTION IN EAST AFRICA**

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HEAD OF SESSION: Prof. Dr. Imran Khalid

Authors	Affiliation	Presentation Title
Dr. Fatoumata Kamara	University of Bamako	**WOMEN'S DIGITAL ENTREPRENEURSHIP AND SOCIOECONOMIC EMPOWERMENT IN RURAL MALI**
Prof. Dr. Elias Matombo	University of Dar es Salaam	**CORAL REEF RESTORATION AND AI-ASSISTED MARINE HABITAT ASSESSMENT IN THE WESTERN INDIAN OCEAN**
Dr. Selam Desta	Addis Ababa University	**DIGITAL ARCHIVING OF ENDANGERED INDIGENOUS LANGUAGES IN ETHIOPIA USING NLP MODELS**
Prof. Dr. Thabo Mensah	University of Ghana	**FINTECH INNOVATION AND FINANCIAL INCLUSION TRENDS IN POST-COVID GHANAIAN MARKET**
Dr. Yasmin Ben Youssef	Hassan II University of Casablanca	**GAMIFICATION AND CULTURAL ADAPTATION IN DIGITAL LEARNING PLATFORMS FOR MOROCCAN SECONDARY SCHOOLS**
Dr. Ayesha Siddiqui	University of Punjab	**DIGITAL THERAPY ADOPTION AND MENTAL HEALTH AWARENESS AMONG UNIVERSITY STUDENTS IN PAKISTAN**
Prof. Dr. Imran Khalid	Quaid-i-Azam University	**ASSESSING AIR POLLUTION TRENDS IN URBAN PAKISTAN USING AI-BASED FORECASTING MODELS**
Prof. Dr. Muhammad Zubair	National University of Sciences and Technology (NUST)	**AUTONOMOUS DRONE SYSTEMS FOR DISASTER MANAGEMENT AND FLOOD MONITORING IN PAKISTAN**

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HEAD OF SESSION: Prof. Dr. Faisal Mahmood

Authors	Affiliation	Presentation Title
Dr. Sara Khan	Lahore University of Management Sciences (LUMS	**STARTUP ECOSYSTEM GROWTH AND DIGITAL BUSINESS MODELS AMONG PAKISTANI YOUTH ENTREPRENEURS**
Dr. Adeel Rehman	University of Karachi,	**BLENDED LEARNING MODELS AND STUDENT ENGAGEMENT IN PAKISTANI HIGHER EDUCATION**
Prof. Dr. Bilal Qureshi	National University of Sciences and Technology (NUST)	**ENHANCING NATIONAL CYBERSECURITY RESILIENCE THROUGH AI-DRIVEN THREAT DETECTION IN PAKISTAN**
Dr. Nadia Ali	University of Agriculture Faisalabad	**MACHINE LEARNING FOR OPTIMIZING CROP YIELD AND PEST MANAGEMENT IN PUNJAB, PAKISTAN**
Prof. Dr. Faisal Mahmood	Aga Khan University	**TELEMEDICINE ADOPTION AND HEALTHCARE ACCESS IN RURAL PAKISTAN: AN AI-ENABLED APPROACH**
Dr. Mariam Shah	Lahore University of Management Sciences (LUMS)	**SMART GRID AND RENEWABLE ENERGY INTEGRATION FOR URBAN PAKISTAN: AI-ENHANCED ENERGY MANAGEMENT**
Prof. Elena Kovacevic	University of Belgrade	**ARTIFICIAL INTELLIGENCE ADOPTION IN BALKAN SMES: BARRIERS, READINESS, AND STRATEGIC OUTCOMES**
Dr. Dimitra Papadopoulos	Aristotle University of Thessaloniki	**AI-SUPPORTED PEDAGOGICAL MODELS IN HIGHER EDUCATION: A COMPARATIVE STUDY IN GREEK UNIVERSITIES**

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HEAD OF SESSION: Assoc. Prof. Dr. Florina Matei

Authors	Affiliation	Presentation Title
Dr. Ana Petrovic	University of Zagreb	AI-**BASED DIAGNOSTIC IMAGING: EVALUATION OF CLINICAL ACCURACY AND WORKFLOW EFFICIENCY IN CROATIAN HOSPITALS**
Prof. Dr. Valeriya Petrov	Sofia University	**CONSUMER TRUST AND EMOTIONAL RESPONSE TO AI-GENERATED ADVERTISING IN THE BALKAN DIGİTAL MARKETPLACE**
Dr. Nermin Hadžić	University of Sarajevo	**THE ROLE OF ARTIFICIAL INTELLIGENCE IN POST-CONFLICT RECONCILIATION AND CULTURAL MEMORY PRESERVATION IN THE WESTERN BALKANS**
Prof. Dr. Tamara Ilievski	Ss. Cyril and Methodius University	**HUMAN-CENTERED ARTIFICIAL INTELLIGENCE FOR SMART CITY DEVELOPMENT: A CASE STUDY OF SKOPJE**
Assoc. Prof. Dr. Florina Matei	University of Buchares	**COGNITIVE EFFECTS OF AI-ASSISTED LEARNING PLATFORMS ON UNIVERSITY STUDENTS: A LONGITUDINAL STUDY**
Dr. Farid Sultani	Kabul University	**MACHINE LEARNING APPLICATIONS FOR EARTHQUAKE-RESILIENT URBAN PLANNING IN POST-CONFLICT AFGHANISTAN**
Dr. Luka Dragićević	University of Montenegro	**AI INTEGRATION IN RENEWABLE ENERGY FORECASTING AND GRID OPTIMIZATION IN MONTENEGRO**

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HEAD OF SESSION: Assoc. Prof. Dr. Nihan ÖKSÜZ NARİNÇ

Authors	Affiliation	Presentation Title
Assoc. Prof. Dr. Nihan ÖKSÜZ NARİNÇ Dr. Nilgün YAPICI	Akdeniz University Akdeniz University	**BLACK SOLDIER FLY–BASED PROTEIN FOR SOYBEAN SUBSTITUTION: ECONOMIC AND ENVIRONMENTAL OUTCOMES AND MULTI-YEAR SCENARIO ANALYSIS FOR TÜRKIYE**
Assoc. Prof. Dr. Nihan ÖKSÜZ NARİNÇ Dr. Nilgün YAPICI	Akdeniz University Akdeniz University	**SOYBEAN IN POULTRY FEED: GLOBAL DEPENDENCE, ECONOMIC DYNAMICS, AND STRATEGIC SOLUTIONS FOR TÜRKIYE**
Dr. Nilgün YAPICI Assoc. Prof. Dr. Nihan ÖKSÜZ NARİNÇ	Akdeniz University Akdeniz University	**THE CLIMATE CRISIS AND THE SEARCH FOR SUSTAINABLE FEED: ENVIRONMENTAL AND NUTRITIONAL EVALUATION OF BLACK SOLDIER FLY (Hermetia illucens) LARVAE**
Ahmet CEYHAN Samet Can SÖNMEZ Dr. Nilgün YAPICI Prof. Dr. Doğan NARİNÇ	Akdeniz University Akdeniz University Akdeniz University Akdeniz University	**FEAR-BASED VOCALISATION RESPONSES IN RED-LEGGED PARTRIDGES DEPENDING ON DIFFERENT SOCIAL AND ENVIRONMENTAL CONDITIONS**
Umut ÇİL	Karamanoglu Mehmetbey University	**THE STRATEGIC STRUCTURE OF OPEN-SOURCE INNOVATION ECOSYSTEMS: NETWORK AND TOPIC MODELING ANALYSIS OF POPULAR AI/ML PROJECTS ON GITHUB**
Umut ÇİL	Karamanoglu Mehmetbey University	**DIGITAL PLATFORM CAPITALISM AND INNOVATION: VALUE CREATION AND EXPLOITATION FROM A CRITICAL PERSPECTIVE**
Lect. Dr. Hasan ERYÜRÜK	Afyon Kocatepe University	**BRAZIL'S ECOLOGICAL CAPITAL: INTEGRATION OF THE RIT SYSTEM, ECOLOGY and SOCIAL POLICY IN THE CURITIBA MODEL**
Lect. Dr. Hasan ERYÜRÜK	Afyon Kocatepe University	**SOCIAL URBANISM IN MEDELLÍN: INTEGRATED URBAN PROJECTS and NATURE-BASED SOLUTIONS**
Prof. Dr. Bedriye TUNÇSİPER Prof..Dr. Dilek SÜREKÇİ YAMAÇLI	Izmir Democracy University Izmir Democracy University	**FRAGILE BALANCES: EVIDENCE OF THE BUDGET DEFICIT-CURRENT ACCOUNT DEFICIT INTERACTION IN TURKEY (2010-2025)**

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HEAD OF SESSION: Assist. Prof. Dr. Zeynep KEMALOĞLU

Authors	Affiliation	Presentation Title
Leyla KESKİN	Artuklu Universty	**THE LOST CYCLE OF THE TIGRIS: ECOLOGICAL MOURNING THROUGH A MYTHOLOGICAL LENS**
Assist. Prof. Dr. Zeynep KEMALOĞLU	Ordu University	**EVALUATION OF 19TH- AND 20TH-CENTURY OTTOMAN COINS IN TERMS OF THEIR COMPOSITIONAL FEATURES (AT THE AMASYA MUSEUM SCALE)**
Assist. Prof. Dr. Zeynep KEMALOĞLU	Ordu University	**AMASYA BAYEZID PASA MOSQUE MIHRAB DECORATION PROGRAM**
Gülçin SAĞIR KESKİN	Ankara Üniversitesi,	**LIVES GOVERNED BY DEATH: ISRAEL'S REGIME OF EXCEPTION AND PALESTINE'S SUMUD RESISTANCE**
Suna Utar Özkan M.A. Ramazan Bulut Prof. Dr. Sevilay Şahin	Gaziantep Islam Science & Technology University Gaziantep University Gaziantep University	**ASSESSING THE IMPACT OF A GROUP GUIDANCE PROGRAM ON REDUCING DIGITAL ADDICTION AND CYBERBULLYING IN PRIMARY SCHOOL STUDENTS**
Res. Asst. Elif BİLGE	Marmara University	**THE TRANSFORMATION OF RELIGIOUS DISCOURSE IN REPUBLIC DAY SERMONS: A THEMATIC ANALYSIS IN THE CONTEXT OF NON-FORMAL RELIGIOUS EDUCATION**
Umid QURBANOV	Ministry of Science and Education of the Republic of Azerbaijan	**THE IMPACT OF THE GREEN ECONOMY ON THE LABOR SECTOR**
Büşra Sümeyye HANÖZÜ Prof. Dr. Orhan KARAMUSTAFAOĞLU	Amasya University Amasya University	**AN EDUCATIONAL GAME DESIGN FOR TEACHING THE TOPIC OF 'COMPARISON SPEED AND VELOCITY'**

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HEAD OF SESSION: Asst. Prof. Dr. Murat KOCA

Authors	Affiliation	Presentation Title
Asst. Prof. Dr. Serap ÖZHAN DOĞAN Hakan AVCI Burak Galip ANIK Umut GÖKTAŞ	İstanbul Beykent University R&D Department of Tersan Shipyard R&D Department of Tersan Shipyard R&D Department of Tersan Shipyard	**STRUCTURAL PERFORMANCE OF A 40-TON TRAVERSE: STATIC ANALYSIS RESULTS AND SAFETY ASSESSMENT**
Asst. Prof. Dr. Serap ÖZHAN DOĞAN Yusuf Ziya KOÇ Ahmet KARATAŞ	İstanbul Beykent University R&D Department of Tersan Shipyard R&D Department of Tersan Shipyard	**SAFE DRIVING IN LOGISTICS AND THE DESIGN OF A GPS-BASED RISK-ORIENTED WARNING SYSTEM**
Gyokhan Ulusoy Hüseyin GARİP Koray KAHVECİOGLU Res. Assist. Dr. Hasan Yavuz ÜNAL	Ege University Ege University Ege University Ege University	**RECENT APPROACHES IN SINGLE-LAP JOINTS: A SHORT REVIEW**
Maryam RAHIMZADEH Asst. Prof. Dr. Murat KOCA	Yüzüncü Yıl University Yüzüncü Yıl University	**REAL-WORLD APPLICATIONS AND SCALABILITY OF AI-ASSISTED AND TRADITIONAL CI/CD PIPELINE SECURITY PRACTICES**
Asst. Prof. Dr. Murat KOCA	Yüzüncü Yıl University	**CYBERSECURITY AND CYBER RISKS IN MARITIME TRANSPORT: INTERNATIONAL LEGAL FRAMEWORK, REGULATORY APPROACHES, AND PERSONNEL TRAINING**
Asst. Prof. Dr. Buket TOPTAŞ Şefiye ARICAN Asst. Prof. Dr. Sultan Deniz ALTINDAĞ Asst. Prof. Dr. Murat TOPTAŞ Prof. Dr. Davut HANBAY	Bandırma Onyedi Eylül University Bandırma Onyedi Eylül University Bandırma Onyedi Eylül University Bandırma Onyedi Eylül University Inonu University	**SELF-SUPERVISED LEARNING STRATEGIES FOR ACUTE LYMPHOBLASTIC LEUKEMIA DETECTION WITH LIMITED DATA**
Melek GÜNER Assoc. Prof. Dr. Betül ÇİÇEK ÖZKAN	Batman University Fırat University	**STRUCTURAL AND BIODEGRADABILITY PROPERTIES OF KERATIN-CHITOSAN NANOCOMPOSITES PRODUCED BY SOLUTION CASTING METHOD**
Assoc. Prof. Dr. Gulnar GURBANOVA Assoc. Prof. Dr. Aytakin AFANDİYEVA Seljan GULUZADE Qumru MİKAYİLOVA Gulay YUSİFLİ	Azerbaijan University of Architecture and Construction Azerbaijan University of Architecture and Construction Azerbaijan University of Architecture and Construction Azerbaijan University of Economics Azerbaijan University	**IMPLEMENTATION OF NETWORK ATTACK INTRUSION DETECTION USING GAN (GENERATIVE ADVERSARIAL NETWORKS)**

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HEAD OF SESSION: Assoc. Prof. Dr. Mücella ÖZBAY KARAKUŞ

Authors	Affiliation	Presentation Title
Hossein NAZRAVAN Prof. Dr. Filiz GÜNEŞ Assoc. Prof. Dr. Peyman MAHOUTİ	Yildiz Technical University Kırklareli University Yildiz Technical University	**DESIGN OPTIMIZATION OF DIPOLE ANTENNA ARRAYS USING THE WHALE OPTIMIZATION ALGORITHM**
Assoc. Prof. Dr. Mücella ÖZBAY KARAKUŞ	Izmir Bakirçay University	**EVALUATION OF THE IMPACT OF BORON DOPING ON THE LATTICE STRUCTURE AND OPTICAL PROPERTIES OF TIO_2 NANOSTRUCTURES**
Assoc. Prof. Dr. Mücella ÖZBAY KARAKUŞ	Izmir Bakirçay University	**LASER-INDUCED GRAPHENE AS A TEMPLATE FOR VERTICALLY ALIGNED ZNO NANOROD GROWTH: STRUCTURAL AND MORPHOLOGICAL CHARACTERIZATION**
Necati Erdem TUĞRAHAN Prof. Dr. Aydoğan ÖZDAMAR	Ege University Ege University	**ORGANIC RANKINE CYCLE AND WORKING FLUID PERFORMANCE ANALYSIS FOR A GLASS MELTING FURNACE**
Melek ALTAY Berat Fırat DALĞIÇ	Koluman Otomotiv Koluman Otomotiv	**EXAMINATION OF ARMOR STEEL MANUFACTURING PROCESSES**
Assist. Prof. Dr .Kevser ÖZYAŞAR Prof. Dr. İsmail BAKAN	Kahramanmaraş Sütçü İmam University Kahramanmaraş Sütçü İmam University	**UTILIZING INTERNAL CONTRAST FOR EFFECTIVE INNOVATION: DIVERSITY AND INCLUSION**
Aleyna Marul Prof. Dr. Jale Yılmazkaya Süngü	Kocaeli University Kocaeli University	**"TWO-POINT QCD SUM RULE ANALYSIS OF THE T_cc (3875)^+ STATE AS A HADRONIC MOLECULE"**
Asst. Prof. Dr. Osman YİĞİD	Bitlis Eren University	**NUMERICAL MODAL ANALYSIS OF CARBONFIBER BICYCLE FRAME REINFORCED WITH POLYURETHANE FOAM**
Afag NURULLAYEVA Jala TARVERDIYEVA	Ministry of Science and Education of the Republic of Azerbaijan Ministry of Science and Education of the Republic of Azerbaijan	**CRMP-2-DRIVEN RADIO-PROTECTION THROUGH SEROTONERGIC ACTIVATION**

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16.12.2025 / ONLINE / SESSION-1 / HALL-10

Paris Local Time: 12.00-13:30 Ankara Local Time: 14.00-15:30

Zoom Meeting ID: *325 629 5864* / Zoom Passcode: meetcon

HEAD OF SESSION: Assoc. Prof. Dr. Javid Ismayilov

Authors	Affiliation	Presentation Title
Assoc. Prof. Dr. Esin SEZGİN Assoc. Prof. Dr. Gülhan GÜVEN Sude Özdemir	Afyon Kocatepe University Gazi University Afyon Kocatepe University	**LEVELS OF FATHERS' PARTICIPATION IN CHILD CARE**
Asst. Prof. Dr. Nihal ŞEN Fatma AKBULUT Selma ÇİÇEK	Harran University Harran University Harran University	**A MECHANICAL STEP, A HUMAN TOUCH: THE JOURNEY OF ROBOTS IN SPECIAL EDUCATION**
Asst. Prof. Dr. Nihal ŞEN Ayşe DOĞRAMACIOĞLU	Harran University Harran University	**EXAMINING THE TRANSFORMATIVE ROLE OF METAVERSE TECHNOLOGY IN SPECIAL EDUCATION**
Akbarova Nurida Yashar Kasimbeyli Minaver Yusif Hasanli Asmar Bahram Ismayilova Zumrud Sabuhi	Nakhchivan State University Nakhchivan State University Nakhchivan State University Nakhchivan State University	**STUDY OF THE EFFECT OF COPPER DIFFUSION AND PHOTOSTIMULATION ON CONTACT AND PHOTOELECTRIC PROPERTIES IN CDS SEMICONDUCTORS**
Ceyda CEYLAN Prof. Dr. Gülay EKİCİ	Gazi University Balıkesir University	**PARALLEL CURRICULUM MODEL: A METHODOLOGICAL COMPARATIVE ANALYSIS BASED ON THREE DOCTORAL THESES**
Prof. Dr. Gülay EKİCİ Ceyda CEYLAN	Balıkesir University Gazi University	**WHAT IS DIGITAL WISDOM? PRACTICAL SUGGESTIONS: AN ANALYSIS STUDY**
Asst. Prof. Dr. Zeynep BÜYÜKSARAÇ	Bolu Abant İzzet Baysal University	**LES OPINIONS DES ENSEIGNANTS SUR LE DÉVELOPPEMENT DE LA COMPRÉHENSION ÉCRITE CHEZ LES APPRENANTS DU FLE**
Yasin SÖNMEZ	Çukurova University	**LA RESTRICTION DE LA VOIE DU CONTRÔLE JURIDICTIONNEL CONTRE LES ACTES ADMINISTRATIFS DANS LE DROIT DU CONTENTIEUX ADMINISTRATIF TURC**
Assoc. Prof. Dr. Javid Ismayilov	Nakhchivan State University	**REINTERPRETING THE CONCEPT OF CLASSICAL ART IN THE CONTEXT OF POSTMODERNISM**

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16.12.2025 / ONLINE / SESSION-1 / HALL-11

Paris Local Time: 12.00-13:30 Ankara Local Time: 14.00-15:30

Zoom Meeting ID: *325 629 5864* / Zoom Passcode: meetcon

HEAD OF SESSION: Assoc. Prof. Dr. Hacer AKER

Authors	Affiliation	Presentation Title
Asst. Prof. Dr. Çağlayan DOĞAN	Gümüşhane University	**FRAGMENTED SUBJECTIVITY AND POSTDRAMATIC IDENTITY IN MARTIN CRIMP'S IN THE REPUBLIC OF HAPPINESS**
Dr. Ersoy Yılmaz DİNİZ Dilara Cansın KEÇİALAN	Taras Shevchenko National University of Kyiv	**NATIONAL STRATEGIES FOR PREVENTING RADICALIZATION: THE BALANCE BETWEEN HUMAN RIGHTS AND SECURITY IN CENTRAL ASIA**
Lect. Hatice Tuğba AKDOĞAR AKBULUT	Recep Tayyip Erdoğan University	**THE INSCRIPTION OF MATARACI ZADE HACI MUSTAFA EFENDI DATED H. 1304 / AD 1886 IN RIZE AND THE TRACES TRANSFORMED INTO A LOST FOUNTAIN OF A LOST WATERWAY**
Assoc. Prof. Dr. Hacer AKER	Selcuk University	**REINTEGRATION THROUGH EDUCATION: SOCIAL ADAPTATION PROCESSES OF INCARCERATED STUDENTS AT SELÇUK UNIVERSITY**
Assoc. Prof. Dr. Hacer AKER	Selcuk University	**PIOUS WOMEN'S PERFORMATIVE RELIGIOSITY AND THEIR PATHS TO DISAFFILIATION**
Assoc. Prof. Dr. Hüsrev TABAK	Recep Tayyip Erdoğan Üniversitesi	**DISCREDITING THE UN'S WORK ON PALESTINE: ACTORS, NARRATIVES, AND IMPLICATIONS**
Assoc. Prof. Dr. Hüsrev TABAK	Recep Tayyip Erdoğan Üniversitesi	**POPULISM, ANTI-GLOBALISM AND THE FUTURE OF GLOBAL GOVERNANCE**
Asst. Prof. Dr. Yasin AVCI	Bandırma Onyedi Eylul University	**COMPARATIVE ANALYSIS OF AI AND STUDENT PRODUCTIONS IN TYPOGRAPHIC POSTERS DESIGNED FOR THE DISABILITY AWARENESS WEEK**
Elxan ZEYNALOV	Nakhchivan State University	**MONUMENTAL HEYKƏLDƏ FORMA VƏ MƏKAN MÜNASIBƏTLƏRI**

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16.12.2025 / ONLINE / SESSION-1 / HALL-12

Paris Local Time: 12.30-14:00 Ankara Local Time: 14.30-16.00

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HEAD OF SESSION: Prof. Dr. Şermin TAĞ KALAFATOĞLU

Authors	Affiliation	Presentation Title
Assoc. Prof. Dr. Metin KETBOĞA	Malatya Turgut Özal University	**AN ASSESSMENT OF THE RESURGENCE OF PROTECTIONIST POLICIES IN INTERNATIONAL TRADE**
Assoc. Prof. Dr. Metin KETBOĞA	Malatya Turgut Özal University	**COMMON OPERATIONAL ERRORS IN OREIGN TRADE AND THEIR CONSEQUENCES**
Asst. Prof. Dr. Çağla TOPGÜL Tuna Çağlar TOPGÜL	Kafkas University Ministry of Family and Social Services	**THE CITY AS A NARRATIVE SPACE IN CINEMA: THE IMAGE OF KARS – AN ARCHITECTURAL AND SOCIOLOGICAL READING OF THE CHARACTER- SPACE RELATIONSHIP**
Dr.Tuna Çağlar TOPGÜL	Ministry of Family and Social Services	**A SOCIOLOGICAL ANALYSIS OF SPACE, MEMORY, AND IDENTITY BASED ON THE QUESTION "IF YOU COULD REUNITE WITH YOUR CHILDHOOD SELF, WHERE WOULD YOU TAKE THEM FIRST?"**
Prof. Dr. Şermin TAĞ KALAFATOĞLU	Ordu University	**REFLECTIONS OF THIRD CINEMA IN THE DOCUMENTARY FIELD**
Prof. Dr. Şermin TAĞ KALAFATOĞLU	Ordu University	**NARRATIONAL FORMS OF ROCK DOCUMENTARIES**
Dr. Uğur İNAN	Yalova University	**ERNST JÄCKH (1875–1959): A JOURNALİST AND CULTURAL ENVOY AT THE INTERSECTİON OF OTTOMAN MODERNİZATİON AND GERMAN CULTURAL IMPERİALİSM**
Assoc. Prof. Dr. Gülxani (Pənah) Şükürova	Philological Sciences	**THE ROOTS OF WESTERN AZERBAIJAN – GOYCHA ASHIG ART (ANALYSIS AND RESEARCH ON ANCIENT OGHUZ, TURKMEN AND AZERBAIJANI FOLKLORE)**
Hacıyeva Siddiqə Zakir qızı	Nakhchivan State University	**THE APPLICATION OF NATIONAL ORNAMENTAL MOTIFS IN CONTEMPORARY ART**

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16.12.2025 / ONLINE / SESSION-1 / HALL-13

Paris Local Time: 11.00-12:30 Ankara Local Time: 14.30-16.00

Zoom Meeting ID: *325 629 5864* / Zoom Passcode: meetcon

HEAD OF SESSION: Prof. Dr. Osman ÇEPNİ

Authors	Affiliation	Presentation Title
Prof. Dr. Fatih AYDIN Prof. Dr. Osman ÇEPNİ	Karabük Üniversitesi Karabük Üniversitesi	**INTEGRATION OF ARTIFICIAL INTELLIGENCE INTO GEOGRAPHY EDUCATION: A THEORETICAL MODEL PROPOSAL**
Prof. Dr. Fatih AYDIN Prof. Dr. Osman ÇEPNİ	Karabük University Karabük University	**THE NEAR-TO-FAR PRINCIPLE IN GEOGRAPHY TEACHING: THEORETICAL FOUNDATIONS AND INSTRUCTIONAL PRACTICES**
Aleyna Yaren KÜPE Prof. Dr. Elvettin AKMAN	Süleyman Demirel University Süleyman Demirel University	**RESEARCH ON UNIVERSITY STUDENTS' KNOWLEDGE AND AWARENESS LEVELS REGARDING THE PRESIDENTIAL GOVERNMENT SYSTEM**
Sevilcan İNCE Prof. Dr Elvettin AKMAN	Süleyman Demirel University Süleyman Demirel University	**THE INVESTMENT AND FINANCE OFFICE AS A NEW INSTITUTION IN TURKEY'S DIRECT FOREIGN INVESTMENT ATTRACTION STRATEGY**
Assoc. Prof. Dr. Muhammed Felat AKTAN	Dicle University	**A VICTORY BOOK IN VERSE DEDICATED BY SEYYID BURHANEDDIN BELHI TO MUSTAFA KEMAL PASHA**
Assoc. Prof. Dr. Muhammed Felat AKTAN	Dicle University	**A LETTER IN VERSE HIDDEN IN THE "DEFTER-I KUYUDAT"**
Onur YANAR Assoc. Prof. Dr. Hicran Özlem ILGIN	Çanakkale Onsekiz Mart University	**THE DEVELOPMENT OF DIGITAL ENTREPRENEURSHIP LITERATURE IN TÜRKIYE: AN EVALUATION BASED ON GRADUATE THESES**
Asena ÇİÇEK Tolga AKCAN	Dokuz Eylül University Dokuz Eylül University	**THE IMPACT OF DISASTERS ON THE GASTRONOMY SECTOR: A REVIEW**
Bahar KARAMAN Tolga AKCAN	Dokuz Eylül University Dokuz Eylül University	**COLLAGEN AS A FUNCTIONAL COMPONENT: ITS ROLE IN GASTRONOMY AND APPLICATION POTENTIAL**

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16.12.2025 / ONLINE / SESSION-1 / HALL-14

Paris Local Time: 12.30-14:00 Ankara Local Time: 14.30-16.00

Zoom Meeting ID: *325 629 5864*/ Zoom Passcode: meetcon

HEAD OF SESSION: Prof. Dr. Kemal Macit Hisar

Authors	Affiliation	Presentation Title
Prof. Dr. Kemal Macit Hisar Prof. Dr. Filiz Hisar	Selcuk University Necmettin Erbakan University	**CANCER EPIDEMIOLOGY IN TÜRKIYE**
Prof. Dr. Kemal Macit Hisar Prof. Dr. Filiz Hisar	Selcuk University Necmettin Erbakan University	**GLOBAL CANCER EPIDEMIOLOGY**
Yağmur ÖZKAN Çetin YAĞCILAR Assoc. Prof. Dr. Muazzez GÜRGAN ESER	Tekirdag Namık Kemal University Tekirdag Namık Kemal University Tekirdag Namık Kemal University	**DETERMINATION OF CHLOROPHYLL, PIGMENT, AND PROTEIN CONTENTS IN LEMNA MINOR (DUCKWEED) SAMPLES**
Yağmur ÖZKAN Assoc. Prof. Dr. Muazzez GÜRGAN ESER Çetin YAĞCILAR	Tekirdag Namık Kemal University Tekirdag Namık Kemal University Tekirdag Namık Kemal University	**DETERMINATION OF PROTEIN, CHLOROPHYLL, AND CAROTENOID CONTENT IN AZOLLA CAROLINIANA AND ITS BIOTECHNOLOGICAL POTENTIAL**
Nurs. Ferhat AKTUZ Assoc. Prof. Dr. Gönül GÖKÇAY	Kafkas University	**EXAMINATION OF CULTURAL SENSITIVITY AND SOCIAL DEGENERATION IN THE CONTEXT OF PUBLIC HEALTH NURSING**
Nurs. Ferhat AKTUZ Assoc. Prof. Dr. Gönül GÖKÇAY	Kafkas University	**EXAMINATION OF XENOPHOBIA FROM THE PERSPECTIVE OF INTERCULTURAL NURSING**
Res. Assist. Cansu YILDIRIM	Bakırçay University	**ARTIFICIAL INTELLIGENCE APPLICATIONS IN DYSPHAGIA INTERVENTION: BIBLIOMETRIC ANALYSIS**
Res. Assist. Cansu YILDIRIM	Bakırçay University	**AN EXAMINATION OF POSTGRADUATE THESES ON DYSARTHRIA**
Assist. Prof. Dr. Ayça ARSLAN	Izmır Democracy University	**REVEALING URBAN SPATIALITY OF THE ICONIC FANTASTIC LINEAR AXIS BETWEEN THE TRUMPHOLSTERY ARCH OF PARIS AND THE LOUVRE MUSEUM**
Asst. Prof. Dr. E.J.Huseynova SH.İ.Alyzade	Gandja State University	**ETIOLOGY AND PATHOGENESIS OF DIABETES MELLITUS**

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16.12.2025 / ONLINE / SESSION-1 / HALL-15

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HEAD OF SESSION: Asst. Prof. Dr. Elza Bitsadze

Authors	Affiliation	Presentation Title
Adel DELIOU Takieddine Bouklia Samir DJIMLI Mohamed Kemiha Meriem DEHBI Sofiane BOULKROUNE Abdelkader FIDJAH	University of UMSB of Jijel University of UMSB of Jijel University of UMSB of Jijel University of UMSB of Jijel University of Djelfa Center of Research in Mechanics University of Djelfa Algeria	**MECHANICAL BEHAVIOURS OF UNIDIRECTIONNAL COMPOSITES LAMINATED**
Abdelhadi ABBADI Zakaria HABYBELLAH Omar TANANE	Hassan II University of Casablanca. Morocco	**CRIMPING TOOL WEAR AND TEAR ANALYSIS**
Asst. Prof. Dr. Elza Bitsadze	Akaki Tsereteli State University, Georgia,	**IMPLEMENTATION OF ARTIFICIAL INTELLIGENCE IN DATABASE SYSTEMS**
Naiya IMSAR Asst. Prof. Dr. Jitender Kumar Assoc. Prof. Dr. Seema Rathee Resist.Schola Khanak Assoc. Prof. Dr. Laxmi Gupta	IMSAR, MDU, Rohtak IMSAR, MDU, Rohtak MDU, Rohtak MDU, Rohtak MDU, Rohtak	**A COMPREHENSIVE REVIEW OF KEY FACTORS INFLUENCING EMPLOYEE RETENTION**
Gresilda GJOKA Ornela HASRAMA	"Isa Boletini" High School, Vora University of Tirana	**RACING AGAINST THE MACHINE: BRIDGING STUDENTS' SKILLS GAP IN THE DIGITAL ERA**
Aminu Ibrahim Kani	Department of Chemical Sciences North-Eastern University Gombe, Nigeria	**ANTIMICROBIAL ACTIVITY EVALUATION OF Zn(II) AND Cu(II) COMPLEXES WITH SCHIFF BASE; N-SALICYLIDENE-1-NAPHTHYLAMINE**
PhD. Fabian Pjetri Assoc. Prof. Dr. Rezart Dibra	University of Tirana Tirana Business University College TBU	**BANK LOANS, LENDING CONDITIONS AND THE DEVELOPMENT OF SMALL AND MEDIUM-SIZED ENTERPRISES IN ALBANIA: DETERMINING FACTORS, OBSTACLES AND MACROECONOMIC IMPLICATIONS DURING THE PERIOD 2018–2024.**
Major Gheorghe GIURGIU Prof dr med Manole COJOCARU	Deniplant-Aide Sante Medical Center, Romania Titu Maiorescu University	**IMUNIPLANT AND NEUROPOLEN IMPACT ON MICROBIOTE AND METABOLITES IN PARKINSON'SDISEASE**

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16.12.2025 / ONLINE / SESSION-1 / HALL-16

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HEAD OF SESSION: Prof Dr. Manole COJOCARU

Authors	Affiliation	Presentation Title
Gomathy Elumalai MEENATCHI S, DEVADHARAHINIR	Bharath Institute Of Higher Education And Research	**ENERGY METABOLISM IN THE HUMAN BODY BHARATH INSTITUTE OF HIGHER EDUCATION AND RESEARCH**
S.Rubin thara, R.Swathi, E.Praveena,N.Arshad Ahamed,R.SriArasuvasan K.Vaishnavi,k.Dinesh,D.Aravindhan,k.Sandhiya,R.kishore	Faculty of pharmacy,Bharath Faculty of pharmacy,Bharath Faculty of pharmacy,Bharath	**APPLICATION OF BIOMEDICAL ENGINEERING IN PHARMACEUTICAL DRUG DELIVERY SYSTEMS**
Principal Res. Shahriar Hasan Mridha Ratul Assist. Prof. Latifa Sultana K.M. Shakik Ahmed Walid	Jahangirnagar University Southeast University University of Asia Pacific	**TRACING THE MUGHAL ARCHITECTURAL HERITAGE OF THE BIBI MARIAM MOSQUE: AN INTEGRATED ASSESSMENT OF ITS ORIGIN AND TAXONOMY IN NARAYANGANJ, BANGLADESH**
S. Leporale M. Cianfriglia R. Moramarco V. Martini C. Marocco C. Bramucci F. Sestito R.Reda L. Testarelli T. Testori G. Perrotti	Sapienza University of Rome Sapienza University of Rome Sapienza University of Rome Sapienza University of Rome Sapienza University of Rome University of Milan Sapienza University of Rome Sapienza University of Rome Sapienza University of Rome University of Milan Lake Como Istitute	**ATHREE-DIMENSIONAL EPHALOMETRIC APPROACH FOR EVALUATING VERTICAL CRANIOFACIAL MORPHOLOGY**
S. Leporale M. Cianfriglia R. Moramarco V. Martini C. Marocco C. Bramucci F. Sestito R.Reda L. Testarelli T. Testori G. Perrotti	Sapienza University of Rome Sapienza University of Rome Sapienza University of Rome Sapienza University of Rome Sapienza University of Rome University of Milan Sapienza University of Rome Sapienza University of Rome Sapienza University of Rome University of Milan Lake Como Istitute	**REINVENTING ORTHOGNATHIC SURGERY PLANNING — COMPLETELY RADIATION-FREE**
Dr.Sc Agim Berisha	Economic Faculty, Republic of Kosovo.	**PUBLIC SPENDING AND THE IMPORTANCE OF PUBLIC INVESTMENT IN THE ECONOMY: THE CASE OF KOSOVO**
Major Gheorghe GIURGIU Prof Dr. Manole COJOCARU	Deniplant-Aide Sante Medical Center Titu Maiorescu University	**OPTIMIZING OUTCOMES IN PSORIASIS: IMPACT OF DENIPLANT NUTRACEUTICALS**

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16.12.2025 / ONLINE / SESSION-1 / HALL-17

Paris Local Time: 11.30-13:00 Ankara Local Time: 13.30-15:00

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HEAD OF SESSION: Ode Onyeche Ann

Authors	Affiliation	Presentation Title
Md. Fahim Shahriar Paris Chakma Sampurna Chakma Nihit Panji Chakma Utsha Chakma Adityo Chakma Gagan Chakma Sun Shine Marma Sabuj Chakma Tamiya Chakma Biplob Tripura	University of Rajshahi University of Rajshahi University of Dhaka University of Rajshahi University of Rajshahi Chittagong University University Of Chittagong Khulna University Jahangirnagar University	**PERCEPTIONS OF THE ENVIRONMENTAL AND ECONOMIC IMPACTS OF INCREASED TOURISM: A SURVEY OF LOCAL RESIDENTS IN RANGAMATI DISTRICT, BANGLADESH**
Ibtissam ELARAAJ Asmae Nakkabi Noureddine EL MOUALIJ Mohammed FAHIM	Faculty of Science Moulay Ismail, MEKNES	**SYNTHESIS, CHARACTERIZATION AND BIOLOGICAL ACTIVITY OF CU(II) AND NI (II) COMPLEXES WITH SCHIFF BASES DERIVED FROM THIOPHENE-2- CARBOXALDEHYDE AND DIAMINOPROPANNE**
Meenatchi.S , Devadharshini.R , Gomathy.E, Keerthana.V, Kishore.R, Swathi.R A. Hari Nandhini	Bharath Institution Of Higher Education	**CONTROLLED RELEASE DRUG DELIVERY SYSTEM: INNOVATION FOR IMPROVED PATIENT COMPLIANCE**
Vandefan James Ode Onyeche Ann	Nigerian Police Force University of Abuja	**SPATIAL AND TEMPORAL PATTERNS OF KIDNAPPING INCIDENTS ALONG THE ABUJA–KADUNA EXPRESSWAY, NIGERIA**
Ode Onyeche Ann Anaga Socchi Otisi Makyur Onyeche Anita	Abuja University National Biotechnology Research Tourism Management Federal University Wukari,	**ASSESSMENT OF HEAVY METAL CONTAMINATION FROM AUTO MECHANIC WORKSHOPS IN ABUJA, NIGERIA**
Ode Onyeche Ann Anaga Socchi Otisi Makyur Onyeche Anita	Abuja University National Biotechnology Research Tourism Management Federal University Wukari	**COMPARATIVE SURVIVAL AND GROWTH PERFORMANCE OF CLARIAS GARIEPINUS AND HETEROBRANCHUS LONGIFILIS HATCHLINGS**
TABTI Senouci BOUCHERDOUD Ahmed, DOUINAT Oukacha BENDJELLOUL Meriem, SEGHIER Abdelkarim, ELANDALOUSSI Elhadj.	University of Relizane University of Relizane University of Relizane University of Relizane University of Relizane. University of Relizane	**DEVELOPMENT AND APPLICATION OF A NEW MATERIAL FOR THE TREATMENT OF PAILMENTS ORGANIQUES**

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16.12.2025 / ONLINE / SESSION-1 / HALL-18

Paris Local Time: 11.30-13.00 Ankara Local Time: 13.30-15:00

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HEAD OF SESSION: Assoc. Prof. Dr. Boudhar Abdeslam

Authors	Affiliation	Presentation Title
ABIJITH B LITHESH KANNA R S ADARSH H L K SABARI JEFFRY JACKSON J GOWRI SANKAR V Dr. R. SUBHASHINI Dr. A. VIJAYALAKSHMI	Engineering College Engineering College Engineering College Engineering College Engineering College Engineering College	**POWER BEGINS WITH YOU: THE INDIVIDUAL'S ROLE IN ENERGY CONSERVATION**
YUVADHARANI G VETHIKA J SRIHARSHINI M A SRIMATHI B TAMIL SELVI A SRISAKTHI J Dr. SANTHI M GEORGE Dr. A. VIJAYALAKSHMI	Engineering College Engineering College Engineering College Engineering College Engineering College	**NANOTECHNOLOGY: THE TINY TOOL RESHAPING GLOBAL ENERGY SAVINGS**
SENHAJ Zakaria Assoc. Prof. Dr. BOUDHAR Abdeslam Co-Assoc. Prof. Dr. OUDGOU Mohamed	Slimane University Slimane University Slimane University	**DIGITAL GOVERNANCE AND THE MODERNIZATION OF DIRECT SOCIAL ASSİSTANCE IN MOROCCO: ASSESSİNG TARGETİNG, TRANSPARENCY, AND SOCIAL INCLUSİON**
Aminu Ibrahim Bello Asma'u Anas Tukur Usman Sama'ila	Umaru Musa Yaradua University Umaru Musa Yaradua University Umaru Musa Yaradua University	**EVALUATION OF THE ANTIMICROBIAL ACTIVITY OF GARLIC (ALLIUM SATIVUM) AGAINST ORAL PATHOGENS ASSOCIATED WITH CARDIOVASCULAR RISK**
Prof. Dr. Elena VASQUEZ	Harvard University	**THE QUANTUM ENTANGLEMENT PARADOX IN MULTI-PARTICLE SYSTEMS: IMPLICATIONS FOR QUANTUM COMPUTING**
Assoc. Prof. Dr. Raj PATEL	Stanford University	**ADVANCEMENTS IN NEURAL NETWORK ARCHITECTURES FOR NATURAL LANGUAGE PROCESSING: A FOCUS ON TRANSFORMER MODELS**

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16.12.2025 / ONLINE / SESSION-2 / HALL-1

Paris Local Time: 13.00-14:30 Ankara Local Time: 15.00-16:30

Zoom Meeting ID: *325 629 5864*/ Zoom Passcode: meetcon

HEAD OF SESSION: Prof. Dr. Liam O'REİLLY

Authors	Affiliation	Presentation Title
Prof. Dr. Sophia LECLERC	Medical Sciences Division	**GENOMIC EDITING TECHNIQUES FOR COMBATING ANTIBIOTIC-RESISTANT BACTERIA: CRISPR-CAS9 APPLICATIONS**
Dr. Amina Rahman	University of Dhaka	**AI-DRIVEN EPIDEMIOLOGICAL SURVEILLANCE MODELS FOR FLOOD-RELATED DISEASE PREDICTION IN BANGLADESH**
Prof. Dr. Saeed Mehmood	Quaid-i-Azam University	**EVALUATING ETHICAL AI GOVERNANCE MODELS IN PAKISTAN'S DIGITAL PUBLIC SECTOR TRANSFORMATION**
Prof. Dr. Henrik Dahl	*University of Gothenburg*	**CLIMATE SIMULATION MODELS AND THEIR ROLE IN PREDICTING EXTREME WEATHER PATTERNS**
Dr. Marta Jelinek	*Charles University*	**ARTIFICIAL INTELLIGENCE IN JUDICIARY: OPPORTUNITIES AND ETHICAL BOUNDARIES**
Prof. Dr**. Elena Kovalenko**	*Taras Shevchenko National University of Kyiv*	**QUANTUM-ENHANCED MACHINE LEARNING FOR HIGH-DIMENSIONAL DATA STRUCTURES**
Dr. Isabelle Fournier	Department of Cognitive Neuroscience, Belgium	**NEURAL CORRELATES OF HUMAN–AI SOCIAL INTERACTION**
Prof. Dr**. Alexei Volkov**	*University of Tartu*	**POST-QUANTUM ENCRYPTION AND THE FUTURE OF DATA SECURITY** ,
Dr. Nora Schneider	*University of Vienna*	**PRESERVING CULTURAL MEMORY THROUGH AI-BASED DIGITAL ARCHIVING** ,

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16.12.2025 / ONLINE / SESSION-2 / HALL-2

Paris Local Time: 13.00-14:30 Ankara Local Time: 15.00-16:30

Zoom Meeting ID: *325 629 5864*/ Zoom Passcode: meetcon

HEAD OF SESSION: Prof. Dr. Lorenzo Armani

Authors	Affiliation	Presentation Title
Prof. Dr. **Miguel Santos**	*University of Barcelona*	**AI-DRIVEN ECONOMIC FORECASTING IN POST-CRISIS EUROPEAN MARKETS**
Dr. Emilia Novak	Charles University	**DIGITAL PUBLIC HEALTH SURVEILLANCE AND AI-BASED PREDICTIVE EPIDEMIOLOGY: A NEW PARADIGM IN DISEASE PREVENTION**
Prof. Dr. Lorenzo Armani	University of Milan	**NEUROMARKETING AND PREDICTIVE CONSUMER ANALYTICS: THE FUTURE OF DIGITAL BRANDING STRATEGIES**
Dr. Sofia Lindgren	Lund University	**HYDROGEN ECONOMY AND RENEWABLE INTEGRATION: EVALUATING FEASIBILITY FOR A CARBON-NEUTRAL EUROPE**
Dr. Elias Weber	Technical University of Munich	**HUMAN–ROBOT COLLABORATION IN MANUFACTURING: ETHICAL AND OPERATIONAL IMPLICATIONS IN INDUSTRY 5.0**
Prof. Dr. Clara Jensen	University of Copenhagen	**COGNITIVE ADAPTATION AND DIGITAL LEARNING: HOW AI-BASED PERSONALIZATION SHAPES STUDENT MOTIVATION**

(All speakers required to be connected to the session 10 min before the session starts)
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16.12.2025 / ONLINE / SESSION-2 / HALL-3

Paris Local Time: 13.00-14:30 Ankara Local Time: 15.00-16:30

Zoom Meeting ID: *325 629 5864*/ Zoom Passcode: meetcon

HEAD OF SESSION: Prof. Dr. Isabella Ruiz

Authors	Affiliation	Presentation Title
Prof. Dr. Anna Kowalska	Jagiellonian University	***LANGUAGE EVOLUTION IN THE AGE OF AI: HOW GENERATIVE SYSTEMS RESHAPE HUMAN COMMUNICATION***
Prof. Dr. Isabella Ruiz	**Universidad Autónoma de Madrid**	**DIGITAL IDENTITY CONSTRUCTION IN THE POST-SOCIAL MEDIA ERA: FROM AUTHENTIC INTERACTION TO ALGORITHMIC SELF-REPRESENTATION**
Dr. Ágnes Farkas	**Eötvös Loránd University**	***NEUROPLASTICITY AND MEMORY TRAINING: EVALUATING COGNITIVE ENHANCEMENT THROUGH DIGITAL NEUROFEEDBACK SYSTEMS***
Dr. Ayumi Nakamura	Kyoto University	**AI-ENHANCED NEURAL RECONSTRUCTION: A HYBRID DEEP LEARNING AND BIO-TISSUE ENGINEERING MODEL FOR NEURODEGENERATIVE REPAIR**
Prof. Dr. Chen Wei	Tsinghua University	**AUTONOMOUS URBAN MOBILITY: ETHICAL AND TECHNICAL FRAMEWORKS FOR AI-DRIVEN SMART COMPACT CITIES**
Dr. Farah Al-Saadi	King Saud University	**DIGITAL IDENTITY FORMATION AMONG GEN-Z IN THE MIDDLE EAST: A CROSS-PLATFORM SOCIOLINGUISTIC AND BEHAVIORAL ANALYSIS**
Assoc. Prof. Dr. Ravi Prakash	**Indian Institute of Technology Bombay**	**MACHINE LEARNING-ASSISTED CLIMATE PREDICTION AND WATER SECURITY STRATEGY FOR SOUTH ASIA**

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16.12.2025 / ONLINE / SESSION-2 / HALL-4

Paris Local Time: 13.30-15:00 Ankara Local Time: 15.00-16:30

Zoom Meeting ID: *325 629 5864*/ Zoom Passcode: meetcon

HEAD OF SESSION: Assoc. Prof. Vikram Patel

Authors	Affiliation	Presentation Title
Nurul Hidayah	University of Malaya	**IMMERSIVE LEARNING AND COGNITIVE RETENTION: EVALUATING VR-ASSISTED LEARNING MODELS IN HIGHER EDUCATIONPROF.**
Dr. Meera Vishwanath	Indian Institute of Science	**HYBRID FEDERATED LEARNING MODELS FOR PRIVACY-PRESERVING HEALTHCARE DATA SYSTEMS IN DEVELOPING NATIONS**
Prof. Dr. Arjun Bhattacharya	University of Faculty of Social Sciences,Delhı	***DIGITAL FINANCIAL INCLUSION AND BEHAVIORAL ECONOMICS: A STUDY ON INDIA'S UPI ECOSYSTEM AND CONSUMER TRUST***
Dr. Kavita Rao	Banaras Hindu University	**CRISPR-CAS-BASED DIAGNOSTIC PLATFORMS FOR RAPID DETECTION OF ANTIMICROBIAL RESISTANCE IN LOW-RESOURCE SETTINGSDR. KAVITA RAO**
Prof. Dr. Anirudh Sharma	Jawaharlal Nehru University (JNU	**ARTIFICIAL INTELLIGENCE AND DIGITAL SOVEREIGNTY: POLICY TENSIONS IN INDIA'S EVOLVING CYBER GOVERNANCE LANDSCAPE**
Dr. Ishita Mathur	University of Hyderabad	**SINGLE-CELL TRANSCRIPTOMICS FOR MAPPING CELLULAR PLASTICITY IN TRIPLE-NEGATIVE BREAST CANCER AMONG INDIAN POPULATIONS**
Assoc. Prof. Vikram Patel	Indian Institute of Technology Kanpur	**DESIGNING INCLUSIVE AI-ASSISTED INTERFACES FOR USERS WITH MOTOR AND COGNITIVE DISABILITIES IN INDIA**
Dr. Priya S. Narayanan	Amrita Vishwa Vidyapeetham	**IMPACT OF INDIAN OCEAN WARMING ON CORAL MICROBIOME STABILITY AND REEF HEALTH ALONG THE LAKSHADWEEP ARCHIPELAGO**

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16.12.2025 / ONLINE / SESSION-2 / HALL-5

Paris Local Time: 13.30-15:00 Ankara Local Time: 15.30-17:00

Zoom Meeting ID: *325 629 5864*/ Zoom Passcode: meetcon

HEAD OF SESSION: Prof. Dr. Ahmad Obeidat

Authors	Affiliation	Presentation Title
Prof. Dr. Deepak R. Kulkarni	Savitribai Phule Pune University	**GAMIFIED LEARNING ECOSYSTEMS AND METACOGNITIVE DEVELOPMENT: EVIDENCE FROM INDIAN HIGHER EDUCATION CLASSROOMS**
Prof. Dr. Samira Al-Haddad	United Arab Emirates	**POST-QUANTUM CRYPTOGRAPHY MODELS FOR SECURING NATIONAL DIGITAL INFRASTRUCTURE IN THE MIDDLE EAST**
Dr. Youssef Hassan	Cairo University	**PHARMACOGENOMICS AND PERSONALIZED DRUG RESPONSE PATTERNS AMONG NORTH AFRICAN POPULATIONS: A CASE STUDY OF CARDIOVASCULAR MEDICATIONS**
Dr. Reem Al-Sayegh	King Abdulaziz University	**METAVERSE-BASED LEARNING ENVIRONMENTS AND CULTURAL ADAPTATION IN HIGHER EDUCATION CLASSROOMS ACROSS THE GULF REGION**
Prof. Dr. Ahmad Obeidat	Jordan, University of Jordan	**AI-DRIVEN EPIDEMIOLOGICAL FORECASTING MODELS FOR VECTOR-BORNE DISEASES UNDER CLIMATE CHANGE CONDITIONS IN THE MIDDLE EAST**
Dr. Fatima Ben-Rahman	Morocco Mohammed V University	**DIGITAL FEMINISM AND SOCIAL TRANSFORMATION: ONLINE ADVOCACY MOVEMENTS AMONG YOUNG WOMEN IN NORTH AFRICA**
Dr. Samira Al-Hassan	University of Jordan	**ETHICAL CHALLENGES AND GOVERNANCE MODELS IN MACHINE LEARNING DEPLOYMENT FOR PUBLIC ADMINISTRATION IN THE MIDDLE EAST**

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16.12.2025 / ONLINE / SESSION-2 / HALL-6

Paris Local Time: 13.30-15:00 Ankara Local Time: 15.30-17:00

Zoom Meeting ID: *325 629 5864*/ Zoom Passcode: meetcon

HEAD OF SESSION: Prof. Dr. James Okoro

Authors	Affiliation	Presentation Title
Prof. Dr. Ahmed Al-Rashid	King Saud University	**DIGITAL HEALTH TRANSFORMATION AND AI-DRIVEN EPIDEMIOLOGICAL MODELING DURING POST-PANDEMIC HEALTH REFORM IN SAUDI ARABIA**
Dr. Layla Ibrahim	United Arab Emirates University	**METAVERSE-BASED LEARNING ENVIRONMENTS: OPPORTUNITIES AND RISKS FOR HIGHER EDUCATION IN THE UAE**
Prof. Dr. Youssef El-Karim	Cairo University	**OPTIMIZATION OF LARGE-SCALE SOLAR ENERGY INTEGRATION IN URBAN CAIRO: A SMART GRID SIMULATIONSTUDY**
Dr. Rana Habib	American University of Beirut	**DIGITAL MIGRATION NETWORKS AND ONLINE IDENTITY RECONSTRUCTION AMONG MIDDLE EASTERN DIASPORA COMMUNITIES**
Dr. Amina NDLOVU	**University of Cape Town**	**AI-POWERED DIAGNOSTIC IMAGING FOR EARLY DETECTION OF TUBERCULOSIS IN SUB-SAHARAN AFRICADR. AMINA NDLOVU**
Prof. Dr. James Okoro	University of Lagos	**BLOCKCHAIN-BASED IDENTITY SYSTEMS FOR STRENGTHENING DIGITAL GOVERNANCE IN NIGERIAPROF**
Dr. Mariam Diallo	Cheikh Anta Diop University	**CLIMATE-SMART AGRICULTURE AND MACHINE-LEARNING-BASED CROP PREDICTION MODELS IN WEST AFRICA**
Prof. Dr. Hassan El-Basha	Alexandria University	**SUSTAINABLE SMART CITY PLANNING FOR RAPIDLY GROWING AFRICAN URBAN CENTERS**
Dr. Zawadi Tembo	University of Nairobi	**AI-SUPPORTED WILDLIFE MONITORING SYSTEMS FOR ENDANGERED SPECIES PROTECTION IN EAST AFRICA**

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16.12.2025 / ONLINE / SESSION-2 / HALL-7

Paris Local Time: 13.30-15:00 Ankara Local Time: 15.30-17:00

Zoom Meeting ID: *325 629 5864*/ Zoom Passcode: meetcon

HEAD OF SESSION: Prof. Dr. Imran Khalid

Authors	Affiliation	Presentation Title
Dr. Fatoumata Kamara	University of Bamako	**WOMEN'S DIGITAL ENTREPRENEURSHIP AND SOCIOECONOMIC EMPOWERMENT IN RURAL MALI**
Prof. Dr. Elias Matombo	University of Dar es Salaam	**CORAL REEF RESTORATION AND AI-ASSISTED MARINE HABITAT ASSESSMENT IN THE WESTERN INDIAN OCEAN**
Dr. Selam Desta	Addis Ababa University	**DIGITAL ARCHIVING OF ENDANGERED INDIGENOUS LANGUAGES IN ETHIOPIA USING NLP MODELS**
Prof. Dr. Thabo Mensah	University of Ghana	**FINTECH INNOVATION AND FINANCIAL INCLUSION TRENDS IN POST-COVID GHANAIAN MARKET**
Dr. Yasmin Ben Youssef	Hassan II University of Casablanca	**GAMIFICATION AND CULTURAL ADAPTATION IN DIGITAL LEARNING PLATFORMS FOR MOROCCAN SECONDARY SCHOOLS**
Dr. Ayesha Siddiqui	University of Punjab	**DIGITAL THERAPY ADOPTION AND MENTAL HEALTH AWARENESS AMONG UNIVERSITY STUDENTS IN PAKISTAN**
Prof. Dr. Imran Khalid	Quaid-i-Azam University	**ASSESSING AIR POLLUTION TRENDS IN URBAN PAKISTAN USING AI-BASED FORECASTING MODELS**
Prof. Dr. Muhammad Zubair	National University of Sciences and Technology (NUST)	**AUTONOMOUS DRONE SYSTEMS FOR DISASTER MANAGEMENT AND FLOOD MONITORING IN PAKISTAN**

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16.12.2025 / ONLINE / SESSION-2 / HALL-8

Paris Local Time: 13.30-15:00 Ankara Local Time: 15.30-17:00

Zoom Meeting ID: *325 629 5864*/ Zoom Passcode: meetcon

HEAD OF SESSION: Prof. Dr. Faisal Mahmood

Authors	Affiliation	Presentation Title
Dr. Sara Khan	Lahore University of Management Sciences (LUMS	**STARTUP ECOSYSTEM GROWTH AND DIGITAL BUSINESS MODELS AMONG PAKISTANI YOUTH ENTREPRENEURS**
Dr. Adeel Rehman	University of Karachi,	**BLENDED LEARNING MODELS AND STUDENT ENGAGEMENT IN PAKISTANI HIGHER EDUCATION**
Prof. Dr. Bilal Qureshi	National University of Sciences and Technology (NUST)	**ENHANCING NATIONAL CYBERSECURITY RESILIENCE THROUGH AI-DRIVEN THREAT DETECTION IN PAKISTAN**
Dr. Nadia Ali	University of Agriculture Faisalabad	**MACHINE LEARNING FOR OPTIMIZING CROP YIELD AND PEST MANAGEMENT IN PUNJAB, PAKISTAN**
Prof. Dr. Faisal Mahmood	Aga Khan University	**TELEMEDICINE ADOPTION AND HEALTHCARE ACCESS IN RURAL PAKISTAN: AN AI-ENABLED APPROACH**
Dr. Mariam Shah	Lahore University of Management Sciences (LUMS)	**SMART GRID AND RENEWABLE ENERGY INTEGRATION FOR URBAN PAKISTAN: AI-ENHANCED ENERGY MANAGEMENT**
Prof. Elena Kovacevic	University of Belgrade	**ARTIFICIAL INTELLIGENCE ADOPTION IN BALKAN SMES: BARRIERS, READINESS, AND STRATEGIC OUTCOMES**
Dr. Dimitra Papadopoulos	Aristotle University of Thessaloniki	**AI-SUPPORTED PEDAGOGICAL MODELS IN HIGHER EDUCATION: A COMPARATIVE STUDY IN GREEK UNIVERSITIES**

16.12.2025 / ONLINE / SESSION-2 / HALL-9

Paris Local Time: 13.30-15:00 Ankara Local Time: 15.30-17:00

Zoom Meeting ID: *325 629 5864*/ Zoom Passcode: meetcon

HEAD OF SESSION: Assoc. Prof. Dr. Florina Matei

Authors	Affiliation	Presentation Title
Dr. Ana Petrovic	University of Zagreb	**AI-BASED DIAGNOSTIC IMAGING: EVALUATION OF CLINICAL ACCURACY AND WORKFLOW EFFICIENCY IN CROATIAN HOSPITALS**
Prof. Dr. Valeriya Petrov	Sofia University	**CONSUMER TRUST AND EMOTIONAL RESPONSE TO AI-GENERATED ADVERTISING IN THE BALKAN DIGİTAL MARKETPLACE**
Dr. Nermin Hadžić	University of Sarajevo	**THE ROLE OF ARTIFICIAL INTELLIGENCE IN POST-CONFLICT RECONCILIATION AND CULTURAL MEMORY PRESERVATION IN THE WESTERN BALKANS**
Prof. Dr. **Tamara Ilievski**	Ss. Cyril and Methodius University	**HUMAN-CENTERED ARTIFICIAL INTELLIGENCE FOR SMART CITY DEVELOPMENT: A CASE STUDY OF SKOPJE**
Assoc. Prof. Dr. Florina Matei	University of Buchares	**COGNITIVE EFFECTS OF AI-ASSISTED LEARNING PLATFORMS ON UNIVERSITY STUDENTS: A LONGITUDINAL STUDY**
Dr. Farid Sultani	Kabul University	**MACHINE LEARNING APPLICATIONS FOR EARTHQUAKE-RESILIENT URBAN PLANNING IN POST-CONFLICT AFGHANISTAN**
Dr. Luka Dragićević	University of Montenegro	**AI INTEGRATION IN RENEWABLE ENERGY FORECASTING AND GRID OPTIMIZATION IN MONTENEGRO**

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FACE TO FACE

Face to Face / LOCATİON: IBIS PARIS TOUR EIFFEL CAMBRONNE 15ÈME	
20.12.2025	HALL-1 / SESSION-1
PARIS LOCAL TIME: 12:00- 17:00	**ANKARA LOCAL TİME** 14:00-19:00

uthors	Affiliation	Presentation Title
Lect. Dr. Ali Onur KAYA Lect.MSc. Mert Can EMRE Berkay EMRE Prof. Dr. İbrahim Halil MUTLU	Akdeniz University Yozgat Bozok University Akdeniz University Akdeniz University	**Sol–Gel OXIDE BARRIERS FOR SUPERIOR CORROSION RESISTANCE: A TIO_2–ZrO_2 COMPARATIVE STUDY**
Assoc. Prof. Dr. Akira TANAKA	Massachusetts Institute of Technology	**BEHAVIORAL ECONOMICS IN CLIMATE POLICY DESIGN: NUDGING TOWARDS SUSTAINABLE CHOICES**
Prof. Dr. Liam O'REİLLY	University of Cambridge	**ECOSYSTEM RESILIENCE IN THE FACE OF CLIMATE-INDUCED EXTREME WEATHER EVENTS**
Prof. Dr. Helena Marković	University of Belgrade	**THE LEGAL LANDSCAPE OF CYBER SOVEREIGNTY: BALANCING NATIONAL REGULATION AND GLOBAL DIGITAL FREEDOM**
Assoc. Prof. Marko Hoxha	University of Tirana	**REGULATORY GAPS AND ETHICAL CHALLENGES OF ARTIFICIAL INTELLIGENCE IN BALKAN GOVERNANCE SYSTEMS**
Dr. Lukas Schneider	**University of Zurich**	**PRECISION MEDICINE AND DEEP LEARNING INTEGRATION: A NEW ERA FOR PREDICTIVE CLINICAL DECISION SUPPORT SYSTEMS**

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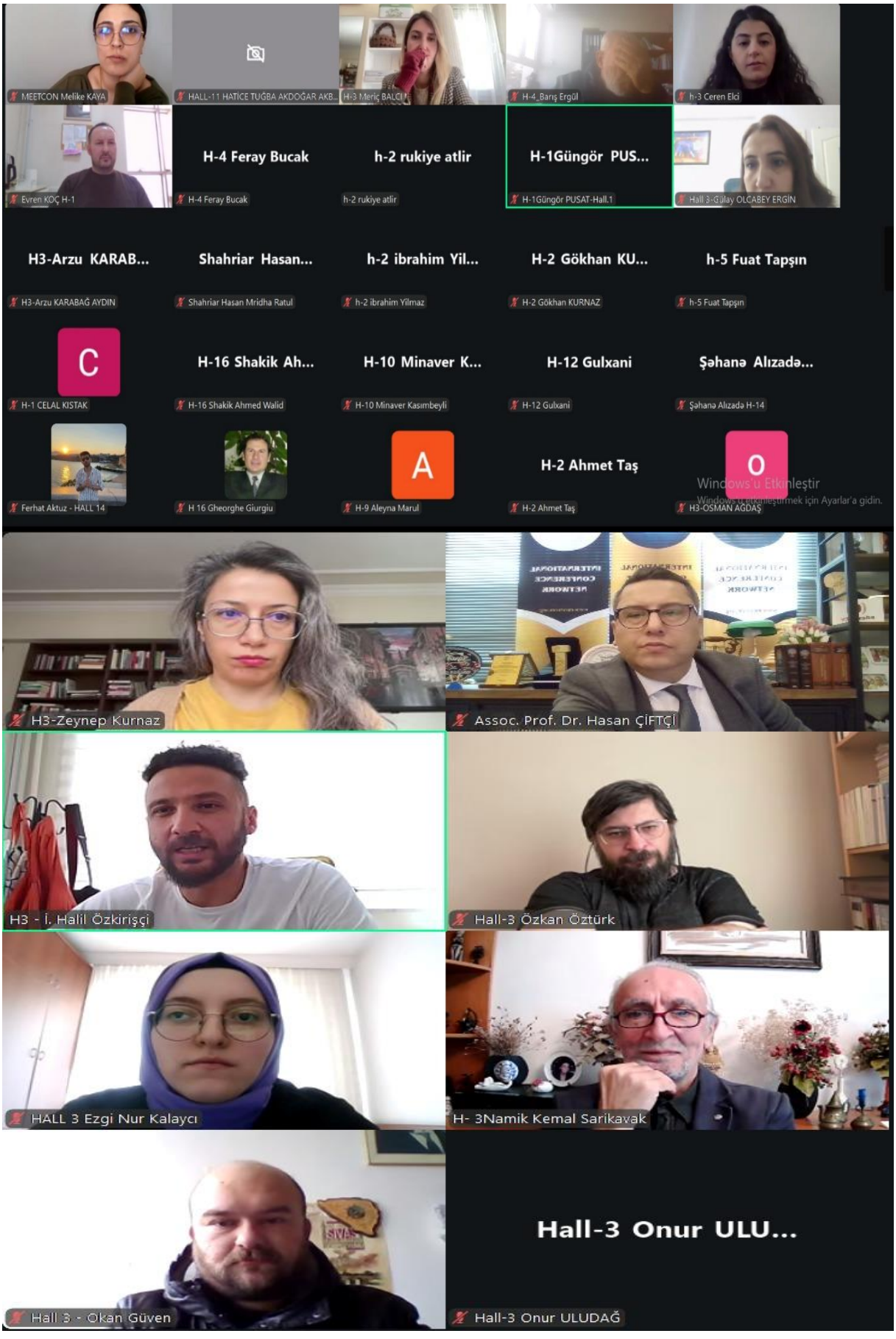
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H-16 Shakik Ah...
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H-2 Ahmet Taş
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Windows'u etkinleştirmek için Ayarlar'a gidin.
H3-Zeynep Kurnaz
Assoc. Prof. Dr. Hasan ÇİFTÇİ
H3 - İ. Halil Özkirişçi
Hall-3 Özkan Öztürk
HALL 3 Ezgi Nur Kalaycı
H- 3Namik Kemal Sarikavak
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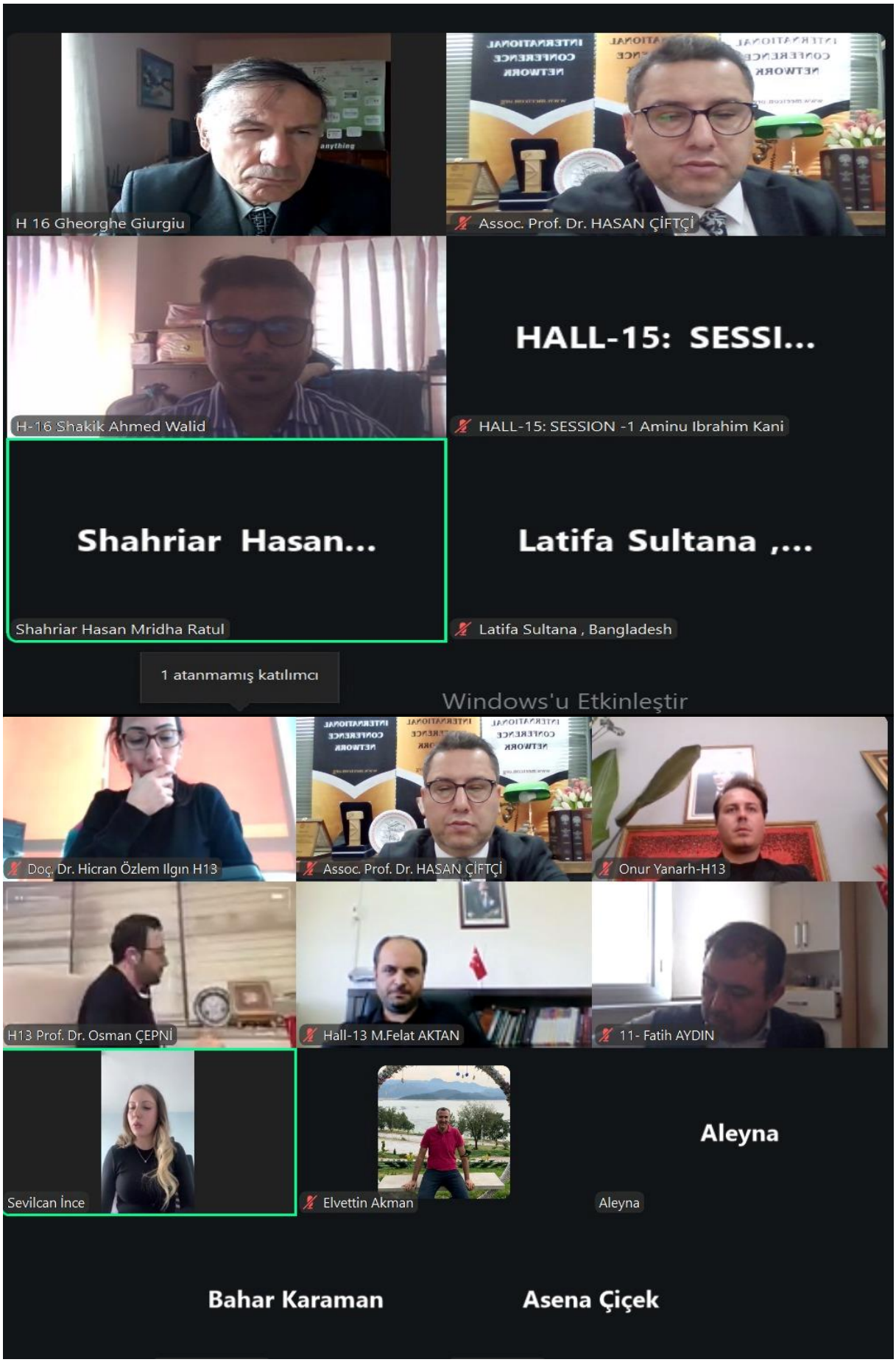
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Shahriar Hasan Mridha Ratul
Latifa Sultana ,...
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Assoc. Prof. Dr. HASAN ÇİFTÇİ
Onur Yanarh-H13
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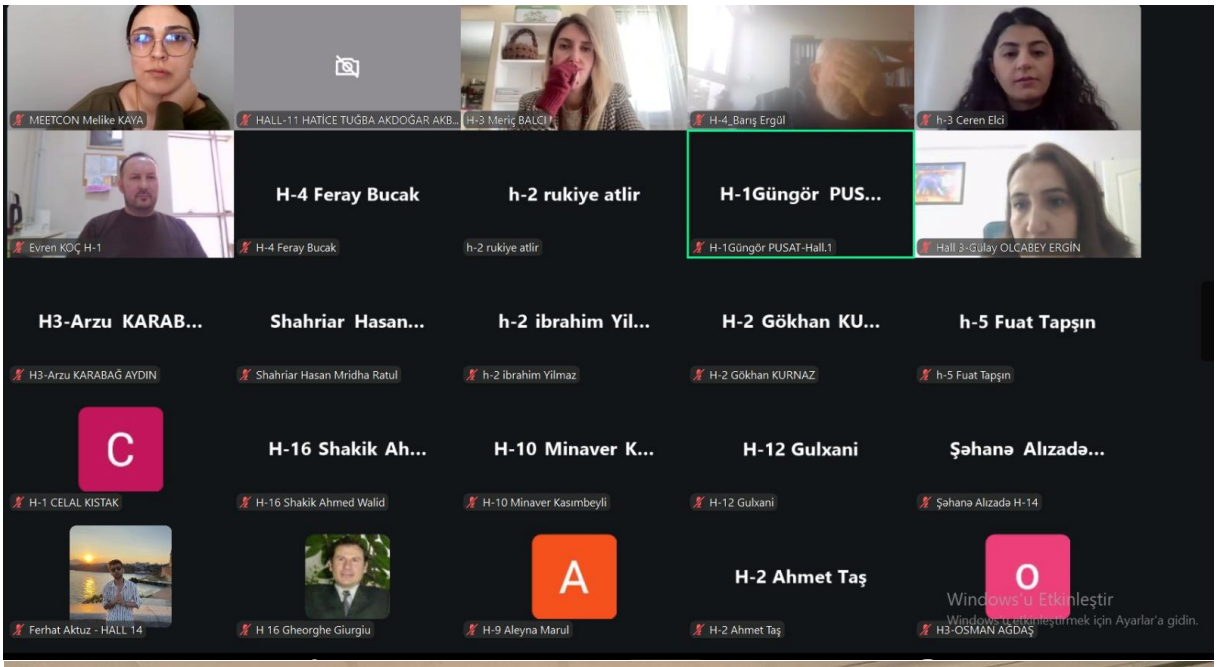
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H 16 Gheorghe Giurgiu
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Assoc. Prof. Dr. Elif SÖNMEZ

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Sayın Dr. Öğr. Üyesi Hakan KÜRKÇÜOĞLU

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Prof. Dr. Emre TANDIRLI

Dekan

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29.12.2025

İLGİLİ MAKAMA

MEETCON-PARIS INTERNATIONAL MULTIDISCIPLINARY STUDIES CONGRESS 16-21 Aralık 2025/ / tarihleri arasında **PARIS/FRANCE'**da yüzyüze ve online olarak 28 farklı ülkeden (**Türkiye:** 106 ve diğer **Ülkeler:** 112; **Toplam:** 218 akademisyen/araştırmacıların katılımı ile gerçekleşmiştir. Kongre, 16 Ocak 2020 Akademik Teşvik Ödeneği Yönetmeliğine getirilen ''Tebliğlerin sunulduğu yurt içinde veya yurtdışındaki etkinliğin uluslararası olarak nitelendirilebilmesi için Türkiye dışından en az 5 ülkeden farklı tebliğ sunan konuşmacının katılım sağlaması ve tebliğlerin yarıdan fazlasının Türkiye dışından katılımcılar tarafından sunulması esastır.'' değişikliğine uygun düzenlenmiştir.

Bilgilerinize arz edilir. Saygılarımla.

Assoc. Prof. Dr. Hasan ÇİFTÇİ
Head Of MeetCon Conference

NOTIFICATIONS

AUTHORS	TITLE	NO
Şirvan KAMAN Assoc. Prof. Dr. Evren KOÇ	THE EFFECTS OF THE HETEROCYCLIC 4,5-DIHYDRO-1H-1,2,4-TRIAZOL-5- ONE COMPOUND ON LIVER TISSUE PROTEIN EXPRESSION AND ENZYME LEVELS IN WISTAR ALBINO RATS	1
Göngür Pusat Assist. Prof. Dr. Abdulmuttalip Şahinaslan Res. Assist. Dr. Celal Kıstak Prof. Dr. Nevin ÇELİK	EXPERIMENTAL INVESTIGATION OF TEMPERATURE DISTRIBUTION IN JET IMPINGEMENT COOLING USING THERMAL IMAGING	2-12
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THE EFFECTS OF THE HETEROCYCLIC 4,5-DIHYDRO-1*H*-1,2,4-TRIAZOL-5-ONE COMPOUND ON LIVER TISSUE PROTEIN EXPRESSION AND ENZYME LEVELS IN WISTAR ALBINO RATS

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ABSTRACT

Liver-mediated hepatotoxicity can cause severe hepatic injury that may progress to acute liver failure. Heterocyclic compounds, known for their antifungal, antioxidant, anticancer, and antiviral activities, are frequently utilized in drug development due to their involvement in biological systems such as vitamins and hormones.

In the present study, Wistar albino rats were used to investigate the potential hepatotoxic effects of a heterocyclic compound. Twenty-eight Wistar albino rats aged 4–5 months were randomly divided into four groups: the control group, the dimethyl sulfoxide (DMSO) group, and two experimental groups receiving 3-methyl-4-(3,4-dihydroxybenzylideneamino)-4,5-dihydro-1*H*-1,2,4-triazol-5-one (3-MTA) at doses of 10 mg/kg and 50 mg/kg for seven days. At the end of the experimental period, blood and liver tissue samples were collected from all animals.

The effects of 3-MTA administration on liver tissue protein expression and enzyme activities including alanine aminotransferase (ALT), aspartate aminotransferase (AST), and total liver protein were evaluated. Electrophoretic analysis revealed a thickening of the 215 kDa protein band and a thinning of the 47 kDa and 41 kDa protein bands in the 10 mg/kg dose group compared with the control group. In the 50 mg/kg dose group, thickening of the 250 kDa, 215 kDa, 166 kDa, 115 kDa, 89 kDa, and 11 kDa bands and thinning of the 47 kDa and 41 kDa bands were observed relative to the control group.

Biochemical analyses showed a numerical increase in AST and ALT enzyme levels in the 50 mg/kg 3-MTA group; however, this increase was not statistically significant. Similarly, no significant differences were found among groups in total liver protein concentrations ($P>0.05$).

In conclusion, administration of 3-MTA to Wistar albino rats for seven days did not cause marked hepatotoxicity, as indicated by the absence of statistically significant changes in serum ALT, AST, or total liver protein levels. Although minor alterations in liver protein band patterns were observed, these did not correspond to biochemical or histological evidence of liver damage.

Keywords: Heterocyclic compound, Alanine Aminotransferase, Aspartate Aminotransferase, Liver Total Protein, SDS-PAGE

* This study is derived from the Master's thesis submitted to the Graduate School of Natural and Applied Sciences, Kafkas University, in 2022.

EXPERIMENTAL INVESTIGATION OF TEMPERATURE DISTRIBUTION IN JET IMPINGEMENT COOLING USING THERMAL IMAGING

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ABSTRACT

This study investigates the utilization and efficacy of high-resolution infrared thermography as a non-intrusive diagnostic tool for analyzing the heat transfer characteristics of an air jet impinging on a rotating cylindrical surface. By capturing high-fidelity transient and steady-state temperature distributions, the thermographic approach allowed for a systematic evaluation of critical parameters, including Reynolds number, nozzle geometry (circular, square, and triangular), and surface rotational speed. The thermal imaging data provided detailed spatiotemporal maps that were essential for quantifying cooling performance, revealing that square nozzles produce a broader cooling footprint and that moderate rotational speeds enhance surface temperature homogeneity through improved tangential convection. Consequently, this work demonstrates that infrared thermography offers a robust visual and quantitative capability for resolving the complex thermal interactions between jet flows and moving boundaries.

Keywords: Thermal imaging, Infrared thermography, Jet impingement, Temperature distribution, Non-intrusive measurement.

1. INTRODUCTION

Jet impingement cooling is widely employed in various industrial and engineering applications due to its superior convective heat transfer characteristics and the formation of localized high Nusselt number regions near the stagnation zone [1], [2]. It is particularly effective for cooling components exposed to high thermal loads, such as turbine blades, power electronics, and photovoltaic systems [3]. The heat transfer performance of impinging jets depends strongly on several parameters, including Reynolds number, nozzle-to-plate distance, nozzle geometry, and surface conditions [4], [5].

Conventional temperature measurement techniques, such as thermocouples and heat flux sensors, have been extensively used in earlier studies [6]. However, their intrusive nature, limited spatial resolution, and slow response times restrict their ability to accurately capture transient temperature distributions. To overcome these limitations, infrared (IR) thermography has emerged as a non-contact, high-resolution method for measuring temperature fields with excellent temporal and spatial accuracy [7]. By utilizing full-field temperature visualization, IR thermography provides valuable insight into the transient behavior and local heat transfer mechanisms of impinging jets [8].

Recent developments in high-speed and high-sensitivity IR cameras have significantly enhanced the capability to analyze complex transient flow–thermal interactions. However, existing studies often focus

on limited experimental parameters or steady-state conditions. There remains a need for a systematic investigation that combines thermal imaging with statistical design of experiments to better understand the combined effects of multiple parameters on heat transfer.

In this study, infrared thermography is employed to experimentally analyze the effects of Reynolds number, nozzle-to-plate spacing, surface rotational speed, and nozzle geometry on jet impingement heat transfer. Leveraging the high spatial resolution of this non-intrusive technique, detailed surface temperature maps were acquired to characterize the thermal footprint without disturbing the flow field. The transient and steady-state temperature distributions are analyzed to visualize the local heat transfer variations, providing a comprehensive understanding of jet impingement behavior through full-field thermal imaging.

2. MATERIAL AND METHODS

This study experimentally examines the heat transfer performance of air jets impinging on a rotating cylindrical surface under various operating conditions. The experimental setup was designed to analyze how flow parameters and nozzle geometry affect surface temperature distribution captured by thermal imaging.

2.1 Experimental Setup

The test rig consists of a controlled air delivery system, interchangeable nozzles, and a heated rotating cylinder. Air is supplied by a centrifugal blower connected to a variable frequency drive , enabling precise adjustment of flow rate and jet velocity. The airflow passes through a straight duct section ($32D_h$ in length) to ensure a fully developed flow before exiting the nozzle. The Reynolds number was varied between 2000 and 7000, covering both laminar and turbulent regimes. The nozzle-to-surface distance (H/D_h) was adjustable to evaluate its effect on the cooling distribution. Schematic view of experimental setup is given in Figure 1.

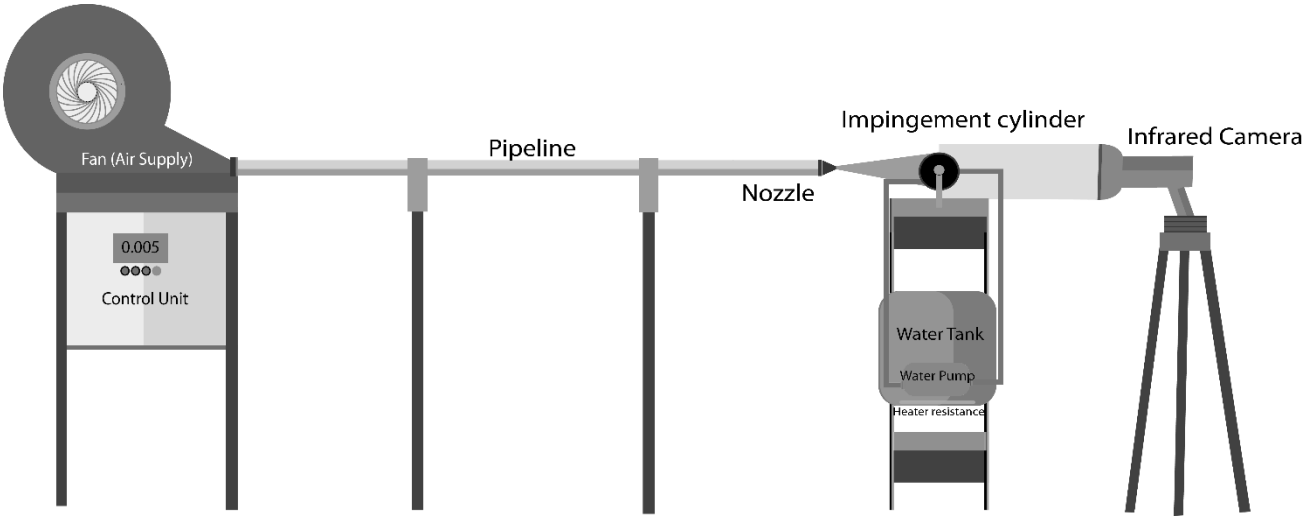


Figure 1. Schematic side view of the experimental setup

2.2 Nozzle and Flow Characterization

Three nozzle geometries—circular, square, and triangular—were fabricated via 3D printing using PLA material. Each nozzle was designed with an equivalent hydraulic diameter of 8 mm to ensure comparability. The jet exit velocity was measured with a hot-wire anemometer (CEM DT-8880) having a resolution of 0.1 m/s . These measurements were used to determine the corresponding Reynolds number for each case. Figure 2 shows the fabricated nozzles.

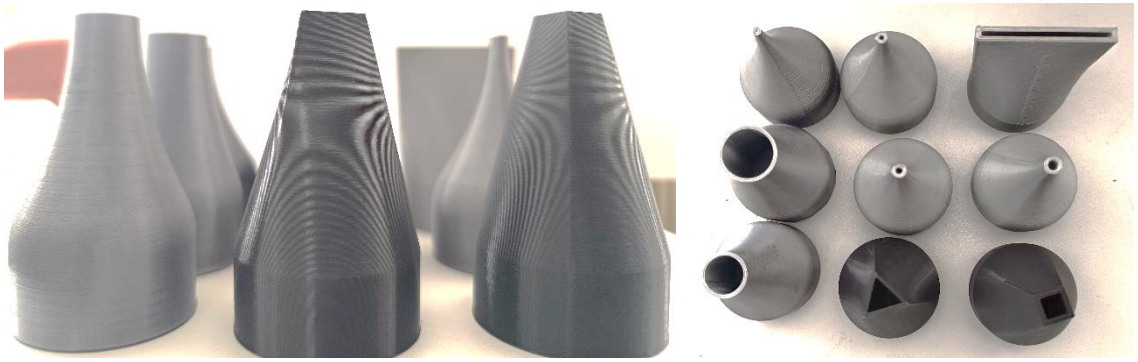


Figure 2. 3d printed nozzles

2.3 Rotational Mechanism

The target surface consisted of an aluminum cylinder rotated by a step motor equipped with an encoder and controlled through a digital interface. The motor speed was varied from 0 to 100 RPM to investigate the influence of rotational motion on the heat transfer behavior. The motion system was designed to minimize vibration and maintain stable alignment during testing. System photograph is given in Figure 3.

Figure 3. Rotating cylinder and air supply control system

2.4 Thermal Imaging and Data Acquisition

Surface temperature measurements were obtained using a high-resolution infrared thermal camera (Optris Xi 400), operating in the range of 20°C–1500°C with an accuracy of ±1.5%. The cylinder surface was coated with matte black paint to enhance emissivity and minimize reflection. Thermal videos were recorded at fixed time intervals until steady-state conditions were achieved. Temperature data were processed using Optris software to evaluate temporal and spatial variations. Environmental parameters such as ambient temperature, jet velocity, and rotational speed were monitored to ensure repeatability and reliability of the results.

Thermal image of rotating cylinder given in figure 4.

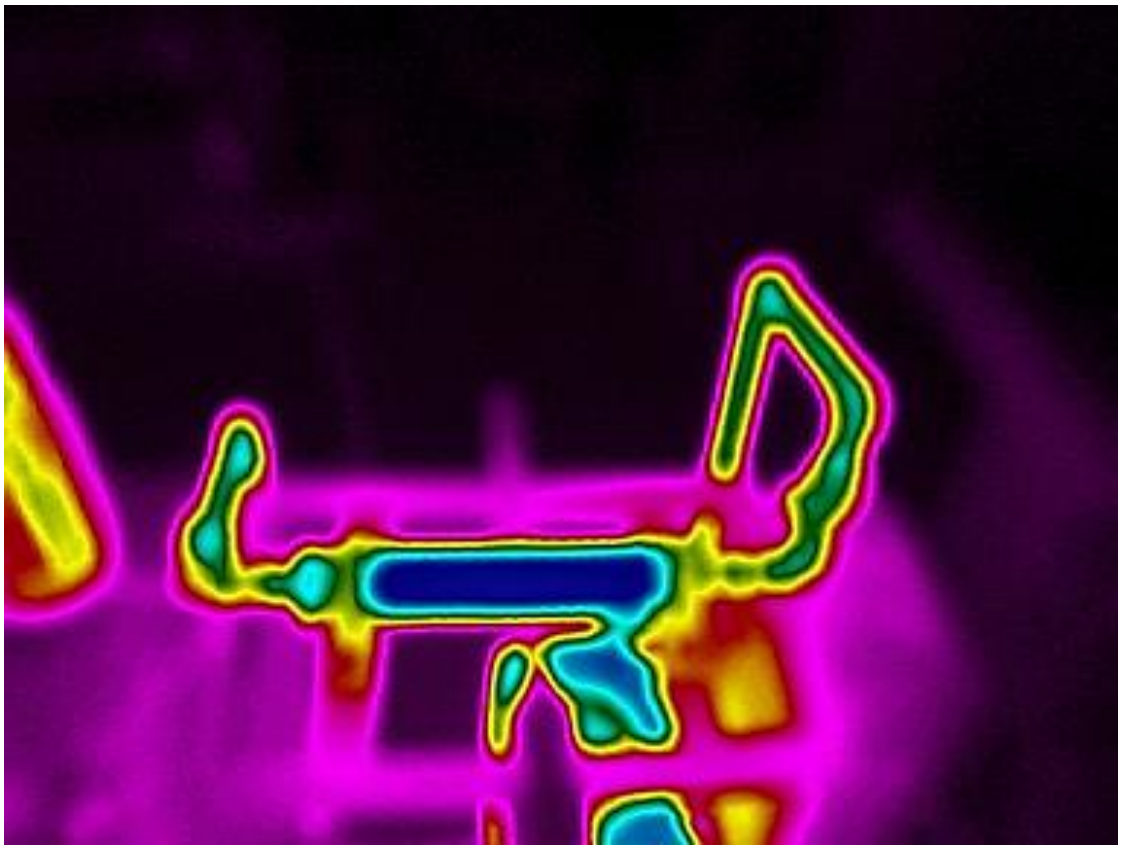
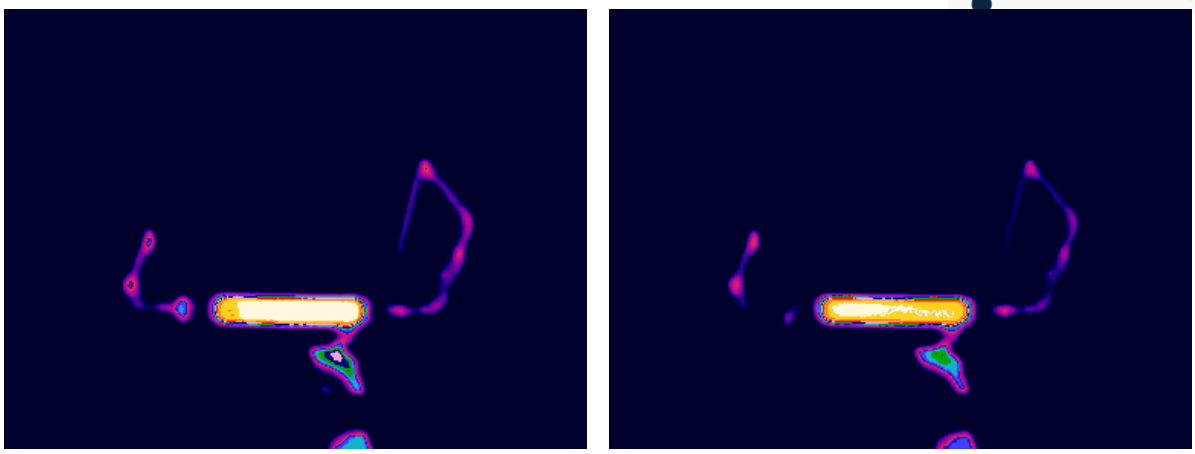


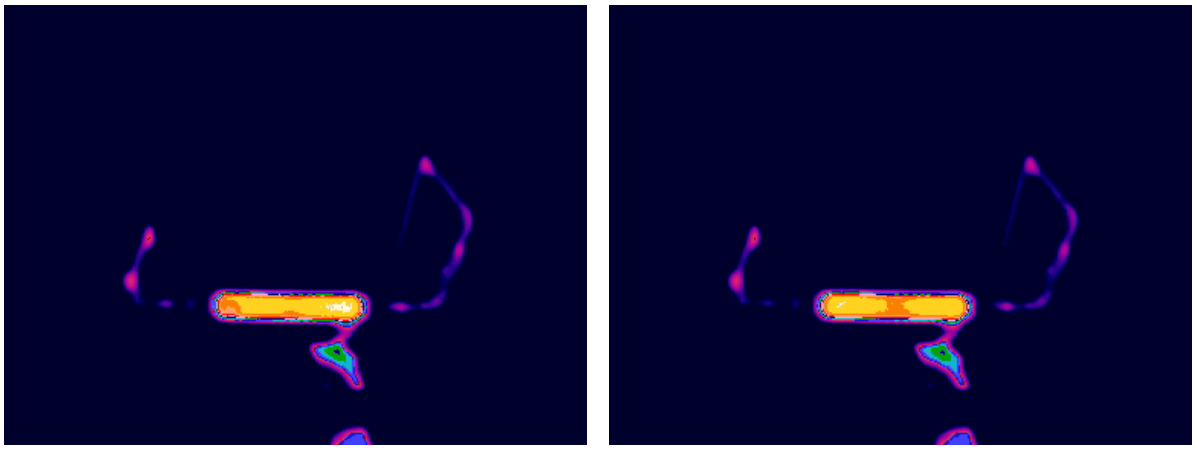
Figure 4. Thermal image of rotating cylinder

3. RESULTS AND DISCUSSION

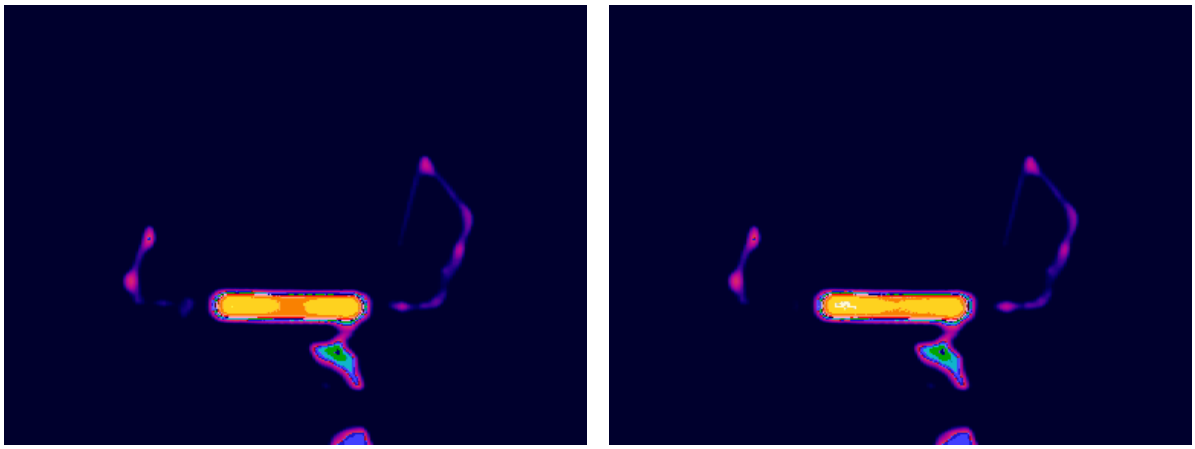
Thermal imaging was employed as a powerful diagnostic tool to visualize and comprehensively analyze the temperature distributions across a cylindrical surface being cooled by jet impingement. This non-intrusive technique allowed for the high-resolution capture of both transient thermal behavior, tracking how temperatures evolved over time, and steady-state conditions, revealing the final, stable temperature map. By mapping the entire surface instead of relying on discrete point sensors, this approach provided a complete picture of the thermal response under a wide range of operating conditions, such as varying jet velocities and distances. Transient temperature evolution of the target surface for 10s given in figure 5.



$t = 0$ $t = 2$ s



$t = 4$ s $t = 6$ s



$t = 8$ s $t = 10$ s

The detailed infrared data gathered from these experiments offered crucial insights into the complex physics at play. This included a clear visualization of the flow–surface interaction, revealing distinct cooling patterns at the stagnation point and the subsequent flow development around the cylinder's curvature. Furthermore, the temperature data was essential for quantifying the influence of key operating parameters on cooling effectiveness. This allowed the researchers to determine the precise local heat transfer rates across the surface, providing the detailed data needed to validate computational models and optimize the design of thermal management systems.

Figure 5. Transient temperature evolution of the target surface for 10s

4. CONCLUSION

This study effectively utilized high-resolution infrared thermography as a primary, non-intrusive diagnostic tool to comprehensively analyze the complex thermal behavior resulting from jet impingement on a rotating cylindrical surface. The thermal imaging technique proved highly effective in capturing the transient evolution of surface temperatures immediately following initial impingement, as well as the resulting steady-state thermal footprint. Key findings, derived quantitatively from the thermal data, indicated that the steady-state cooling condition was reliably established at approximately 600-1200 seconds, with the thermal contours distinctly illustrating the radial expansion of the cooling pattern over time. Ultimately, this research validates infrared thermography as an essential and powerful methodology for capturing the detailed spatial and temporal characteristics of surface temperatures in complex flow interactions, offering comprehensive insights that surpass the capabilities of traditional point-based sensing methods.

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REFERENCES

[1] R. Viskanta, “Heat transfer to impinging isothermal gas and flame jets,” *Experimental Thermal and Fluid Science*, vol. 6, no. 2, pp. 111–134, 1993.
[2] S. V. Garimella and B. Nenaydykh, “Nozzle-geometry effects in liquid jet impingement heat transfer,” *Int. J. Heat Mass Transfer*, vol. 39, no. 14, pp. 2915–2923, 1996.
[3] N. Zuckerman and N. Lior, “Jet impingement heat transfer: Physics, correlations, and numerical modeling,” *Advances in Heat Transfer*, vol. 39, pp. 565–631, 2006.
[4] K. Jambunathan, E. Lai, M. A. Moss, and B. L. Button, “A review of heat transfer data for single circular jet impingement,” *Int. J. Heat Fluid Flow*, vol. 13, no. 2, pp. 106–115, 1992.
[5] J. San and Y. Huang, “Heat transfer enhancement of impinging jet array with crossflow,” *Int. J. Heat Mass Transfer*, vol. 49, no. 19–20, pp. 3477–3486, 2006.
[6] H. Martin, “Heat and mass transfer between impinging gas jets and solid surfaces,” *Advances in Heat Transfer*, vol. 13, pp. 1–60, 1977.
[7] G. M. Carlomagno and G. Cardone, “Infrared thermography for convective heat transfer measurements,” *Exp. Fluids*, vol. 49, no. 6, pp. 1187–1218, 2010.
[8] T. L. Bergman, A. S. Lavine, F. P. Incropera, and D. P. DeWitt, *Fundamentals of Heat and Mass Transfer*, 7th ed., Wiley, 2011.

DESIGN AND DEVELOPMENT OF A DOMESTIC ELECTROMAGNETIC NEEDLE SELECTION SYSTEM FOR ELECTRONIC FLAT KNITTING MACHINES

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ABSTRACT

Electronic flat knitting machines rely heavily on precise needle selection systems to execute complex knitting patterns. Currently, the Turkish textile industry acts as a major global manufacturer but remains dependent on imported electromagnetic selection devices, primarily supplied by German and Chinese manufacturers. Existing solutions often suffer from performance degradation due to the demagnetization of permanent magnets under high operating temperatures and reverse magnetic fields, as well as mechanical failure caused by metal dust and friction in electromechanical alternatives. This paper presents the design, mathematical modeling, and prototype production of a domestic electromagnetic selection device intended to localize production and enhance service life. The design methodology utilizes MATLAB/Simulink for mathematical modeling and ANSYS for electromagnetic finite element analysis (FEA) to determine the optimum magnetic flux density and coil configuration. To address thermal instability and wear issues, the proposed system incorporates hard ferrite permanent magnets for superior thermal resistance and a tungsten carbide contact surface to minimize abrasion on the selection jacks. The study demonstrates that a locally manufactured device can meet the rigorous precision requirements of high-speed knitting operations while significantly reducing costs and supply chain risks for the national textile industry.

Keywords: Electronic Flat Knitting Machines, Electromagnetic Selection Device, Finite Element Analysis, Import Substitution, Textile Machinery Design.

INTRODUCTION

The needle selection system is the most critical mechanism determining the production speed and patterning capability of computerized flat knitting machines [1]. In modern machines, this process is predominantly achieved through electromagnetic actuators operating on a "hold-and-release" principle [2, 3]. However, existing systems suffer from chronic problems such as irreversible demagnetization of permanent magnets due to heat generation under intense operating conditions [4, 5,6,7] and mechanical wear caused by friction [8]. Furthermore, the Turkish textile industry is heavily dependent on imports for this critical component, which are primarily sourced from Germany and China.

This study presents a unique electromagnetic selection device developed to overcome these technical challenges and achieve localization. Unlike conventional designs, this study utilizes hard ferrite magnets to enhance thermal stability and tungsten carbide contact surfaces to maximize wear resistance. Critical design parameters, such as magnetic flux density and holding force, were optimized using ANSYS Maxwell finite element analysis (FEA). The general structure of the electronic flat knitting machine, where the developed needle selection system is integrated, is illustrated in Figure 1.

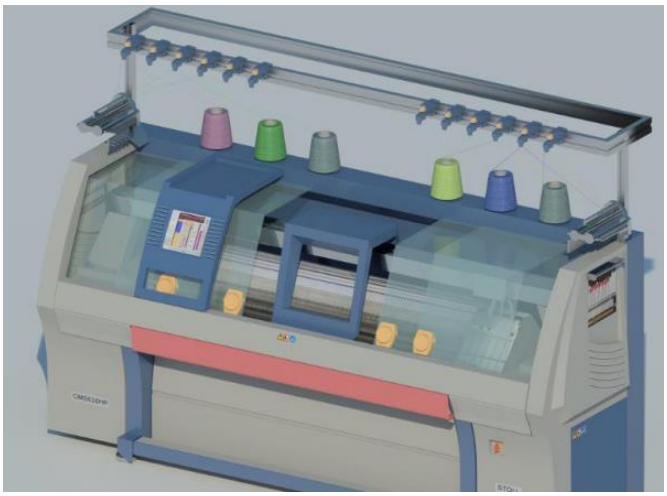

Figure 1: 3D representation of a modern flat knitting machine.

MATERIALS AND METHODS

This study addresses the development of the electromagnetic needle selection system through an integrated approach covering mechanical design, material selection, and electromagnetic analysis. The precise interaction between the selection jacks and the tungsten carbide contact surface during thehold-and-release process is depicted in Figure 2.

Figure 2: Interaction of selection jacks with the electromagnetic selection device.

System Architecture

The designed device consists of four main sub-components: (1) An Electronic Control Unit (ECU) acting as the signal processor and coil driver, (2) A coil group with ferromagnetic cores to direct magnetic flux, (3) A permanent magnet providing the passive holding force, and (4) A contact surface that physically interacts with the selection jacks.

The outer casing is designed in two parts: a cover housing the electronic card and a bottom block containing the magnetic components. The system is configured to operate stably within a temperature range of 0°C to 100°C and a voltage range of 24-30 Volts, suitable for industrial knitting machine conditions. The assembly of the designed actuator and its internal components, including the hard ferrite magnet and wire-wound coils, are presented in the exploded view in Figure 3.

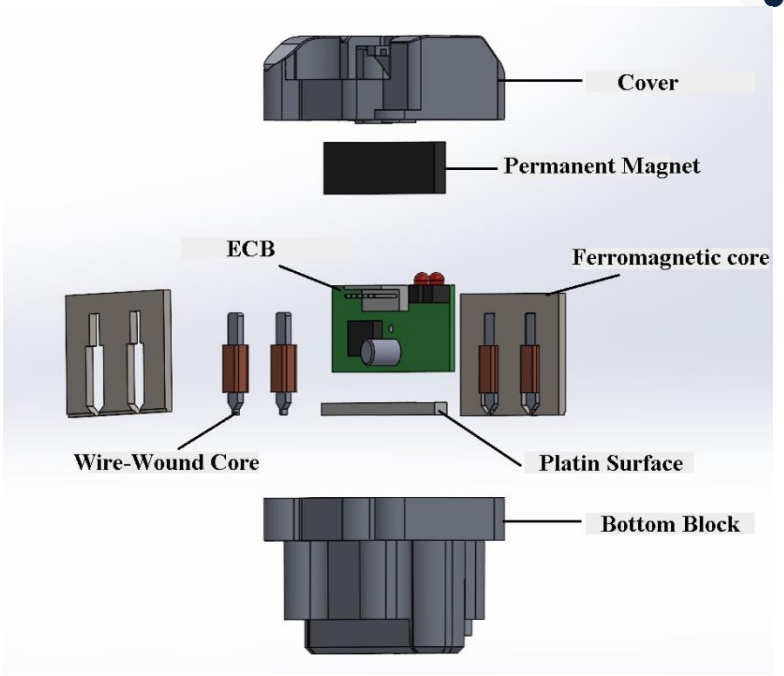

Figure 3: Exploded view of the electromagnetic needle selection device components.

Material Selection and Characterization

To ensure reliability under high-speed and continuous operating conditions, the following material choices were made for critical components:

Permanent Magnet (Hard Ferrite): It was determined that Neodymium magnets carry a risk of demagnetization in an environment where internal machine temperatures reach 70°C and reverse magnetic fields from coils are present. Therefore, Hard Ferrite Magnets were selected for their high thermal stability and coercivity.

Contact Surface (Tungsten Carbide): To prevent wear caused by the continuous impact and friction of selection jacks against the surface, a Tungsten Carbide composite was used. This material aims to achieve a hardness value of ~2000 HV (Vickers) [9].

Casing (Aluminum): Aluminum was chosen as the body material due to its high thermal conductivity, allowing it to effectively dissipate heat generated by the coil group and semiconductors on the electronic card.

Modeling and Simulation

Before prototype production, numerical analysis methods were employed to determine optimum design parameters.

Mathematical Modeling: The system's dynamic response and coil triggering timings were modeled in the MATLAB/Simulink environment.

Finite Element Analysis (FEA): ANSYS Maxwell software [10] was used to optimize magnetic flux paths and coil geometry. The analysis targets were set to achieve a holding force of 1.5-2 N for secure jack retention and a magnetic flux density of 1.1 Tesla for error-free selection.

RESULTS AND DISCUSSION

Design and Electromagnetic Analysis Findings

The electromagnetic performance and magnetic circuit efficiency of the proposed design were comprehensively validated using Finite Element Analysis (FEA) via ANSYS Maxwell software. The primary objective of these simulations was to optimize the coil geometry and core material to achieve a magnetic flux density sufficient for high-speed actuation without reaching magnetic saturation. The analysis results confirmed that the target magnetic flux density of 1.1 Tesla was successfully achieved at the critical air-gap regions, ensuring precise and error-free control of the selection jacks.

Furthermore, the simulations verified the mechanical feasibility of substituting Neodymium magnets with Hard Ferrite variants. The analysis demonstrated that the Hard Ferrite magnets generated a passive holding force in the range of 1.5 – 2 N. This force range is critical for the system's "hold-and-release" reliability; it provides sufficient retention strength to prevent accidental jack release due to machine vibrations, while remaining low enough to be rapidly neutralized by the coil's reverse magnetic field during the selection process. These findings confirm that the designed magnetic circuit operates within the optimal parameters required for industrial knitting applications

Material Characterization

The structural integrity and phase composition of the produced Tungsten Carbide (WC) contact surfaces were rigorously evaluated using X-Ray Diffraction (XRD) techniques. The analysis revealed sharp and distinct intensity peaks characteristic of the hexagonal WC phase, confirming the high purity and successful sintering of the composite material. The diffraction patterns indicated a dense microstructural formation without the presence of detrimental secondary phases (such as brittle eta-phases), which verifies the "suitability" of the material's crystal structure for high-stress applications. Following the structural verification, the mechanical performance was assessed via Vickers micro-hardness testing. The samples exhibited an average hardness value of approximately 2000 HV. This value is a critical indicator of resistance against abrasive wear. When compared to conventional hardened steel surfaces found in standard imported alternatives (which typically range between 600-800 HV), the developed Tungsten Carbide surface demonstrates a significantly superior hardness profile. This substantial increase in surface hardness is projected to minimize the deformation caused by the repetitive, high-frequency impact of selection jacks, thereby directly extending the operational lifespan and reliability of the actuator.

Economic Evaluation

Currently, the Turkish textile industry, despite being a global manufacturing hub, lacks domestic production capabilities for high-precision electromagnetic needle selection systems, resulting in total dependence on imports. This dependency creates a significant economic burden, with an estimated annual foreign currency outflow of approximately 1.5 Million TL solely for spare parts replacement. The prototype developed in this study addresses this challenge by offering a dual economic advantage through import substitution and supply chain security. By localizing production, the project mitigates the foreign currency deficit and eliminates the high logistics costs and customs duties associated with imported counterparts from Germany and China, thereby providing a substantial cost advantage to local manufacturers. Additionally, domestic manufacturing minimizes the risks of supply chain disruptions and reduces lead times, ensuring continuous operation for knitting mills. Furthermore, the commercial potential of the device extends beyond the national market, as evidenced by direct inquiries from textile-producing nations such as Peru and Ecuador. This international interest highlights the product's potential to transform Turkey from an importer of this technology into a competitive exporter in the global textile machinery market.

CONCLUSION

This study validates the feasibility of manufacturing a domestic electromagnetic needle selection system that meets international standards, thereby reducing the Turkish textile industry's dependency on foreign suppliers. Beyond import substitution, the proposed design offers a robust technical solution to the chronic issues of thermal demagnetization and mechanical wear observed in existing commercial actuators. The successful attainment of critical performance metrics, such as 1.1 Tesla magnetic flux density, confirms that cost-effective materials like Hard Ferrite can be effectively utilized in high-speed knitting operations when optimized through advanced finite element analysis. Consequently, this prototype not only offers a significant economic advantage by curbing foreign currency outflow but also promises extended service life through superior material characterization. Future phases will focus on validating these findings through long-term fatigue tests under real-world operating conditions. Parallel to these technical advancements, intellectual property protection processes have been initiated to secure the commercial rights of this unique design.

REFERENCES

[1] D. J. Spencer, Knitting Technology: A Comprehensive Handbook and Practical Guide, 3rd ed. Cambridge, UK: Woodhead Publishing, 2001.

[2] K. Okoyama and T. Morita, "Needle selection device for a flat knitting machine," European Patent EP 0 748 887 A1, Dec. 18, 1996.

[3] Bo Chen, Yu Zeng and Ming-Yu Gao, "Design of the Needle selection system for the computerized flat knitting machines," 2011 International Conference on System science, Engineering design and Manufacturing informatization, Guiyang, 2011, pp. 237-240, doi: 10.1109/ICSSEM.2011.6081286.

[4] N. Bianchi, Electrical Machine Analysis Using Finite Elements. Boca Raton, FL: CRC Press, 2005.

[5] S. R. Trout, "Material selection of permanent magnets considering thermal properties correctly," in Proceedings of the Electrical Electronics Insulation Conference, Cincinnati, OH, USA, 2001, pp. 33-37.

[6] J. F. Gieras, Advancements in Electric Machines. Springer, 2008.

[7] A. Boglietti, A. Cavagnino, D. Staton, M. Shanel, M. Mueller, and C. Mejuto, " Evolution and Modern Approaches for Thermal Analysis of Electrical Machines," IEEE Transactions on Industrial Electronics, vol. 56, no. 3, pp. 871-882, 2009

[8] K. Jia and T. E. Fischer, "Sliding wear of conventional and nanostructured cemented tungsten carbides," Wear, vol. 203-204, pp. 310-318, 1997.

[9] Hardide Coatings, "Properties and applications of nano-structured tungsten carbide coatings," Technical Paper, 2020. [Online]. Available: https://www.hardide.com

[10] ANSYS Inc., *ANSYS Maxwell User's Guide*, "Release 2022 R1, Canonsburg, PA, USA, 2022.

A COMPREHENSIVE REVIEW OF CARBON FIBER REINFORCED POLYMERS (CFRP): MANUFACTURING, PROPERTIES, AND INDUSTRIAL APPLICATIONS

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ABSTRACT

The demand for materials that offer superior mechanical performance without compromising on weight has positioned Carbon Fiber Reinforced Polymers (CFRP) at the forefront of advanced engineering. This presentation provides a detailed technical examination of CFRP composites, exploring the synergistic interaction between high-strength carbon fibers and polymer matrices, including both thermoset and thermoplastic resins. The study begins by analyzing the fundamental structure of carbon fibers, detailing the critical production stages from precursor selection—specifically Polyacrylonitrile (PAN) and Pitch—to stabilization, carbonization, and graphitization, which are essential for aligning carbon atoms to maximize tensile strength.

Furthermore, the presentation evaluates key manufacturing methodologies used in the industry, such as Filament Winding, Prepreg lay-up, and Resin Transfer Molding (RTM), comparing their advantages in terms of production speed, cost-efficiency, and geometric complexity. The unique properties of CFRP, including its high strength-to-weight ratio, excellent fatigue resistance, low coefficient of thermal expansion, and chemical durability, are discussed in contrast to traditional metallic materials like steel and aluminum.

Finally, the study addresses the practical challenges of CFRP, such as high production costs and recycling difficulties, while highlighting its diverse applications across industries. Specific case studies from the automotive sector (chassis components), aerospace industry (fuselage and wing structures), and civil engineering are reviewed to demonstrate the material's versatility. This review aims to provide a holistic understanding of CFRP technology, emphasizing its role in the future of sustainable and high-performance design.

Key Words: Automotive Engineering, CFRP, Light-weighting, Composite Manufacturing, Material Science, Crashworthiness

DIGITAL TRANSFORMATION IN WAREHOUSE MANAGEMENT SYSTEMS: THE SCOPE, PROCESS, AND OPERATIONAL IMPACTS OF THE TRANSITION FROM LVS TO THE LV3+ PLATFORM

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ABSTRACT

This study examines the transition process from an existing LVS-based warehouse management system (Lv3) to an advanced Lv3+ platform within a logistics service provider. The primary aim is to evaluate the effects of digital transformation on process efficiency, data integrity, inventory accuracy, and user performance in warehouse operations. The migration project was implemented in five phases—planning, pilot implementation, evaluation and optimization, gradual rollout, and hyper-care. The findings indicate that the system transition significantly enhanced operational efficiency, with measurable improvements observed in order cycle time, put-away efficiency, and on-time shipment rate. The study reveals that process standardization, data-driven decision-support systems, and user adaptation are the key success factors in logistics digital transformation projects.

Keywords: Logistics, LVS, Warehouse Management System

INTRODUCTION

Warehouse management constitutes a critical component of the supply chain and directly influences a company's competitiveness. Effective warehouse management enables accurate and timely inventory control, rapid order fulfillment, and enhanced customer satisfaction.
As warehouse operations become increasingly complex, the demand for software capable of managing these processes has grown accordingly. Within this context, Warehouse Management Systems (WMS) have emerged as comprehensive software solutions designed to plan and monitor all in-warehouse operations (such as goods receipt, put-away, inventory tracking, order picking, and shipping) in real time (Minashkina & Happonen, 2023). The literature emphasizes that the implementation of WMS provides substantial benefits to enterprises. Table 1 summarizes the literature about this subject.

Table 1: Literature Review

Ref	Year	Explanation
Amoako et al.	2019	Demonstrates a positive correlation between warehouse practices—such as material handling, storage, and inventory management—and firm performance, highlighting how a well-designed WMS strengthens these practices and improves outcomes.
Rahman and Subramaniam	2020	Underlines improvements in accuracy, speed, and cost metrics within their WMS framework.
Liu and Huang	2021	Reveals that the integration of RFID, IoT, and automation technologies with WMS/ERP systems enhances visibility, scalability, and cost advantages, while also emphasizing the importance of effective investment and integration management.
Mulla	2022	Frames the contribution of WMS to efficiency and decision accuracy in terms of information connectivity, equipment automation, and process integration.
Lee and Kim	2022	Demonstrates that advanced WMS functions shorten order cycle time and improve accuracy.
Smith and Johnson	2022	Indicates that WMS and digitalization contribute to sustainability performance by reducing energy consumption, errors, and waste.
Kusrini and Salwa	2023	Reports a significant increase in labor productivity and operational efficiency following WMS deployment.
Peng et al.	2023	Finds that WMS implementation substantially improves supply chain performance in inventory management, capacity planning, and handling practices.
Zhang and Wang	2023	Shows that RFID–WMS integration enhances service levels by improving traceability and speed.

These advantages have become crucial in today's highly competitive logistics sector. Alamsah et al. (2024) further argue that the success of WMS implementations—through system, information, and service quality—significantly enhances both user satisfaction and operational performance.

The increasing global competition and rapid growth of e-commerce have elevated the operational effectiveness of warehouse management systems (WMS) to a strategic priority. WMS solutions provide enterprises with cost advantages and flexibility by ensuring accurate management of inventories, stock flows, and customer demands. In this context, this study analyzes the transition from LVS to Lv3+, an upgraded version of the LVS-based system. The case focuses on TLS Logistics, one of Turkey's leading logistics companies, which aims to standardize systems across multiple warehouses and achieve digital transformation in its operational processes. The main motivations for the transition include enhancing warehouse efficiency, ensuring data integrity, and establishing robust decision-support mechanisms, as well as enabling integration between WMS and other enterprise information systems. The company's vision is to achieve operational excellence by maximizing transparency and traceability across all processes. To align with these objectives, the need emerged to establish globally standardized and consistent business processes across all warehouses. The WMS migration thus aims to ensure operational consistency by applying the same processes and reporting standards enterprise-wide. Additional drivers include overcoming the limitations of the legacy system, strengthening integration among different systems, and minimizing manual interventions. This transformation project represents not merely a technological update but a holistic change encompassing process design, user training, and data integrity. The unique contribution of this research lies in its practical case study approach to a WMS transformation and its quantitative analysis linking system transition to measurable performance improvements.

MATERIALS and METHODS

This study adopts a case study approach to examine the digital transformation process from the Lv3 to the Lv3+ warehouse management system. Data were collected from project documentation, operational performance reports, user surveys, and system logs.

Study Phases

- **Planning and Preparation:** This stage involved analyzing existing processes, mapping data structures, and identifying integration requirements. During this phase, the receipt of incoming goods, rapid stock entry into the system, and automatic delivery confirmation were reviewed in detail. The new system aims to minimize document-based procedures during goods receipt, thereby reducing the time required for product entry into the warehouse.

- **Pilot Implementation (Agena & Regulus Warehouses):** The pilot stage tested the system's functionality on a limited scale and assessed user experience. Core operations included stock management and counting, order management and dispatch, supplier and customer integrations, device integrations, and customer-based reconciliation and invoicing. Goods receipt operations involved accepting incoming goods, quickly entering them into the system, and issuing automatic delivery confirmations. Stock management and inventory counting enabled real-time inventory tracking, automatic location (address) management, and dual-level stock control. Order management and shipping processes included picking, packing, loading, and dispatching customer orders. In supplier and customer integration, the WMS was configured to operate in full synchronization with supplier and customer systems. For RF device integration, handheld terminals and barcode scanners used within the warehouse were adapted to work seamlessly with the new WMS. In customer-based reconciliation and invoicing, the system was designed to support warehouses serving multiple clients by enabling monthly service summaries and automated invoicing for each customer through WMS integration.

- **Evaluation and Optimization:** In this phase, the results of the pilot were compared with the predefined key performance indicators (KPIs), and process flows were revised accordingly to address identified gaps and inefficiencies.
- **Gradual Rollout:** The system was deployed across other warehouses in sequential phases, accompanied by user training sessions and parallel operations to ensure continuity and minimize transition risks.

- **Hyper-Care Period:** This final stage focused on system stabilization, shift-based technical support, and the assessment of user feedback. The hyper-care phase ensured that post-implementation issues were promptly identified and resolved, leading to sustainable system performance.

Data Collection and Analysis

Performance data were collected for both pre-transition and post-transition periods and analyzed using a comparative analysis approach. The primary performance indicators measured were as follows:

- Order cycle time
- Put-away time
- On-time shipment rate
- Inventory accuracy rate
- Error rate per transaction

Data were analyzed using SPSS and Microsoft Excel, employing percentage change analysis, mean difference tests, and graphical evaluations to interpret the results.

RESULTS

The new WMS platform, Lv3+, introduced substantial technological and operational advancements compared to its predecessor, Lv3. With Lv3+, standardized process flows and business rules were defined across all warehouses and operational units, thereby eliminating the process discrepancies previously observed among different locations and achieving global standardization. This standardization enables performance metrics across various locations to be monitored consistently, facilitating the dissemination of best practices throughout the organization. Furthermore, it promotes uniformity in training, documentation, and quality control processes.
The major findings obtained from the study are presented below.

- **Productivity Increase and Speed Enhancement:** The literature indicates that WMS implementation improves order processing speed and increases the number of order lines processed per unit of time. Consistent with this, the present study found that the new system fosters higher automation and optimized workflow structures within warehouse operations. The transition to Lv3+ resulted in shorter dispatch times, reduced unnecessary movements within the warehouse, and a decrease in time cost per transaction. Additionally, minimizing manual data entry and related errors allows employees to focus more on value-added tasks. Overall, Lv3+ contributed to measurable operational efficiency gains, aligning with prior empirical findings on WMS-driven automation and digital optimization.

- **Inventory Accuracy and Visibility:** The new WMS was designed to improve inventory accuracy and inventory visibility through real-time tracking and advanced stock management capabilities. Every product movement (receiving, dispatching, transferring, counting) was recorded instantaneously, ensuring consistency between physical and system-based stock levels. Research has shown that the implementation of WMS substantially enhances inventory counting accuracy. The observed improvements in stock accuracy are expected to reduce costs associated with overstocking or stock shortages, while simultaneously increasing the rate of successful order fulfillment. Moreover, Lv3+ provides consolidated inventory visibility, allowing stock across multiple warehouses to be monitored and managed from a single control point. This facilitates more effective inventory planning across the entire supply chain network, increasing responsiveness and optimizing resource allocation.

- **Advanced Reporting and Analytics:** One of the most significant advantages of the Lv3+ platform lies in its integrated data analytics and real-time reporting capabilities. The new system collects and interprets operational data continuously, providing managers with up-to-date, actionable insights. For instance, metrics such as real-time stock levels, order fulfillment status, and process duration can be monitored through interactive dashboards. These dashboards function as decision-support tools, enabling management to make faster and more accurate decisions. The system also includes a “Control Tower” feature—a high-level visibility platform that enables end-to-end monitoring of the entire supply chain and supports proactive intervention in case of potential disruptions. Through such a logistics control tower approach, anomalies can be identified and resolved before they escalate into operational issues. For example, by integrating WMS and ERP systems, businesses can track inventory levels and order statuses in real time, enabling immediate responses to fluctuations in demand. As a result, stock-outs and delays are minimized, while operational flexibility is enhanced.

- **Easy Integration and Sustainability:** The Lv3+ system is designed to comply with modern integration technologies such as API-based services and web service integrations, ensuring seamless interoperability with other enterprise systems. This architecture allows the WMS to

integrate efficiently with ERP (Enterprise Resource Planning) and TMS (Transportation Management System) platforms. Enhanced integration capability prevents data silos and facilitates continuous data synchronization across systems. For instance, synchronization between WMS and ERP ensures that stock and order data remain consistent across departments, granting all stakeholders access to real-time, unified information. Integration success contributes not only to operational efficiency but also to data consistency. From a sustainability perspective, the modular and scalable architecture of Lv3+ enables the system to adapt to future technological developments—such as warehouse automation equipment and IoT integration. Emerging trends indicate that WMS solutions are evolving toward integration with IoT, artificial intelligence (AI), and automation technologies. Therefore, this project lays a strong foundation for smart warehousing and advanced optimization applications in the future.

- **Quantitative Outcomes:** The analytical results demonstrate that the system transition produced statistically significant improvements in operational performance indicators:
    - Average order cycle time decreased by 18%
    - Put-away time decreased by 22%
    - On-time shipment rate increased from 94% to 98%
    - Inventory accuracy improved from 96% to 99%
    - Overall system error rate decreased by 35%

Moreover, thanks to comprehensive training and participatory testing processes, user adaptation to the new system was achieved within **three weeks**. The presence of **"floor-walker" s**upport personnel was a critical factor in reducing user errors during the early stages of implementation. Finally, the integration between Lv3+, ERP, TMS, and EDI systems enabled **real-time data synchronization,** while real-time control dashboards accelerated decision-making processes across the organization.

DISCUSSION and CONCLUSION

In any system, process standardization, data integrity, and user engagement directly affect operational success. The findings of this study align with the fundamental principles of digital transformation emphasized in the existing literature. In particular, the study demonstrates the effectiveness of phased roll-out and pilot implementation strategies in mitigating operational risks during system transitions. This research highlights that a WMS migration project is not merely a technical transformation, but also a process-oriented and cultural restructuring effort. The transition to the Lv3+ system produced tangible improvements in operational efficiency, inventory accuracy, and customer service levels. However, these achievements were not solely driven by technology; rather, they resulted from structured transition management, active user participation, and ensured data integrity.

Future research should extend this framework by examining the long-term performance effects, cost optimization, and user satisfaction dimensions of WMS transitions. Although the successful completion of the migration project represents a major milestone, it should be viewed as one step in the organization's continuous improvement journey in warehouse management. Going forward, the company should focus on leveraging the full capabilities of the new system. Regular performance monitoring and continuous improvement activities are recommended to sustain and expand the benefits achieved. The impact of the WMS transition on key operational KPIs should be periodically assessed—at 3-, 6-, and 12-month intervals—to validate and quantify performance gains. Metrics such as order cycle time, put-away duration, hourly order line picking rate, on-time shipment percentage, and transaction capacity per user should be continuously tracked through a performance dashboard. By comparing post-transition values with pre-transition baselines, the organization can clearly identify the realized improvements and diagnose underperforming areas that fall short of expected targets.

Corrective and preventive actions should then be implemented based on these insights. This approach not only ensures the verification of project outcomes but also clarifies the return on investment (ROI) of the digital transformation initiative.

In summary, the transition from Lv3 to Lv3+ represents a strategic advancement in warehouse digitalization—combining technological innovation, process optimization, and human adaptation. It provides a strong foundation for future integration with smart warehousing, AI-driven analytics, and IoT-based automation, paving the way toward a more efficient, data-driven, and sustainable logistics ecosystem.

REFERENCES

Alamsah, U., Muftiadi, A., & Arifianti, R. (2024). *Comparative analysis of outsourcing and in-house warehouse management systems to improve productivity and stock accuracy*. JPPI, 10(4), 908–919.

Amoako, G. K., Acquah, I. S. K., & Arthur, D. A. (2019). *Warehouse management practices and firm performance: Empirical evidence from Ghana.* Cogent Business & Management, 6(1), 1–17.

Kusrini, E., & Salwa, N. (2023). *Warehouse management system implementation and its impact on operational efficiency: Evidence from manufacturing warehouses.* Procedia Computer Science, 225, 1124–1133.

Lee, S., & Kim, H. (2022). *Impact of warehouse management system adoption on firm performance: An empirical analysis using DeLone–McLean success model.* Journal of Industrial Engineering & Management, 15(2), 121–135.

Liu, X., & Huang, J. (2021). *Warehouse management systems in supply chain integration: Effects on order fulfillment and inventory accuracy*. International Journal of Production Research, 59(18), 5521–5534.

Minashkina, D., & Happonen, A., (2023). *Warehouse Management Systems for Social and Environmental Sustainability: A Systematic Literature Review and Bibliometric Analysis*, Logistics, 7(3), 40.

Mulla, F. M. (2022). *Challenges and strategic best practices for successful implementation of warehouse management systems (WMS).* Journal of Mathematical & Computer Applications, 1(2), 1–4.

Peng, J., Yue, W., Müller, J., & Zhang, S. (2023). *Improving the quality of warehousing processes in the context of Industry 4.0: A study in the logistics sector.* Sustainability, 16(6), 2595.

Rahman, M., & Subramaniam, R. (2020). *RFID-enabled warehouse management systems and their impact on supply chain visibility.* Sustainability, 12(17), 6957.

Smith, T., & Johnson, L. (2022). *A literature review of smart warehouse operations management: Information interconnection, automation, integration, and sustainability.* Journal of Logistics & Supply Chain Innovation, 3(1), 45–68.

Zhang, X., & Wang, Y. (2023). *The effect of implementing a warehouse management system on operational efficiency: Evidence from Indonesia.* European Supply Chain Review, 5(2), 127–140.

INTEGRATION OF CORPORATE REPORTS INFRASTRUCTURE INTO DATA WAREHOUSE ENVIRONMENT

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ABSTRACT

In-house report data consists many different type and formatted data. In-house data sets involve managing all properties of data gathering in a company, firm and/or organization. This approach offers greater control and potential for higher data quality, but requires careful consideration of the associated costs. This study covers the transfer and integration of in-house report data sources from live queries and procedures to report tables updated at specific intervals, using procedures to populate them, and the data warehouse (DWH) environment. The primary reasons for this study were the long report update times and the need to perform more control or improvements on report sources. Report-based DWH implementations significantly reduced report update times and facilitated faster resolution of errors and problems.

Keywords: Logistics, in-house data, data wareshouse

INTRODUCTION

This study aims to collect data obtained from various systems used by TLS Logistics Inc., one of Türkiye's leading logistics companies and located in Tuzla, Istanbul's gateway to Anatolia, under a single Data Warehouse (DWH) environment.

Each of the software used by this company as an ERP, which handles numerous operations including logistics and finance, is used for internal process management, inventory data collection, and project tracking, generating a wealth of data. These software programs are generally categorized as follows: ERP software: Siber; internal process management software: TFLOW; inventory data collection

software: GLPI; and project tracking software: Redmine. Data from these software, applications, and systems is transferred and integrated into the TDWH database under a single reporting server.

All data in all IT systems is stored in databases. Therefore, there are numerous database systems on the market, varying in purpose, size, and operating method, and the integration of these systems is crucial for the efficiency and compatibility of IT systems. This study combines data held in different database systems (MySQL, PostgreSQL, SQL Server) into a single environment, creating an infrastructure for using tables from multiple sources together for common analysis and reporting purposes.

This study also has various objectives. One of the primary objectives of this study is to prevent access difficulties and data consistency issues arising from storing data in different systems.

Problems such as extended report runtimes due to direct connection to live data, difficulty in taking action in case of errors or improvements, and data security risks arising from accessing live tables are present. The potential damage from this problem can be greater than in other sectors, especially in sectors such as logistics and supply chain, due to the use of live and dynamic data. This study aims to resolve these problems and create a more secure, faster, and manageable reporting infrastructure. In the literature, there are some studies about data warehouse integration reports.

Ghosh et al. (2015) study is a study about data warehouse in business intelligence (BI). This study tries to examine a data warehouse structure and constitute an architecture about BI components as OLAP (Online Analytical Processing), KDD (Knowledge Discovery in Database) and so on.

Nookala (2023) study presents a comparative analysis about real-time data integration in traditional data warehouses. In this study the authors analyzes case studies and the criteria in real organizations. Some of these criteria are latency, scalability, limitations and consistency.

Calvanese et al. (2001) is a general study about data integration in data warehousing. In this study, authors present a method to obtain materials in data warehouse system. Kahn et al. (2022) study researches data warehouses to a public cloud, it explains the challenges amd the opportunities of the system.

Zeng et al. (2003) study explains enterprise integration wit advances information technologies and it amalyzes the relationship between ERP and data warehousing. For this analysis, two case studies have been examined and some criteria are compared.

Nemati et al.(2002) study presents a knowledge warehouse and explains an architectural integration of knowledge management, decision support, artificial intelligence and data warehousing. The main purpose of this study is to propose the data warehouse model architecture that will not only facilitate the capturing and coding of knowledge.

Güneş ve Birgin (2023) study presents an implementation data warehouse infrastructure for an e-learning system, Anadolum e-Kampus. The data warehouse has made it easy to obtain student analytics for various periods, including daily, monthly, and yearly. The reports provided through this infrastructure are used in studies to increase the quality of the LMS system.

Hasanati et al. (2021) designs data warehouse for academic data in Academic Information System (AIS) and other systems integration at a university in Indonesia. This university is UIN Syarif Hidayatullah Jakarta campus that accommodates the need for data history and archiving to support reports in the academic field.

Sæbø et al. (2011) study compares strategies to integrate health information systems following a data warehouse approach in different countries as Zanzibar, Sierra Leone and Botswana. In these four

different countries, four different case studies are examined four technical properties. Bankole and Lateefat (2023) study examines data reports about financial systems.

Ugonnia et al. (2024) study is a study about data warehouse in green computing. This study explains the integration data warehouse and big data technologies in green computing field and the study examines the environmen criteria of integration.

MATERIALS and METHODS

The data warehouse transfer process containing the data in the study was carried out using SQL. This process used report-based stored procedures over SQL. Subsequently, resources on different servers, computers, and technological infrastructures were analyzed. Linked server connections were established for this data (for example, the MYSQL database system, which is the source of the GLPI application, which is the source of IT Inventory), and the query was run on the main server using OPENQUERY or EXECUTE AT in the relevant report procedures. This structure then returned the results to the DWH server, enabling optimization of the timeframe. A different planning was implemented for SQL database systems such as Siber, one of the structures and software used by TLS Logistics, the host of this study. Because this data resides on the same server as the existing DWH database, operations such as OPENQUERY or EXECUTE AT were not used, and the processes were carried out in accordance with existing studies. The procedures in this study consist of five steps:

- Extract: Data is drawn from the source systems used by TLS Logistics (Cyber, TFLOW, Redmine, etc.) at specified times through established jobs and transactions. During these data extraction processes, additional logging is also done and the logs are made to the DWHLog table. Thanks to these logs, the integrity and characteristics of the captured data are checked daily by the company's Digital Transformation Team, and thus potential problems are resolved in a short time.

- Transform: Data within TLS Logistics is cleaned, transformed and enriched in accordance with business rules specific to logistics processes. The data mentioned here may be, for example, location codes, customer codes, codes used during transportation, and date data. In this process, first the conversion steps and rules are documented, and then, as in the other stages, faulty or missing data, or in other words errors and deficiencies in the data, are reported and notified to the relevant units. Apart from incorrect and missing data, there may also be data marked as undefined in the report, in which case the necessary units are informed. Afterwards, the quality of the data is checked, and during this control, criteria such as consistency, integrity, and accuracy are examined.

- Load: In this stage, the data converted in the previous stage is handled and loaded into the DWH database in the system. As in every stage, errors may occur at this stage. Accordingly, if any errors occur during uploading to the database, logs of these errors are kept and reported to the relevant units, as in the previous stages. After the entire upload process is completed successfully, the next step is to check the data integrity and consistency. Again, after this integrity and consistency check is completed, the loading processes are automated and the monitoring process begins.

- Tracking and Reporting: At this stage, all ETL transactions are logged into the TDWH_History database. The last 30 days of this monitoring and reporting process and the last 30 days before the Friday of the last 10 weeks are also considered. The screenshots of the records on these days are written to the relevant tables in the TDWH_History database. The main reason for this tabulation process is to resolve the inconsistency in case there is an inconsistency between logs, records, etc. At this stage, processes are monitored regularly, performance and error reports are prepared, and process improvement studies are carried out when necessary. As a result of this process, information such as the running time and number of rows of each table is logged in the DWHLog table to analyze how much a procedure has changed in terms of time compared to previous times.

- Security: All data used in ETL processes at TLS Logistics, the host of this study, is protected in accordance with the company's information security policies. Access to reports fed from DWH tables is restricted by function using RLS and regularly reviewed.

RESULTS

Within the system designed for this study, the extract, transform, load, tracking, reporting, and security stages were implemented, as described in previous sections. Numerous operations were performed on the data during these stages. As a result, the report table at TLS Logistics, the host of the study, was integrated into the data warehouse and database systems. During the study, a total of more than 90 report tables were integrated into the data warehouse and database systems. This integration process is carried out daily, and during each integration, errors and omissions in the data and processes are identified. The process is completed after these errors and omissions are resolved. Significant reductions in daily report updates are observed, making the process more efficient and faster, errors are reduced, and reports are easier to create. All of this has been shown to simplify data verification of reports and, indirectly, increase their consistency.

CONCLUSIONS

This study aims to collect data obtained from various systems used by TLS Logistics Inc., one of Türkiye's leading logistics companies and located in Tuzla, Istanbul's gateway to Anatolia, under a single Data Warehouse (DWH) environment. In the literature, there are some studies about data warehouse integration reports. This study summarizes and compares these studies. The procedures in this study consist of five steps. In extract phase, data is drawn from the source systems used by TLS Logistics (Cyber, TFLOW, Redmine, etc.) at specified times through established jobs and transactions. In transform phase, data within TLS Logistics is cleaned, transformed and enriched in accordance with business rules specific to logistics processes. In load phase, the data converted in the previous stage is handled and loaded into the DWH database in the system. In tracking and reporting phase, all ETL transactions are logged into the TDWH_History database. In security phase, all data used in ETL processes at TLS Logistics, the host of this study, is protected in accordance with the company's information security policies. During the study, a total of more than 90 report tables were integrated into the data warehouse and database systems. This integration process is carried out daily, and during each integration, errors and omissions in the data and processes are identified.

This study demonstrates that a data warehouse-based structure significantly contributes to the speed and accuracy of corporate reporting processes. Future work aims to complement the DWH work completed in the 9/28 report with the remaining 19 reports and maintain this structure in newly developed reports.

REFERENCES

Bankole, F.A., Lateefat, T., (2023), Data-Driven Financial Reporting Accuracy Improvements Through CrossDepartmental Systems Integration in Investment Firms, International Journal of Advanced Multidisciplinary Research and Studies, Vol.3, No.6, 2080-2097

Calvanese, D., De Giacomo, G., Lenzerini, M., Nardi, D., Rosati, R., (2001), Data Integration In Data Warehousing, International Journal of Cooperative Information Systems, Vol.10, No.3

Ghosh, R., Haider, S., Sen, S., (2015), An integrated approach to deploy data warehouse in business intelligence environment, Proceedings of the 2015 Third International Conference on Computer, Communication, Control and Information Technology (C3IT)

Güneş, İ., Birgin, M.K., (2023), Implementing data warehouse infrastructure for an e-learning system, Gümüşhane University Journal of Science and Technology, Vol.13, No.3, 750-756

Hasanati, N., Khudzaeva, E., Nurmiati, E., (2021), Designing Data Warehouse for Academic Data Integration at the University in Indonesia, International Conference on Cyber and IT Service Management (CITSM)

Kahn, M.G., Mui, J.Y., Ames, M.J., Yamsani, A.K., Pozdeyev, N., Rafaels, N., Brooks, I.M., (2022), Migrating a research data warehouse to a public cloud: challenges and opportunities, Journal of the American Medical Informatics Association, Vol. 29, No. 4, 592–600

Nemati, H.R., Steiger, D.M., Iyer, L.S., Herschel, R.T., (2002), Knowledge warehouse: an architectural integration of knowledge management, decision support, artificial intelligence and data warehousing, Decision Support Systems, Vol.33, No.2, 143-161

Nookala, G., (2023), Real-Time Data Integration in Traditional Data Warehouses: A Comparative Analysis, Journal of Computational Innovation, Vol.3, No.1

Sæbø, J.I., Kossi, E.K., Titlestad, O.H., Tohouri, R.R., Braa, J., (2011), Comparing strategies to integrate health information systems followinga data warehouse approach in four countries, Information Technology for Development, Vol. 17, No. 1, 42–60

Ugonnia, J.C., Olaniyi, O.O., Olaniyi, F.G., Arigbabu, A.A., Oladoyinbo, T.O., (2024). Towards Sustainable IT Infrastructure: Integrating Green Computing with Data Warehouse and Big Data Technologies to Enhance Efficiency and Environmental Responsibility, Journal of Engineering Research and Reports

Zeng, Y., Chiang, R.H.L., Yen, D.C., (2003), Enterprise integration with advanced information technologies: ERP and data warehousing, Information and Computer Security, Vol.11, No.3, 115–122

THE EFFECT OF HANGER ELEMENTS ON THE NATURAL FREQUENCIES AND MODE SHAPES OF A VENTILATION DUCT

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ABSTRACT

The dynamic behaviour of ventilation ducts is an important research topic in engineering, particularly due to vibration and noise observed in thin-walled structures. However, the performance and the structural integrity of the system can be adversely affected when the resonance phenomena occurs. Therefore, shifting the natural frequencies into a safe operating range and controlling vibration levels are of great importance.

In this study, the modal behaviour of a ventilation duct is examined, and the potential improvements in the system's dynamic characteristics are investigated by altering the positions of the suspension points and adjusting the spring constants of the suspension elements. A frequency response function–based approach is adopted to determine the effects of these modifications on the natural frequencies.

In this study, a commonly used section of a ventilation duct was considered, and the variations in its natural frequencies and mode shapes were examined for different suspension configurations. The analyses revealed that the vibration characteristics of the duct are influenced by structural modifications related to the locations of the support points. The modal analysis results provide important insights for understanding resonance behaviour in duct systems and for preventing vibration-induced noise problems.

Keywords: Ventilation Duct, Modal Analysis, Natural Frequency, Vibration, Structural Modification, Finite Element Method.

INTRODUCTION

In modern buildings, ventilation ducts are widely used to provide air conditioning and maintain indoor air quality, and they are exposed to various dynamic loads during operation. This situation leads to unwanted vibration and acoustic noise problems in duct systems. Due to their thin-walled sheet-metal construction, these structures can easily enter resonance under dynamic loads caused by environmental effects, fan vibrations and airflow, as their rigidity is relatively low. For this reason, determining the natural frequencies and mode shapes of ventilation ducts is of great importance for maintaining the structural integrity of the system. The dynamic characteristics of ventilation systems are influenced not only by the geometric and material properties of the duct, but also by the support conditions, the location

of connection points and any structural attachments. Therefore, during the design process, the modal behaviour of the duct should be analyzed in advance, and if necessary, structural modifications should be applied to improve the dynamic properties of the system.

Several studies have shown that boundary conditions and suspension characteristics significantly influence the dynamic behaviour and natural frequencies of ventilation duct systems (Chavan and Venkatesham, 2015; Bautista Ordoñez et al., 2017; Tang et al., 2023).Previous research has shown that ANSYS-based finite element analysis is a reliable tool for evaluating the dynamic behaviour of engineering structures, as demonstrated across various materials and geometries (Saini et al., 2021; Ahiwale et al., 2022; Kovalovs et al., 2024). In engineering applications, it is often necessary to reanalyse a system when geometrical or physical modifications are required. In this case, remodelling and re-analysing the system is very consuming time especially for large system. The structural modification techniques can be used to overcome this challenge. This technique is processed as direct or inverse structural modifications. The direct structural modification is used to determine the dynamic properties of a system after known modifications. Conversely inverse structural modification is used to determine the necessary modifications so that the structure under investigation has the desired dynamic properties. Both techniques are based on using modal properties or frequency response functions (FRFs) which can be get from numerical or experimental modal analysis. Several studies have demonstrated the effectiveness of receptance-based and FRF-driven structural modification approaches, particularly in identifying nonlinearities, updating FE models, and determining the required changes to achieve targeted dynamic behaviour (Özer et al., 2005; Kozak et al., 2007). Ouyang and his collaborators (2012a, 2012b) developed several methods aimed not only at achieving the desired natural frequencies but also at obtaining the corresponding mode shapes. These studies present different approaches that make use of the system's modal properties, physical parameters, or direct receptance functions, each offering its own advantages and limitations. One of the efficient structural modification methods that uses FRFs is based on the Sherman–Morrison formula (Çakar (2011), Hüseyinoğlu and Çakar (2017), Çakar (2018)).

Although numerous studies in the literature have examined the dynamic characteristics of beams, plates, pipes, and fluid-conveying structures, detailed modal analyses of ventilation ducts with realistic geometries and support configurations remain limited. In particular, the effects of support point locations on natural frequencies and mode shapes have been addressed in only a small number of studies. Furthermore, many studies have relied on idealized boundary conditions and homogeneous structures, without sufficiently investigating the influence of practical suspension elements such as hanger rods on structural dynamics. In this context, the present study numerically investigates the dynamic behaviour of a rectangular ventilation duct segment using the (FEM), with a particular focus on the effects of support configurations—designed in accordance with relevant standards—on the natural frequencies and mode shapes via structural modification technique. This study aims to fill a gap in the literature and provide dynamic insights that can be utilized in practical engineering design applications.

ANALYSIS MODEL

Real ventilation systems used in practical applications consist of highly complex assemblies made up of multiple interconnected ducts, connection components, suspension systems, and various boundary conditions. In such systems, duct sections are typically joined to one another through bolted, welded, or flanged connections. The system is mounted to the upper parts of the building using elements such as rods, hanger bars, cross members, or flexible suspension components. These configurations significantly influence the dynamic response of the system and may lead to localized mode shapes, mode coupling, or the resonance conditions. Figure 1 shows a section of the ventilation duct located in the laboratories of Fırat University.

Figure 1. A section of the ventilation duct located in the laboratories of Fırat University.

In this study, an idealized analysis model was selected in order to evaluate the fundamental dynamic characteristics of the system within a simpler and more controllable framework. The model consists of a rectangular ventilation duct segment and a rod-type support element rigidly connected to the duct at two points. This approach allows the effects of the geometric and structural properties of the system on the modal parameters to be assessed in an isolated manner. It also provides an advantage in clearly identifying the natural frequencies and mode shapes of the duct.

Several assumptions were adopted throughout the study:

The duct was modeled using a homogeneous and isotropic material.

The duct wall thickness was assumed to be constant, and manufacturing-induced geometric imperfections were not considered.

The suspension elements were modeled as cylindrical steel components exhibiting linear elastic behaviour, and the connection points were assumed to be rigid.

The duct was considered to be suspended from a fixed support through these suspension elements, and environmental damping effects were neglected.

The modal analysis and FRF calculations were carried out within the framework of linear elasticity theory.

This simplified model allows the modal characteristics to be systematically analyzed and compared, providing a basis for transitioning to more complex systems.

In this study, a thin-walled ventilation duct with a rectangular cross-section was selected as the subject of analysis. Due to its thin-walled construction, this structure is highly sensitive to dynamic excitations arising from the air fan, airflow in the duct, boundary conditions, and environmental effects. Ventilation ducts are supported at specific points using suspension elements, and these connections have a direct influence on the vibration behaviour of the duct. For this reason, they were included in the analysis. The rods were made of steel and positioned on the upper surface of the duct at distances specified by the relevant standards. In all analyses, the duct was modeled with a fully fixed (cantilever) boundary condition at its inlet end, ensuring zero displacement and rotation at the support. The overall

configuration of the system is shown in Figure 2. The material properties of the steel sheet used in the duct and the suspension elements are given in Table 1 below.

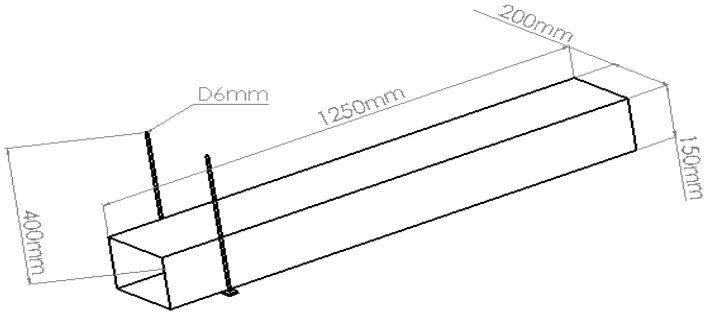

Figure 2. Technical Drawing and Dimensions of the Duct

Table 1. Mechanical properties of the material used in the system

			Sheet Metal	Hanger rod (Suspension)
Property	Symbol	Unite	Value	Value
Elastic Modulus	E	Pa	2.1×10^{11}	2.1×10^{11}
Poisson's Ratio	ν	–	0.3	0
Density	ρ	kg/m^3	7850	7850

The suspension element was modelled as an equivalent spring in the analysis model. Based on its axial stiffness, the equivalent spring constant k was calculated using the following formula:

$$k = \frac{EA}{L}$$

Here, A is the cross-sectional area, d is the diameter of the hanger rod, and L is the length of the rod.

$$d = 0{,}006m \Rightarrow A = \frac{\pi d^2}{4} = 2{,}8274 * 10^{-5} m^2$$

$$L = 0{,}4m,\ E = 2{,}1 * 10^{11} Pa$$

$$k = \frac{(2{,}1*10^{11}*2{,}8274*10^{-5})}{0{,}4} \cong 1{,}48 * 10^{7} N/m$$

an equivalent spring constant was obtained accordingly. The suspension elements were modeled as linear springs providing stiffness only in the axial direction. For this reason, the Poisson's ratio of the suspension elements was taken as zero.

MODE SHAPES AND NATURAL FREQUENCIES OF A VENTILATION DUCT

A vibration analysis of a rectangular ventilation duct segment was carried out in ANSYS Workbench, and the Block Lanczos method was used in the computations. The objective is to determine the natural frequencies of the duct and the corresponding mode shapes. The results provide valuable insight into the vibration characteristics of the duct and form a basis for potential structural improvement studies. Within the scope of the analysis, not only the vibration characteristics of the duct geometry but also the way the system is supported by the suspension elements was taken into consideration.

The three-dimensional CAD model of the ventilation duct was created in SolidWorks, and the necessary material definitions were assigned in ANSYS Mechanical. The mesh was generated with sufficient refinement to ensure adequate numerical accuracy. A total of 416 nodes were identified on the model. The system is clamped along the plane defined by $x = 0$ and $y = 0$, providing a fully fixed boundary condition at that end. The appearance of the model in ANSYS Mechanical is shown in Figure 3. The obtained first eight natural frequencies of the system are given in Table 2.

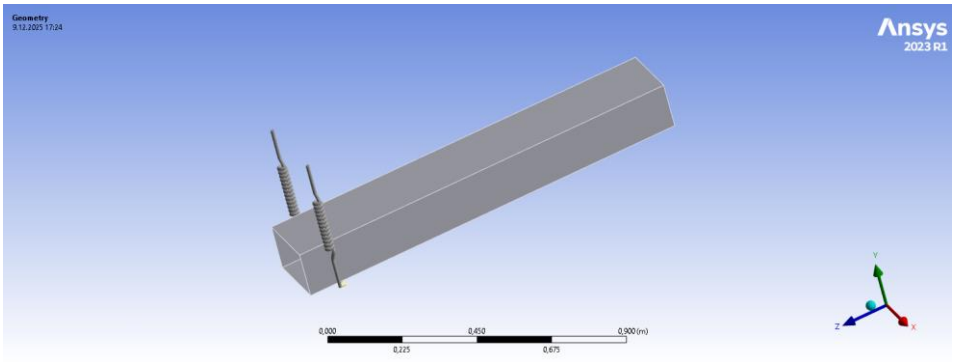

Figure 3. ANSYS Mechanical representation of the model

Table 2. The first six natural frequencies of the model

Mode	1	2	3	4	5	6
Frequency (Hz)	40,561	42,079	45,091	49,692	55,988	57,828

The equation used in the eigenvalue problem of the modal analysis is given below:

$$[K - \omega^2 M]\{\emptyset\} = 0 \quad (1)$$

In this formulation, K represents the stiffness matrix, ω the natural frequency, M the mass matrix, and $\emptyset$ the corresponding mode shape vector. The mode shapes corresponding to Modes 1 through 6 are presented in Figure 4. Each mode reflects the deformation characteristics of the cantilevered duct, and for clarity, the hanger springs were suppressed in the visualization.

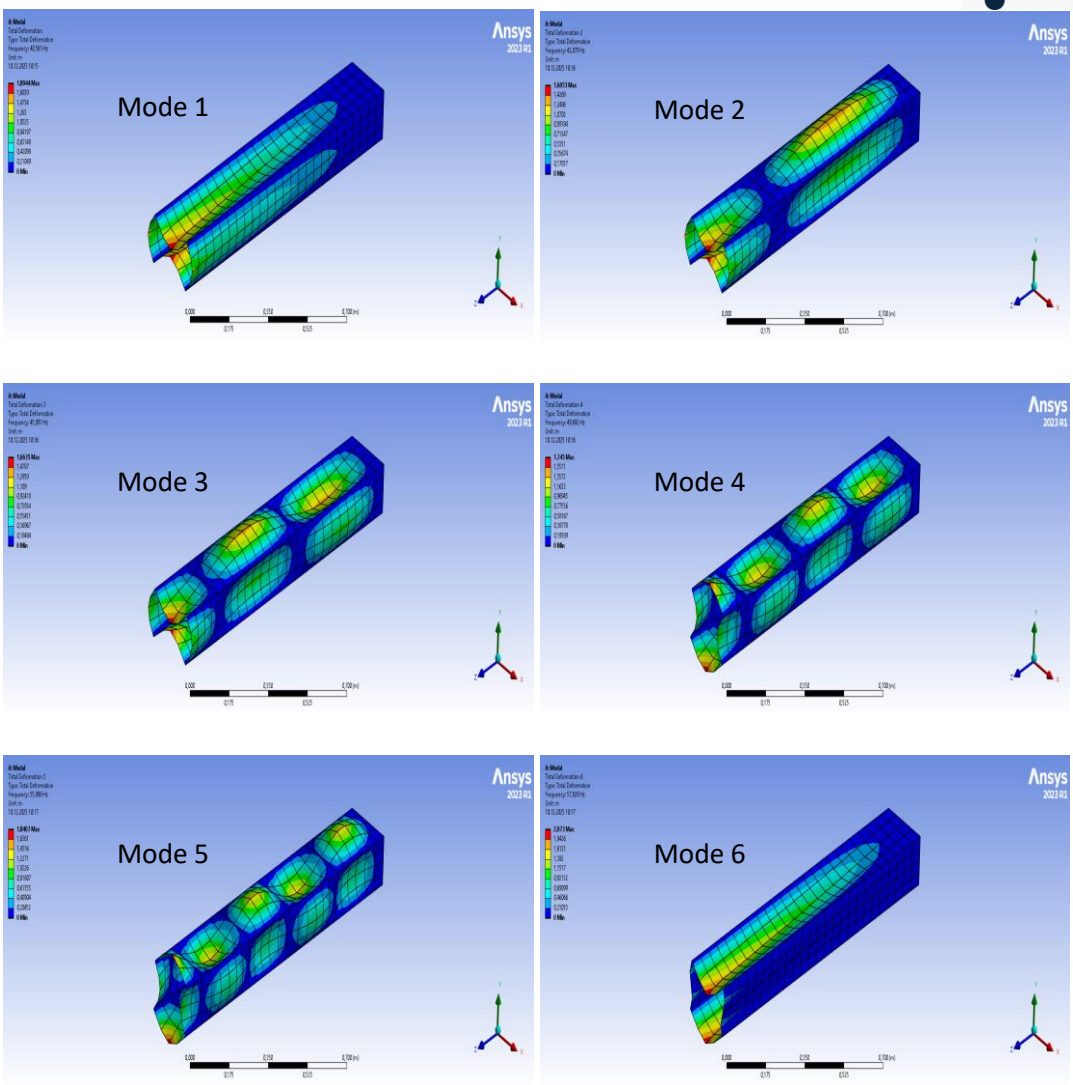

Figure 3. Mode shapes for Modes 1 to 6

The mode shapes shown in Figure 4 can be described as follows:

Mode 1 (40.56 Hz) exhibits a single half-wavelength deformation pattern with cantilever-like behaviour. In Mode 2 (42.08 Hz), a similar single half-wavelength deformation occurs in the vertical plane. Mode 3 (45.09 Hz) involves rotational motion about the longitudinal axis of the structure, with the maximum angular deformation appearing at the free end.

Mode 4 (49.69 Hz) presents a combined deformation pattern in which torsional and lateral bending components occur simultaneously. Mode 5 (55.99 Hz) consists of a different-phase combination of torsional and lateral bending components. In Mode 6 (57.83 Hz), the deformation is predominantly concentrated near the fixed end.

INVESTIGATION OF THE EFFECTS OF SUSPENSION RELOCATION AND STIFFNESS VARIATIONS

In this section, the dynamic behaviour of the duct was examined under various structural modification scenarios by using Sherman–Morrison (SM) Formula. Two groups of modifications were considered. In the first group, the support springs were shifted by 15 cm to investigate how geometric repositioning affects the natural frequencies and FRF characteristics. In the second group, the diameter of the hanger rod was altered to obtain a new spring stiffness, representing practical manufacturing-based stiffness variations. For each scenario, the analytically modified FRFs obtained via the structural modification method were compared with the natural frequencies calculated from the numerical model. The discrepancies between the results were discussed within the theoretical limitations of the structural modification approach.

Method

This study employs a receptance-based Structural Modification method rooted in the Sherman–Morrison (SM) Formula to predict the dynamic behaviour of the ventilation duct after changes in its physical properties. The SM method uses only the FRFs of the original configuration and does not require direct access to the mass or stiffness matrices. The modified receptance matrix $[\alpha *]$ can then be expressed in terms of the original receptance $[\alpha]$ and the matrices representing the applied mass or stiffness changes:

$$\alpha^* = \alpha - \alpha u(1 + v^T \alpha u)^{-1} v^T \alpha \qquad (2)$$

where u and v are vectors defining the coordinates where the structural modification is applied. For a spring attached to ground, the modification matrix reduces to $\Delta k u u^T$. This formulation allows the FRF of the modified system to be computed directly using the known FRFs of the original system (Çakar (2011), Hüseyinoğlu and Çakar (2017), Çakar (2018)).

Several modifications are introduced sequentially using the SM formula, enabling prediction of the final system response after multiple mass or stiffness changes. Since the formulation operates only on active coordinates it is computationally efficient and suitable for experimental as well as numerical applications. The FRFs of the original system considered in this study were computed in MATLAB. The necessary modal parameters are extracted from the ANSYS ModeDump files.

Modification Scenarios

In this section, several structural modification cases are evaluated to examine how changes in spring locations and spring stiffness affect the dynamic characteristics of the ventilation duct. Each scenario is independently applied to the baseline model, and the resulting natural frequencies and FRF are compared to assess the sensitivity of the system to these modifications.

Scenario-1: Relocation of the Hanger Support (-15cm)

In this scenario, the suspension points are shifted $15\ cm$ toward the inlet direction of the duct. FRFs of the modified system are calculated by using Eq.2. and one of them compared with the original FRF in Figure 5. In the figure, H_0 represents the FRF of the original system, whereas H_1 denotes the FRF of the modified system. Since the springs provide positional constraints that directly influence the system's stiffness distribution, even a small shift in their attachment points leads to a noticeable reorganization

of modal participation. The updated model shows that the first global bending mode increases in frequency, while higher modes exhibit smaller but systematic shifts. These changes are also observed in the FRF plot, particularly in the amplitude and peak locations around the first and second global modes.

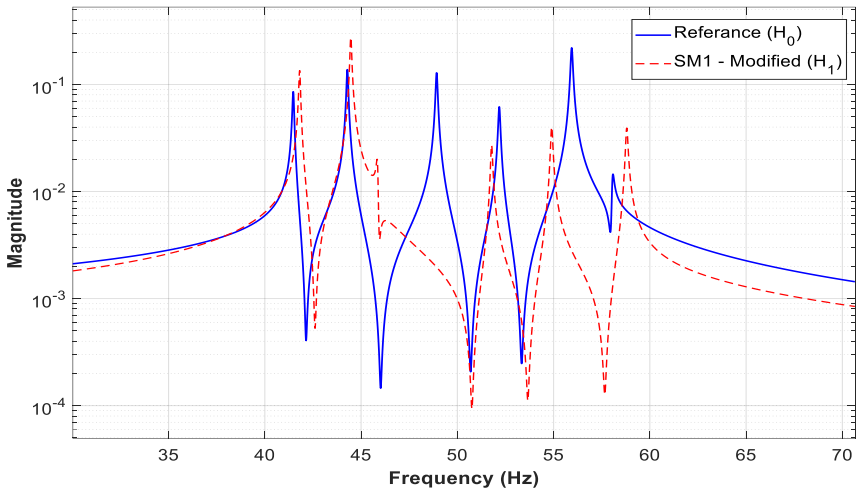

Figure 5. Comparative FRF of the original system and the modified system obtained by shifting the suspension point by 15 cm

The comparison of the receptance curves for the original and modified configurations shows that relocating the suspension supports produces distinct changes in both the resonance frequencies and the amplitude characteristics of the first six modes. The first two bending modes exhibit the most significant frequency shifts, accompanied by a noticeable redistribution of peak amplitudes, indicating that these modes are highly sensitive to the geometric position of the hangers For the higher modes, the deviations between H_0 and H_1remain present but are smaller in magnitude, confirming that the influence of support relocation gradually diminishes with increasing modal order. Overall, the FRF comparison demonstrates that a $15\ cm$ shift in hanger location alters the global dynamic characteristics in a systematic and physically consistent manner.

To quantify the relative impact of the hanger relocation on the system dynamics, the amplitude ratio H_1/H_0 and difference $|H_0 - H_1|$ were evaluated across the full frequency range and plotted in Figure 6.

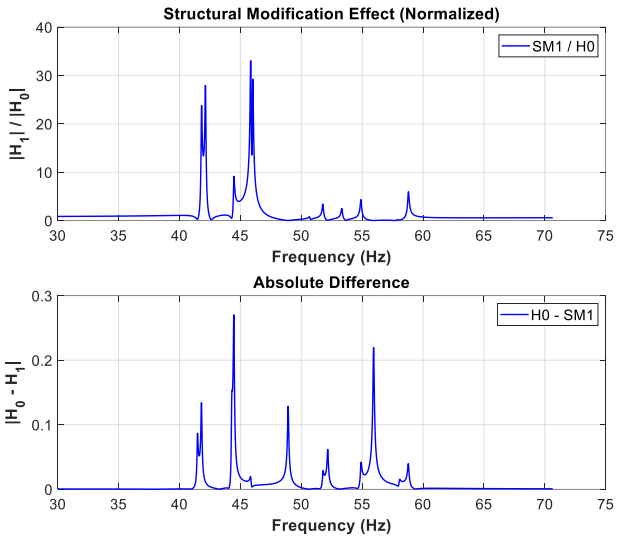

Figure 6. Amplitude ratio H_1/H_0 and difference $H_0 - H_1$ for the suspension relocation scenario.

The amplitude ratio plot indicates that the hanger relocation produces the most pronounced relative changes around the first two global modes, where the ratio exhibits sharp peaks exceeding an order of magnitude. This behaviour confirms that the lower-frequency bending modes are highly sensitive to the geometric positioning of the suspension supports. In the higher modes (approximately $50-60\ Hz$), the amplitude ratio remains above unity but with significantly reduced magnitude, demonstrating that the influence of the modification diminishes as modal order increases. Overall, the ratio distribution provides a clear quantitative measure of how the support shift alters modal participation within the first six modes.

Scenario-2: Hanger Diameter Reduction

In this scenario, the axial spring constant was recalculated by reducing the diameter of the suspension road (from 6 mm to 4 mm). The resulting spring constant was found to be $6{,}6 \times 10^6\ N/m$. The FRFs of the modified system were calculated using Eq.(2) and one of them was compared with the original FRF in Figure 7. It was observed that reducing the diameter of the suspension road did not significantly change the boundary conditions or affect the vibration modes of the system.

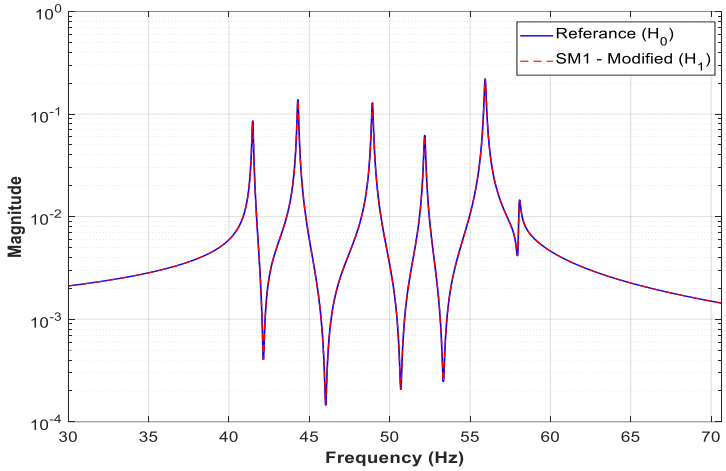

Figure 7. Comparative FRF graph of the original system and the modified system obtained by reducing the hanger rod diameter

As expected, the FRF curves of the original and modified systems almost completely overlap, indicating that the stiffness reduction caused by decreasing the rod diameter produces only minor changes in the global dynamic behaviour. The resonance frequencies and peak amplitudes remain nearly identical for all six modes, demonstrating that the hanger stiffness variation is not a dominant parameter in the overall modal characteristics of the duct (Figure 7). To reveal subtle differences that are not visible in the raw FRF curves, the amplitude ratio H_1/H_0 and difference $|H_0 - H_1|$ are evaluated in Figure 8.

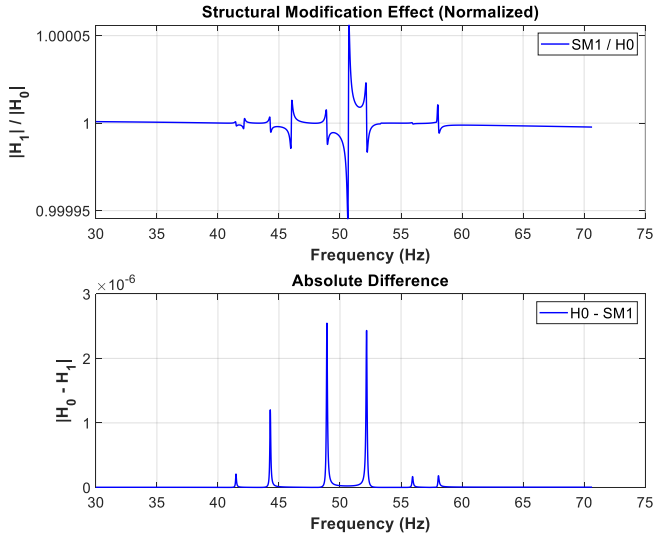

Figure 8. Amplitude ratio H_1/H_0 and difference $H_0 - H_1$ for the hanger diameter reduction scenario

As expected the amplitude ratio plot highlights extremely small yet measurable differences between the two configurations. The ratio remains almost exactly equal to unity across the frequency range, with only slight perturbations occurring near the resonance peaks. These localized variations, on the order of 10^{-6}, indicate that the reduction in hanger rod diameter introduces only a minimal change in modal participation. This behaviour suggests that the change in the spring stiffness of the hanger supports is

not sufficiently large compared to the effective modal stiffness of the system to significantly influence its dynamic response. To verify this interpretation and to clearly demonstrate whether the spring stiffness can indeed affect the system dynamics, a new scenario was considered that is physically impractical but conceptually illustrative. In this scenario, the spring stiffness of the hanger supports was drastically reduced to $k = 2\ N/m$, and the frequency response functions of the system were recalculated using the Sherman–Morrison–based structural modification method. A comparison of the resulting FRFs with those of the original system shows pronounced shifts in the resonance frequencies of all modes (Figure 9).

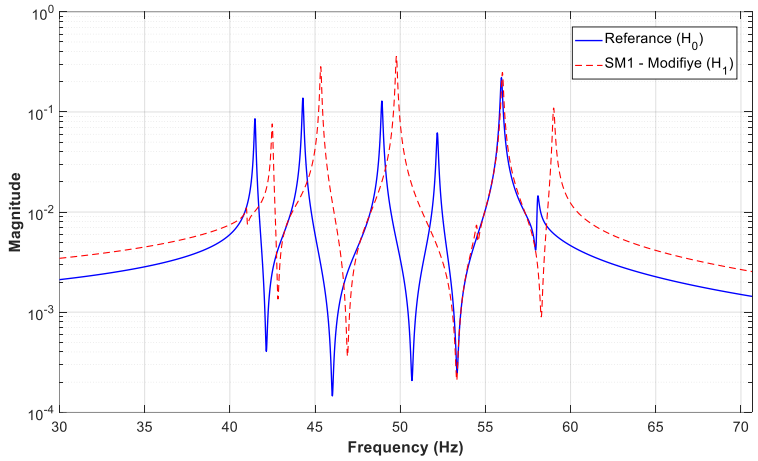

Figure 9. Comparison of the FRFs of the original system and the modified system with extremely reduced hanger stiffness.

This result clearly indicates that when the stiffness of the hanger supports is reduced to sufficiently low levels, it can significantly influence the global dynamic behavior of the system.

Therefore, the limited effect of the stiffness difference between the practically used 6 mm and 4 mm diameter hanger rods on the modal characteristics can be attributed to the fact that their spring stiffness values are relatively large compared to the dominant structural stiffness of the duct.

CONCLUSION AND DISCUSSION

This study investigated the sensitivity of a suspended ventilation duct to two different types of structural modifications:

Relocating the hanger supports by 15 cm along the duct axis

Reducing the hanger rod diameter, thereby altering the support stiffness.

The analysis was performed using the receptance-based Structural Modification (SM) method, which enabled efficient prediction of the modified frequency response functions (FRFs) without re-solving the full finite element model.

The results clearly show that the dynamic behaviour of the system is highly sensitive to changes in the geometric positioning of the hangers. The 15 cm shift introduced noticeable variations in the resonance frequencies and modal amplitudes of the first six modes. Both the comparative FRF curves and the amplitude ratio plots demonstrated that the global bending modes, particularly the first and second

modes, were significantly affected. These observations confirm that the hanger location directly alters the stiffness path and modal energy distribution, making geometric repositioning an effective practical tool for tuning the system response and mitigating resonance.

In contrast, reducing the hanger rod diameter produced almost no observable change in the FRF behaviour. The original and modified receptance curves are nearly identical. Even in these refined analyses, the deviations remained extremely small—on the order of 10^{-6}. This indicates that the axial stiffness contribution of the hanger rods is relatively weak compared to the dominant structural stiffness of the duct itself. Therefore, changes in rod diameter do not substantially influence the modal properties unless the reduction is extreme or accompanied by other geometric or boundary modifications.

The findings highlight the importance of distinguishing between geometric boundary-related modifications, which can significantly reorganize modal behaviour, and stiffness-related changes in the support system. While variations in hanger stiffness within practically realizable ranges were found to have a negligible influence on the global dynamics, the additional analysis with extremely reduced stiffness demonstrated that stiffness effects can become significant once a critical threshold is exceeded. The SM method successfully captured both regimes with high fidelity, demonstrating its suitability for rapid what-if analyses in duct and support design. Future work may extend this framework to include damping modifications, multi-point support variability, or experimentally validated operational conditions to further enhance predictive accuracy.

REFERENCES

Chavan, P. N., & Venkatesham, B. (2015). Free vibration analysis of a rectangular duct with different axial boundary conditions. *International Journal of Acoustics and Vibration, 20*(1), 10–14.

Bautista Ordoñez, J., & Nunes, M. (2017). HVAC duct system modeling through the component mode synthesis for structural vibration analysis. https://doi.org/10.26678/ABCM.COBEM201

Tang, Y., Pan, J., Zhu, J., Xiao, D., & Wang, H. (2023). Finite element seismic analysis of large air duct hangers based on ASME-AG-1 code. In *Frontiers of Civil Engineering and Disaster Prevention and Control* (Vol. 2). CRC Press.

Saini, M. K., Bagha, A. K., Kumar, S., & Bahl, S. (2021). Finite element analysis for predicting the vibration characteristics of natural fiber reinforced epoxy composites. *Materials Today: Proceedings,* 41(Part 2), 223–227. https://doi.org/10.1016/j.matpr.2020.08.717

Ahiwale, D., Madake, H., Phadtare, N., Jarande, A., & Jambhale, D. (2022). Modal analysis of cracked cantilever beam using ANSYS software. *Materials Today: Proceedings, 56*(Part 1), 165–170. https://doi.org/10.1016/j.matpr.2022.01.055

Kovalovs, A., Chate, A., & Kulakov, V. (2024). The modal analysis of laminated composite cylinders under axial tension loading in ANSYS. *MATEC Web of Conferences, 396,* 05007. https://doi.org/10.1051/matecconf/202439605007

Özer, M. B., Özgüven, H. N., & Royston, T. J. (2005). Identification of structural nonlinearities using describing functions and Sherman–Morrison method. *In Proceedings of the 23rd International Modal Analysis Conference,* Orlando, FL, January 2005, 199–212.

Kozak, M. T., Cömert, M. D., & Özgüven, H. N. (2007). Titreşim analizinde kullanılan sonlu eleman modeli güncelleme yöntemlerinin incelenmesi ve gerçek yapılara uygulanması. *In 13. Ulusal Makina Teorisi Sempozyumu, Cumhuriyet Üniversitesi,* Sivas, 07–09 Haziran 2007, 83–90.

Ouyang, H., Richiedei, D., Trevisani, A., & Zanardo, G. (2012a). Eigenstructure assignment in undamped vibrating systems: A convex-constrained modification method based on receptances. *Mechanical Systems and Signal Processing*, 27, 397–409.

Ouyang, H., Richiedei, D., Trevisani, A., & Zanardo, G. (2012b). Discrete mass and stiffness modifications for the inverse eigenstructure assignment in vibrating systems: Theory and experimental validation. *International Journal of Mechanical Sciences*, 64, 211–220.

Çakar, O. (2011). Mass and stiffness modifications without changing any specified natural frequency of a structure. *Journal of Vibration and Control, 17*(5), 769–776.

Hüseyinoğlu, M., & Çakar, O. (2017). Determination of stiffness modifications to keep certain natural frequencies of a system unchanged after mass modifications. *Archive of Applied Mechanics, 87*(10), 1629–1640. https://doi.org/10.1007/s00419-017-1276-3

Çakar, O. (2018). A method for shifting natural frequencies of a dynamic system to desired values with concentrated mass modifications. *Journal of Vibroengineering, 20*(1), 508–515. https://doi.org/10.21595/jve.2017.18881

AN ADVANCED EVALUATION FRAMEWORK INTEGRATED MACHINE LEARNING WITH MULTI-CRITERIA DECISION-MAKING FOR POTENTIAL LOCATIONS OF SOLAR POWER PLANTS

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ABSTRACT

The increasing demand for renewable energy has led to an increase in the number of solar power plants in recent years. However, the productivity of solar power plants could not be as successful as desired. One important factor in the success of a solar power plant is its location, which can significantly impact on its efficiency and profitability. Location decisions require comprehensive evaluation under conflicting criteria. This study presents an integrated evaluation framework by combining machine learning techniques and multi-criteria decision making techniques. Alternative locations are evaluated based on multiple criteria, such as sunbathing, wind speed, rainfall, air pollution, and humidity. However, determining the criteria weights is the crucial step of any Multi Criteria Decision Making. For this purpose, the Machine Learning Algorithm is applied to determine the coefficient of dependent variables. The proposed decision framework is a pioneering approach to evaluate and determine the appropriate location decisions. The results show that the proposed approach can effectively identify locations that are both technically and economically viable and can be easily adapted to different locations. Selecting the most suitable location for a solar power plant can expand the use of solar power in the future, and it will be important to the growth of this industry.

Keywords: Location selection, renewable energy, machine learning, MCDM

INTRODUCTION

Energy is a fundamental input for economic development in both developed and developing economies. At present, the global energy mix is still dominated by fossil fuels, which are associated with problems such as resource depletion and severe environmental impacts. Nevertheless, their widespread availability and relatively low cost maintain fossil fuels as a major energy source. In contrast, solar energy emerges as an economical, renewable and environmentally sustainable alternative. According to the International Energy Agency, photovoltaic (PV) and solar thermal systems are expected to generate approximately 9000 TWh of electricity by 2050, potentially avoiding around 6 billion tons of CO_2 emissions per year. The significant decline in the costs of PV modules and associated systems has further strengthened the role of solar power as a primary electricity source. Owing to its geographical position and high solar irradiation potential, Türkiye possesses highly favorable conditions for photovoltaic solar power plants (SPPs), offering a comparative advantage over many other countries (Colak et al., 2020).

In the context of renewable energy systems, and solar energy in particular, the determination of optimal locations for generation and consumption is a critical planning problem. Site selection for SPPs directly

influences the amount of energy produced, overall plant efficiency, and total investment and operating costs. Consequently, many studies in literature have focused on identifying suitable sites for SPP construction (Mehrez et al., 2024). The location of an SPP has implications not only for construction and installation phases but also for long-term operation, process management, and cost performance. Site selection decisions are shaped by a broad set of criteria, including economic, social, environmental and cultural factors (Gastli and Charabi, 2010). In such decision environments, Multi-Criteria Decision Making (MCDM) methods are widely used to support project managers. MCDM approaches enable the simultaneous evaluation of multiple and conflicting, criteria by decomposing a complex problem into simpler subcomponents and integrating them to obtain a coherent and interpretable solution.

Machine learning (ML) is a broad research domain at the intersection of information technology, statistics, probability, artificial intelligence, psychology and neuroscience. It aims to construct models that accurately represent complex datasets and thereby provide data-driven solutions to real-world problems. ML algorithms essentially seek to emulate human learning processes by employing adaptive programming techniques capable of detecting patterns, learning from historical data, drawing new inferences, and progressively improving the accuracy and efficiency of computations and outputs (Nasteski, 2017).

The literature review indicates that, in the field of SPP site selection, there are notable limitations, particularly regarding the integrated use of ML and MCDM. Although a considerable number of studies address SPP location problems using Geographic Information Systems (GIS), MCDM frameworks and AHP-based approaches, several shortcomings persist (Kocabaldir and Yucel, 2020; Mansoor et al., 2023). This study seeks to respond to these gaps by exploiting ML algorithms to enhance time efficiency, operational effectiveness and model dynamism. A major deficiency identified in prior work concerns the incomplete treatment of factors influencing SPP efficiency, especially in relation to data loss and data processing issues. Core data operations such as data retention, storage and management are frequently overlooked. Furthermore, the literature demonstrates that key problems such as SPP spatial allocation have not been adequately addressed through ML-based methods.

To overcome these deficiencies, the present study proposes a comprehensive SPP site selection framework for Türkiye. A survey is planned to identify and prioritize relevant criteria, and an integrated ML–MCDM approach will be employed to analyze and evaluate potential locations across the country. By combining ML and MCDM techniques within a unified decision-making structure, the study aims to provide a novel perspective on SPP location planning and to contribute both to the refinement of existing research and to the development of robust examples for future empirical studies.

LITERATURE REVIEW

The literature shows that, in line with global sustainability targets, renewable resources such as biomass and solar energy are increasingly used for green hydrogen and electricity generation, both to reduce carbon emissions and to enhance energy security (Goh et al., 2023). Within this context, a substantial body of work has focused on the location selection of power plants—particularly Solar Power Plants (SPPs) using Multi-Criteria Decision Making (MCDM) techniques. A variety of methods, including AHP and its fuzzy extensions, ANP, TOPSIS, ELECTRE, VIKOR and related hybrids, have been applied under diverse sets of criteria such as climatic, geographical, environmental, economic and social factors for SPP siting in different countries (e.g. Turkey, Vietnam, Bangladesh). Comparative applications generally confirm that MCDM tools are effective in structuring the SPP location problem and in capturing trade-offs among candidate sites.

More recent studies integrate Geographic Information Systems (GIS) with MCDM, where AHP and fuzzy AHP are frequently employed to process spatial data and to evaluate alternatives (Aly et al., 2017). In parallel, machine learning (ML) techniques have been widely used in the solar energy domain, though predominantly to address technical performance issues rather than strategic location decisions (Salazar-Caceres et al., 2024). Only a limited number of studies employ ML directly for SPP siting. For example, Sun et al. (2023) analyze a national inventory of large-scale PV installations using interpretable ML models (MLP, random forest, XGBoost) and explain location drivers via SHAP-based importance measures.

In the broader facility location literature, ML–MCDM integration is gaining traction. Hybrid frameworks combining clustering algorithms (e.g. k-means, fuzzy c-means) with MCDM methods such as TOPSIS, ARAS, EDAS, MOORA and BORDA have been proposed for problems like energy storage siting, hub location and airport location selection under uncertainty. These studies highlight the advantages of ML–MCDM integration: improved handling of large and noisy datasets, data-driven criterion weighting, and more robust ranking of alternatives in complex decision environments (Yilmaz et al., 2023).

Therefore, the literature demonstrates that integrating ML with MCDM significantly strengthens location-allocation decisions. However, despite extensive work on SPP site selection using MCDM and GIS, and growing use of ML in solar energy analysis, there is still a clear gap regarding the joint application of ML and MCDM specifically for SPP location decisions. The present study is designed to address this research gap by proposing an integrated ML–MCDM decision support model for SPP siting, with the aim of enhancing decision quality and maximizing the benefits of renewable energy investments.

METHODOLOGY

This study aims to select the best location for a SPP in 15 provinces in Turkey. The SMART method compares provinces across multiple criteria, considering their relative importance. The PIV method considers the proximity of each province to the optimal solution. This systematic approach will help identify and prioritize provinces with the most favorable conditions for locating a SPP. However, careful data collection, accurate implementation of MLR, and appropriate application of SMART and PIV methods are required. The proposed approach within the scope of this paper was illustrated in Figure 1.

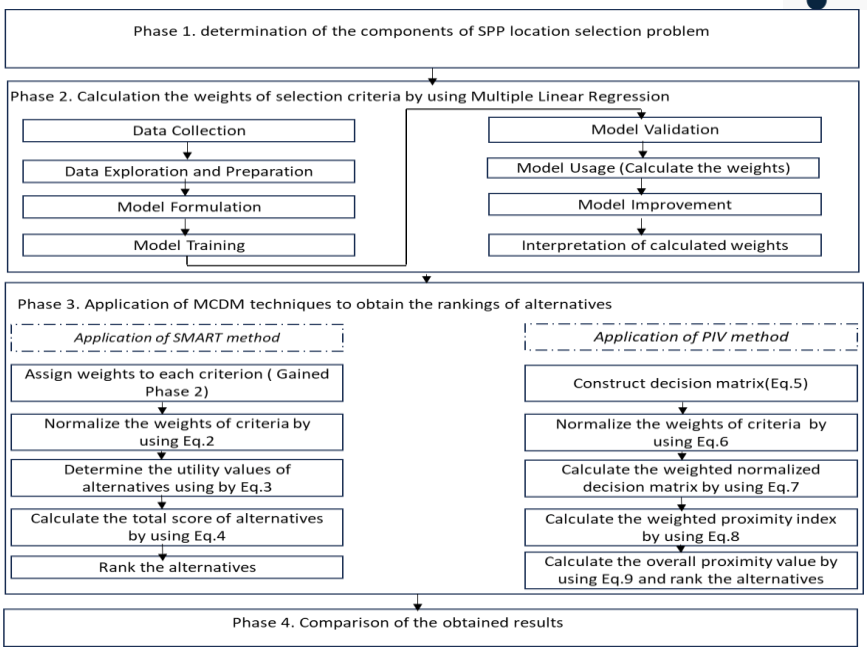

Figure 1. Proposed approach.

In this study, a solar power plant (SPP) location selection application was conducted for 15 different provinces in Turkey, each considered as an alternative site. The main purpose of the analysis was to identify which provinces are more suitable for SPP investments under several environmental and climatic criteria. To obtain the relative importance of the criteria, Multiple Linear Regression (MLR) was employed as a first step. Based on the collected dataset, the regression model produced coefficients that were interpreted as criterion weights in the decision process, and the obtained weights were then carried into the subsequent evaluation stage.

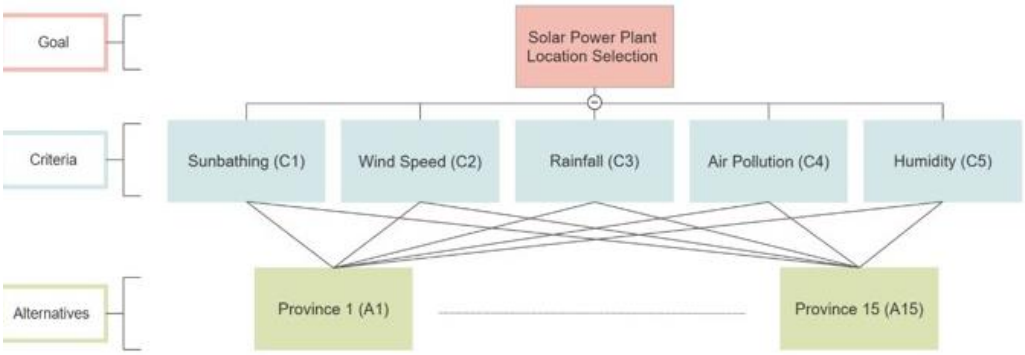

Figure 2. Hierarchical chart of criteria and alternatives.

After the weighting phase, the SMART and PIV methods were applied to rank the 15 provinces according to their performance. In this way, a systematic comparison of the provinces was achieved, reflecting their scores under the weighted criteria. Five criteria were defined for each province: solar radiation/sunbathing (C1), wind speed (C2), rainfall (C3), air pollution (C4) and humidity (C5). A simple hierarchical structure was also constructed to represent the relationship between the overall goal of SPP location selection, the criteria and the provincial alternatives; the structure is shown conceptually in Figure 2. Overall, the study presents a relatively comprehensive yet practical evaluation framework for SPP site selection in Turkey. The reliability of the results largely depends on the quality of the data

and on the careful implementation of both the regression model and the MCDM procedures, so a certain level of caution is still required in interpreting the rankings.

Experimental results and analysis of Multiple Linear Regression

Multiple linear regression (MLR) is a statistical technique used to describe the relationship between one dependent variable and several independent (explanatory) variables. As a generalization of simple linear regression to multiple predictors, the MLR model is usually written as (Aiken et al., 2003):

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n + \varepsilon \qquad (1)$$

In this expression, Ydenotes the dependent (response) variable, $\beta_0$denotes the intercept term, $\beta_1, \beta_2, \ldots, \beta_n$denote the regression coefficients associated with the independent variables $X_1, X_2, \ldots, X_n$, and εrepresents the random error term. When the MLR framework is adopted in an empirical study, a number of stages are generally followed, such as model specification, parameter estimation, diagnostic checking and model validation (Tranmer and Elliot, 2008).

Based on an extensive investigation for 15 alternative provinces and five evaluation criteria, the data set used in the analysis is summarized in Table 1. The provinces were selected so as to reflect the diversity of the country under the defined criteria, rather than focusing on a single region or climate type. In this way, the collected data set allows a detailed comparison of the provinces with respect to these criteria and supports a more comprehensive evaluation of their environmental conditions at a national scale.

Table 1. Data of different alternatives and criteria.

Alternatives	C_1	C_2	C_3	C_4	C_5
A_1	7.5	10.61	668.8	48.88	65
A_2	6.3	11.33	524.9	40.44	63
A_3	6.7	11.28	391.1	13.26	55
A_4	8.2	10.54	1054.9	27.89	53
A_5	7.5	8.41	490.7	34.20	48
A_6	6.4	10.48	459.6	14.49	68
A_7	6.2	12.08	707.4	46.85	73
A_8	7.2	18.9	624.4	20.58	69
A_9	6.3	10.28	416	14.55	56
A_{10}	7.9	9.53	493.3	25.92	49
A_{11}	6	13.42	601.9	33.88	64
A_{12}	1	17.17	660.9	34.28	74
A_{13}	8.1	15.22	709.9	16.98	63
A_{14}	7.4	12.73	331.8	30.69	52
A_{15}	7.5	9.1	717.9	30.91	51

The SMART method involves identifying relevant attributes, assigning weights to each attribute based on their importance, scoring each alternative on each attribute, and choosing the option with the highest total score as the preferred option. It has been widely used in various applications, including project selection, supplier evaluation, and performance evaluation (Patel et al, 2017). The weight of each criterion was obtained by applying the MLR model given in Eq. (1). Through this model, the available dataset was analyzed and regression coefficients were calculated, quantifying the relative influence of

each criterion within the location selection process. The coefficients were derived by fitting the MLR equation to the data, considering the relationship between the criteria and their effect on the identification of optimal SPP locations. The raw and normalized weights are reported in Table 2.

Table 2. Weight evaluation for each criterion.

Criteria	Weight	Normalized Weight
C_1	134.62	0.39
C_2	175.92	0.51
C_3	2.62	0.01
C_4	13.51	0.04
C_5	18.91	0.05

Experimental results and analysis of SMART

The SMART approach was applied by following the steps listed below.

Step 1: Identify the criteria and options that are pertinent to the choice and define the decision problem.

Step 2: Assign weights to each criterion by giving each one a value between 1 and 100 according to how important it is.

Step 3: Normalize each criterion by dividing its weight by the total of all the criteria' weights.

$$Normalization = \frac{w_j}{\sum_j w_j} \quad (2)$$

Step 4: Determine the utility value for converting the criterion value of each attribute to the raw data value by utilizing the formula:

$$U_i = \frac{c_{out} - c_{min}}{c_{max} - c_{min}} \quad (3)$$

After the raw and normalized weights for each criterion were obtained, utility values for the criteria were calculated using Eq. (3) to convert the original data into a common scale suitable for analysis. By means of this transformation, the criteria values were standardized and reported in Table 3 to be compared consistently based on these unified utility scores.

Table 3. Evaluation of utility values of raw data.

Alternatives	C_1	C_2	C_3	C_4	C_5
A_1	0.90	0.21	0.47	1.00	0.65
A_2	0.74	0.28	0.27	0.76	0.58
A_3	0.79	0.27	0.08	0.00	0.27
A_4	1.00	0.20	1.00	0.41	0.19
A_5	0.90	0.00	0.22	0.59	0.00
A_6	0.75	0.20	0.18	0.03	0.77
A_7	0.72	0.35	0.52	0.94	0.96
A_8	0.86	1.00	0.40	0.21	0.81
A_9	0.74	0.18	0.12	0.04	0.31
A_{10}	0.96	0.11	0.22	0.36	0.04
A_{11}	0.69	0.48	0.37	0.58	0.62
A_{12}	0.00	0.83	0.46	0.59	1.00
A_{13}	0.99	0.65	0.52	0.10	0.58
A_{14}	0.89	0.41	0.00	0.49	0.15
A_{15}	0.90	0.07	0.53	0.50	0.12

Step 5: Calculate the total score for each criterion by combining the raw data criteria with the weighted value criteria, then multiplying them with a formula.

$$U(a_i) = \sum_{j=1} w_j . u_i \quad (4)$$

After the determination of utility values and the presentation of the transformed criteria data in Table 3, the next step was to calculate the total score for each criterion. This involved combining the raw data value of each criterion with its weight-normalized value, as indicated in Table 4. To calculate the total score for each criterion, Eq. (4) was employed.

Table 4. Final values of alternatives.

ALTERNATIVES	$U(a_i)$	Ranking
A_8	90.0	1
A_{13}	75.4	2
A_{14}	58.4	3
A_{11}	57.3	4
A_7	55.3	5
A_1	53.7	6
A_4	52.7	7
A_{12}	50.6	8
A_2	49.2	9
A_3	46.3	10
A_{10}	44.6	11
A_6	43.8	12
A_{15}	41.5	13
A_9	39.7	14
A_5	37.6	15

Table 4 implies that A_8 is identified as the most suitable location for the SPP, while Batman is evaluated as the least appropriate alternative. The higher composite score of A_8 indicates stronger performance across the selected criteria, whereas the comparatively low score of A_5 shows that the required conditions are not satisfied to the same extent. The resulting ranking provides stakeholders and decision-makers with a clear basis for selecting project locations in line with the strategic objectives of the SPP investment.

Step 6: Rank the alternatives.

According to the ranking results reported in Table 4, Çanakkale is identified as the most suitable location for the SPP, while Batman is evaluated as the least appropriate alternative. The higher composite score of Çanakkale indicates stronger performance across the selected criteria, whereas the comparatively low score of Batman shows that the required conditions are not satisfied to the same extent. The resulting ranking provides stakeholders and decision-makers with a clear basis for selecting project locations in line with the strategic objectives of SPP investment.

Experimental results and analysis of PIV

In Table 2, the criterion weights obtained from the MLR model in Eq. (1) and used consistently in the SMART procedure are summarized. These weights express the relative importance of each factor in the evaluation and selection of optimal SPP locations, based on a detailed analysis of the underlying data set. Through normalization, the weights were rescaled to a 0–100 range, which provides a common scale for interpretation and highlights the contribution of each criterion to the overall decision-making process. The PIV method is an MCDM technique used to evaluate alternatives under multiple criteria. In this approach, the proximity and relevance of each criterion to the target variable are examined, and the closeness of data features to the target can be computed rapidly, which makes the method suitable for large-scale datasets. In addition, PIV supports the identification of strongly correlated features and can enhance prediction accuracy (Trung, 2021). Model interpretability is also improved, since the

technique provides insight into how individual characteristics contribute to the target variable (Yahya et al., 2019).

Step 1: Construct a Decision Matrix

$$Y = [Yij]mxn = \begin{bmatrix} Y_{11} & \cdots & Y_{1n} \\ \vdots & \ddots & \vdots \\ Y_{m1} & \cdots & Y_{mn} \end{bmatrix} \quad (5)$$

As shown in Table 5, the normalized decision matrix was obtained by applying Eq. (6) to each decision value of every alternative under each criterion. Through this procedure, all criterion values were brought into a comparable scale, which enables more consistent comparison and evaluation of the alternatives across the full set of criteria.

Table 5. Normalized decision matrix for PIV.

Alternatives	C_1	C_2	C_3	C_4	C_5
A_1	0.28	0.22	0.28	0.41	0.28
A_2	0.24	0.24	0.22	0.34	0.27
A_3	0.25	0.24	0.16	0.11	0.23
A_4	0.31	0.22	0.44	0.23	0.23
A_5	0.28	0.17	0.21	0.29	0.20
A_6	0.24	0.22	0.19	0.12	0.29
A_7	0.23	0.25	0.30	0.39	0.31
A_8	0.27	0.39	0.26	0.17	0.29
A_9	0.24	0.21	0.17	0.12	0.24
A_{10}	0.30	0.20	0.21	0.22	0.21
A_{11}	0.22	0.28	0.25	0.28	0.27
A_{12}	0.04	0.36	0.28	0.29	0.31
A_{13}	0.30	0.32	0.30	0.14	0.27
A_{14}	0.28	0.26	0.14	0.26	0.22
A_{15}	0.28	0.19	0.30	0.26	0.22

Step 2: Data Normalization

$$R_i = \frac{Y_i}{\sqrt{\sum_{i=1}^{m} Y_i^2}} \quad (6)$$

Step 3: Produce the Weighted Normalized Decision Matrix

$$V_i = W_i \cdot R_i \quad (7)$$

After construction of the normalized decision matrix, the entries were multiplied by the corresponding criterion weights in accordance with Eq. (7). Through this weighting step, differences in the relative importance of the criteria were incorporated into the evaluation. The resulting weighted matrix is summarized in Table 6, where alternatives are identified based on the maximum values for benefit-type

criteria and the minimum values for cost-type criteria, providing a compact overview of the selection results.

Table 6. Weighted normalized decision matrix.

Weight of Criteria	39%	51%	1%	4%	5%
Alternatives	**C_1**	**C_2**	**C_3**	**C_4**	**C_5**
A_1	0.110	0.112	0.0021	0.0159	0.0151
A_2	0.092	0.120	0.0017	0.0132	0.0146
A_3	0.098	0.120	0.0012	0.0043	0.0128
A_4	0.120	0.111	0.0034	0.0091	0.0123
A_5	0.110	0.089	0.0016	0.0112	0.0112
A_6	0.093	0.111	0.0015	0.0047	0.0158
A_7	0.091	0.128	0.0023	0.0153	0.0170
A_8	0.105	0.200	0.0020	0.0067	0.0160
A_9	0.092	0.109	0.0013	0.0048	0.0130
A_{10}	0.115	0.101	0.0016	0.0084	0.0114
A_{11}	0.088	0.142	0.0019	0.0111	0.0149
A_{12}	0.015	0.182	0.0021	0.0112	0.0172
A_{13}	0.118	0.161	0.0023	0.0055	0.0146
A_{14}	0.108	0.135	0.0011	0.0100	0.0121
A_{15}	0.110	0.096	0.0023	0.0101	0.0119

Step 4: Determine the Weighted Proximity Index (WPI).

$$U_i = \begin{cases} V_{max} - V_i, \text{for cost attributes} \\ V_i - V_{max}, \text{for benefit attributes} \end{cases} \quad (8)$$

This calculation was performed using Eq. (8), which allowed for the quantification of how far the value of each alternative in the criterion pillar deviated from the ideal criterion. Table 7 presents the calculated proximity values for each criterion.

Table 7. Proximity values.

Alternatives	C_1	C_2	C_3	C_4	C_5
A_1	0.0102	0.0879	0.0011	0.0000	0.0040
A_2	0.0278	0.0805	0.0006	0.0028	0.0035
A_3	0.0219	0.0805	0.0002	0.0116	0.0016
A_4	0.0000	0.0890	0.0023	0.0068	0.0012
A_5	0.0102	0.1112	0.0005	0.0048	0.0000
A_6	0.0263	0.0890	0.0004	0.0112	0.0046
A_7	0.0292	0.0720	0.0012	0.0007	0.0058
A_8	0.0146	0.0000	0.0009	0.0092	0.0049
A_9	0.0278	0.0911	0.0003	0.0112	0.0019
A_{10}	0.0044	0.0996	0.0005	0.0075	0.0002
A_{11}	0.0321	0.0583	0.0009	0.0049	0.0037
A_{12}	0.1052	0.0180	0.0010	0.0048	0.0060
A_{13}	0.0015	0.0392	0.0012	0.0104	0.0035
A_{14}	0.0117	0.0657	0.0000	0.0059	0.0009
A_{15}	0.0102	0.1038	0.0012	0.0059	0.0007

Step 5: Calculate the Overall Proximity Value:

$$d_i = \sum_{i=1}^{n} U_i \quad (9)$$

The overall proximity for each alternative was calculated by applying Eq. 9.

Table 8. Evaluation of overall proximity.

Alternatives	C_1	C_2	C_3	C_4	C_5	Overall Proximity	RANK
A_1	0.0102	0.0879	0.0011	0.0000	0.0040	0.1032	10
A_2	0.0278	0.0805	0.0006	0.0028	0.0035	0.1151	7
A_3	0.0219	0.0805	0.0002	0.0116	0.0016	0.1158	6
A_4	0.0000	0.0890	0.0023	0.0068	0.0012	0.0993	12
A_5	0.0102	0.1112	0.0005	0.0048	0.0000	0.1268	4
A_6	0.0263	0.0890	0.0004	0.0112	0.0046	0.1315	3
A_7	0.0292	0.0720	0.0012	0.0007	0.0058	0.1089	9
A_8	0.0146	0.0000	0.0009	0.0092	0.0049	0.0296	15
A_9	0.0278	0.0911	0.0003	0.0112	0.0019	0.1322	2
A_{10}	0.0044	0.0996	0.0005	0.0075	0.0002	0.1122	8
A_{11}	0.0321	0.0583	0.0009	0.0049	0.0037	0.0999	11
A_{12}	0.1052	0.0180	0.0010	0.0048	0.0060	0.1350	1
A_{13}	0.0015	0.0392	0.0012	0.0104	0.0035	0.0557	14
A_{14}	0.0117	0.0657	0.0000	0.0059	0.0009	0.0842	13
A_{15}	0.0102	0.1038	0.0012	0.0059	0.0007	0.1218	5

Table 9 shows the comparison of the SMART and PIV ranks for the best SPP locations.

Table 9. Rank of the Alternatives based on SMART and PIV

Alternatives	SMART	PIV
A_1	6	6
A_2	9	9
A_3	10	10
A_4	7	4
A_5	15	12
A_6	12	13
A_7	5	7
A_8	1	1
A_9	14	14
A_{10}	11	8
A_{11}	4	5
A_{12}	8	15
A_{13}	2	2
A_{14}	3	3
A_{15}	13	11

CONCLUSION AND DISCUSSION

This study investigates the selection of suitable locations for solar power plants (SPPs) in Turkey by combining ML algorithms with MCDM methods. Locations are evaluated in terms of both technical and economic suitability using five criteria: sunbathing, wind speed, rainfall, air pollution and humidity. The results indicate that the proposed framework successfully identifies feasible SPP locations adaptable to different regions, supporting wider use of renewable energy, reduced dependence on fossil fuels and mitigation of environmental impacts.

Based on the MLR-derived weights and the SMART method, 15 provinces were ranked; A_8 achieved the highest score, followed by A_{13}, and A_{14}. When the MLR-based weights were used together with the PIV method, A_8 again emerged as the best alternative, this time with the lowest total distance to the ideal, followed by A_{13}, and A_{14}. These outcomes underline that both the choice of criterion weights and the selected decision-making procedure (SMART vs. PIV) have a direct influence on the ranking, with SMART providing a more transparent, preference-based structure and PIV offering a more numerical, proximity-based assessment.

Future work may extend the model by incorporating additional criteria, such as socioeconomic or infrastructural factors, and by using more advanced ML techniques or ensemble models to refine the estimation of weights. Integration with spatial analysis and GIS tools is also expected to strengthen the evaluation of SPP locations. Beyond renewable energy planning, the combined use of SMART and PIV can be transferred to other facility location problems in areas such as urban planning, transport infrastructure or public service siting.

REFERENCES

Aly, A., Jensen, S. S., & Pedersen, A. B. (2017). Solar power potential of Tanzania: Identifying CSP and PV hot spots through a GIS multicriteria decision making analysis. Renewable Energy, 113, 159–175. https://doi.org/10.1016/j.renene.2017.05.077

Colak, H. E., Memişoğlu, T., & Gerçek, Y. (2020). Optimal site selection for solar photovoltaic (PV) power plants using GIS and AHP: A case study of Malatya Province, Turkey. Renewable Energy, 149, 565–576. https://doi.org/10.1016/j.renene.2019.12.078

Gastli, A., & Charabi, Y. (2010). Solar electricity prospects in Oman using GIS-based solar radiation maps. Renewable and Sustainable Energy Reviews, 14(2), 790–797. https://doi.org/10.1016/j.rser.2009.08.018

Goh, Q. H., Zhang, L., Ho, Y. K., & Chew, I. M. L. (2023). Modelling and multi-objective optimisation of sustainable solar-biomass-based hydrogen and electricity co-supply hub using metaheuristic-TOPSIS approach. Energy Conversion and Management, 293, 117484. https://doi.org/10.1016/j.enconman.2023.117484

Kocabaldır, C., & Yücel, M. A. (2020). GIS-based multi-criteria decision analysis of site selection for photovoltaic power plants in Çanakkale Province. International Journal of Environment and Geoinformatics, 7(3), 347–355. https://doi.org/10.30897/ijegeo.689570

Mansoor, M., Mirza, A. F., Usman, M., & Ling, Q. (2023). Hybrid forecasting models for wind-PV systems in diverse geographical locations: Performance and power potential analysis. Energy Conversion and Management, 294, 117574. https://doi.org/10.1016/j.enconman.2023.117574

Mehrez, Z., Maaoui, W., & Najjari, M. (2024). Recent advancements in enhancing the efficiency of solar energy systems through the utilization of ferrofluids and magnetic fields. Energy Conversion and Management, 307, 118353. https://doi.org/10.1016/j.enconman.2024.118353

Nasteski, V. (2017). An overview of the supervised machine learning methods. Horizons B, 4, 51–62. https://doi.org/10.20544/HORIZONS.B.04.1.17.P05

Patel, M. R., Vashi, M. P., & Bhatt, B. V. (2017, March). SMART-multi-criteria decision-making technique for use in planning activities. In New Horizons in Civil Engineering (NHCE 2017) (pp. 1–6). Surat, India.

Salazar-Caceres, F., Ramirez-Murillo, H., Torres-Pinzón, C. A., & Camargo-Martínez, M. P. (2024). Performance estimation technique for solar-wind hybrid systems: A machine learning approach. Alexandria Engineering Journal, 87, 175–185. https://doi.org/10.1016/j.aej.2023.12.029

Sun, L., Jiang, Y., Guo, Q., Ji, L., Xie, Y., Qiao, Q., … & Xiao, K. (2021). A GIS-based multi-criteria decision making method for the potential assessment and suitable sites selection of PV and CSP plants. Resources, Conservation and Recycling, 168, 105306. https://doi.org/10.1016/j.resconrec.2020.105306

Tranmer, M., & Elliot, M. (2008). Multiple linear regression. The Cathie Marsh Centre for Census and Survey Research (CCSR), 5(5), 1–5.

Trung, D. D. (2021). The combination of Taguchi–Entropy–WASPAS–PIV methods for multi-criteria decision making when external cylindrical grinding of 65G steel. Journal of Machine Engineering, 21(4), 90–105. https://doi.org/10.36897/jme/144260

Yahya, S. M., Asjad, M., & Khan, Z. A. (2019). Multi-response optimization of TiO_2/EG-water nano-coolant using entropy based preference indexed value (PIV) method. Materials Research Express, 6(8), 0850a1. https://doi.org/10.1088/2053-1591/ab23bb

Yilmaz, I., Adem, A., & Dağdeviren, M. (2023). A machine learning-integrated multi-criteria decision-making approach based on consensus for selection of energy storage locations. Journal of Energy Storage, 69, 107941. https://doi.org/10.1016/j.est.2023.107941

Yilmaz, I., & Ecemis Yilmaz, H. K. (2024). A consensus framework for evaluating dispute resolution alternatives in international law using an interval-valued type-2 fuzzy TOPSIS approach. Applied Sciences, 14(23), 11046. https://doi.org/10.3390/app142311046

A DEMATEL–VIKOR-BASED MULTI-CRITERIA FRAMEWORK FOR EVALUATING CUSTOMER SATISFACTION IN E-COMMERCE PLATFORMS

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ABSTRACT

Due to the rapid digitalization of markets and the growth in online shopping demand, competition among e-commerce platforms has become significantly more intense. Under these conditions, customer satisfaction has emerged as a critical determinant of competitive success. However, the inherently multidimensional nature of customer satisfaction requires that the evaluation process be handled through integrated and analytically robust approaches. In this study, the satisfaction performance of online shopping websites is assessed using the DEMATEL and VIKOR techniques within the framework of Multi-Criteria Decision Making (MCDM). In the first phase, expert opinion was obtained, and the satisfaction-related criteria were identified based on this dataset. Subsequently, the DEMATEL method was employed to analyze the causal relationships among these criteria and to derive their relative weights, after which the VIKOR method was used to rank the e-commerce sites according to their performance levels. The experimental results imply that the primary drivers of customer satisfaction reveal performance differences between platforms, and indicate specific areas in need of improvement. Accordingly, the study is considered to offer decision makers in the e-commerce sector actionable analytical insights and to support the design of more customer-oriented strategies.

Keywords: Customer Satisfaction, Multi-Criteria Decision Making, DEMATEL and VIKOR.

INTRODUCTION

In the global digital economy, the rapid diffusion of online shopping has repositioned e-commerce platforms from ordinary transaction interfaces to core points of customer experience. Intensified competition and increasingly heterogeneous user expectations have elevated customer satisfaction to a strategic determinant of sustainable competitive advantage for online retailers. However, the multidimensional and dynamic nature of satisfaction, together with the variability in consumer expectations, renders its systematic evaluation non-trivial and calls for rigorous analytical tools.

This study addresses the problem of evaluating customer satisfaction performance of online shopping sites within a multi-criteria decision-making (MCDM) framework. Rather than focusing solely on traditional determinants such as product quality or price, the research adopts a holistic perspective that encompasses a broad set of interrelated criteria, including service quality, perceived reliability, price advantage and user-friendly interface design. The central premise is that customer satisfaction emerges from the joint impact of these interdependent factors and that the structural relationships among them must be explicitly modelled.

To this end, an integrated DEMATEL-VIKOR approach is proposed. First, expert opinions are collected via a structured survey and the criteria influencing satisfaction are identified. DEMATEL method is then employed to analyse the causal relationships among these criteria and to distinguish driving from dependent factors. This causal mapping enables the derivation of criterion weights in a way that is consistent with the underlying structural interdependencies, rather than relying on purely subjective or ad hoc weighting schemes. In the second stage, these weights are incorporated into VIKOR method to evaluate and rank online shopping sites with respect to their proximity to an ideal satisfaction profile. VIKOR's compromise solution logic allows the trade-offs among conflicting criteria to be handled explicitly and supports balanced performance assessment.

The empirical application demonstrates that the proposed framework can differentiate the relative performance of e-commerce sites and highlight their strengths and weaknesses in a transparent manner. The results provide actionable insights into which criteria require priority improvement to enhance both current satisfaction levels and long-term customer loyalty. From a managerial perspective, the integrated use of DEMATEL and VIKOR supports more informed and structurally grounded strategic decisions in the design and management of digital customer experience.

Methodologically, the study underscores the potential of DEMATEL-VIKOR integration, which is still relatively underutilized in the customer satisfaction literature, particularly in the context of e-commerce. The framework is generalizable to other digital service environments where customer experience is shaped by multiple interacting factors.

Nonetheless, several limitations are acknowledged. The analysis is confined to a limited number of online shopping platforms and to survey data collected in a specific time frame, while customer expectations and digital interfaces evolve continuously. Moreover, the implementation of advanced MCDM techniques such as DEMATEL and VIKOR requires a certain level of methodological expertise, which may restrict their direct adoption by some practitioners. Future research could extend the model to larger samples and different sectors, incorporate fuzzy data to capture temporal dynamics in satisfaction, and explore more user-friendly decision support tools that embed the proposed methodology for broader practical use.

LITERATURE REVIEW

In the last decade, there is a growing body of literature showing that Multi-Criteria Decision Making (MCDM) methods are very useful for analyzing complex decision problems in industrial engineering. Among these methods, VIKOR has become a popular tool because it focuses on compromise solutions and allows decision makers to handle trade-offs between conflicting criteria in a systematic way (Gul. Et. al., 2016). This method is often combined with other techniques, especially DEMATEL, to model causal relations among criteria before ranking alternatives.

One of the early studies that integrates DEMATEL and VIKOR is the work of Lin. et al., (2011) who propose a hybrid fuzzy DEMATEL-VIKOR framework for product concept evaluation. DEMATEL is first used to identify cause-effect relationships among product design criteria and to compute more realistic weights. These weights are then used in VIKOR to rank product concepts according to their closeness to an ideal solution (Lin et al., 2011). This study shows that the combination of structural modeling and compromise ranking can support more robust design decisions.

The methodological link between DEMATEL, network-based weighting and VIKOR is further developed by Ou Yang et. al., (2009, 2013). In their 2009 study, they integrate DEMATEL and Analytic Network Process (ANP) to capture interdependencies among criteria and then use VIKOR to generate compromise solutions (Ou Yang et. al., 2009). Later, they apply a DEMATEL-ANP-VIKOR framework to information security risk control assessment, showing that this hybrid model can deal with both subjective judgments and complex interaction structures in a consistent way (Ou Yang et al., 2013).

Several application-oriented papers extend this integrated approach to service quality, risk and sustainability problems. Ma et., al. Guo (2019) evaluate bike-sharing service quality from a multi-stakeholder perspective using DEMATEL-VIKOR. DEMATEL is used to identify key service attributes and their causal relations, while VIKOR ranks the bike-sharing systems in terms of overall performance (Ma et al., 2019). Zhu et al. (2020) apply the DEMATEL-VIKOR method to dam failure path identification, where the interaction among failure factors is first modeled and then potential failure paths are prioritized under uncertainty (Zhu et al., 2020). These studies illustrate that DEMATEL-VIKOR integration is especially suitable when the decision problem involves high interaction among criteria and a clear need for ranking alternatives.

Hybrid models that include DEMATEL and VIKOR are also used in innovation management and sustainable supply chain performance. In the Turkish context, Memiş and Korucuk (2019) use a DEMATEL-VIKOR approach to prioritize innovation types in food companies and to select the most suitable firm. DEMATEL helps to clarify which innovation dimensions (product, process, marketing, etc.) are more influential, and VIKOR provides a compromise ranking of firms (Memiş & Korucuk, 2019). Guo and Wu (2023) propose a fuzzy AHP-DEMATEL-VIKOR model to assess sustainable social supply chain performance, combining initial fuzzy weights, causal analysis and compromise ranking in one integrated framework (Guo & Wu, 2023).

More recently, Lien. et. al., (2025) use a fuzzy DEMATEL-VIKOR framework to evaluate the sustainable development of digital inclusive finance, considering both financial inclusion and institutional governance dimensions (Lien, et al., 2025). Their work shows that DEMATEL-VIKOR is also well-suited for data-rich digital environments where multiple indicators interact in a non-trivial way.

Overall, the literature shows that DEMATEL-VIKOR integration is widely applied in product design, information security, transport service quality, risk assessment, innovation and sustainability. In many of these studies, DEMATEL is used to uncover causal structure and derive criterion weights, while VIKOR is used to obtain a compromise ranking of alternatives. However, despite this rich body of work, applications focusing specifically on customer satisfaction in e-commerce platforms are still relatively limited. This gap suggests that using an integrated DEMATEL-VIKOR framework to evaluate online shopping sites and customer experience can provide an original contribution to the industrial engineering literature.

The existing literature mainly evaluates online shopping platforms in terms of different performance criteria, but only a few studies really focus on customer satisfaction factors by using DEMATEL and VIKOR together. This paper tries to close this gap by proposing a more holistic framework that combines both methods in one integrated model for customer satisfaction-based performance evaluation. In this way, the study contributes to the methodological gap in the literature and shows that multi-criteria decision-making approaches

can be jointly applied in a consistent way when analyzing customer satisfaction performance. At the same time, the proposed framework provides a more structural and practical tool for decision makers in the e-commerce sector, helping them to identify critical improvement areas and to support more informed strategic decisions about online customer experience.

METHODOLOGY

In the study, in the first stage, DEMATEL method was applied to reveal the levels of impact of the criteria on each other and thus the causal relationships between the criteria were determined. Through this method, the structural integrity of the decision process was strengthened by defining the effective (cause) or affected (result) role of each criterion within the system. According to this obtained relational structure, the criterion weights were calculated and the basic data set for the decision-making process was created. Then, VIKOR method was used to rank the alternatives and determine the most appropriate option. VIKOR proposes a compromise solution between the alternatives by considering the distances to the ideal solution and offers a balancing approach in multi-criteria decision-making problems.

Application of DEMATEL and VIKOR for E-Commerce Customer Satisfaction

This study evaluates that customer satisfaction performance of online shopping platforms by using Multi-Criteria Decision Making (MCDM) tools. Five major e-commerce platforms operating in Turkey are taken as alternatives (A_i) and comparedunder a common decision framework. The analysis is based on five key criteria (C_j) that frequently appear in the e-commerce and service quality literature: Product and Service Quality (PSQ), Shipping and Delivery Process (SDP), Customer Service and Communication (CSCC), Pricing and Campaigns (PC), and Web/Mobile Application Usability (WMAU). First, DEMATEL method is used to analyse the causal structure among these criteria and to obtain their relative importance levels. Then, VIKOR method is applied to rank platforms according to their closeness to the ideal solution. Thus, the integrated DEMATEL-VIKOR framework systematically reveals strengths and weaknesses of each platform and provides useful guidance for strategic improvement decisions in the e-commerce context.

Application of DEMATEL Method

DEMATEL method is a completekes approach that enables the establishment and analysis of causal relationships between complex factors within a structural model (Karaoğlan, 2016). This method was developed within the scope of the Science and Human Relations Program within the Geneva Battelle Memorial Institute between 1972 and 1976. In the application of the method, expert opinions are used in the creation of the structural model related to the decision problem (Karaoğlan, 2016). The degrees of influence between the criteria can be determined, the relative weights of the criteria can be calculated depending on these effects and the ranking can be made according to their importance levels. The following steps are followed in order in the application of DEMATEL method (Özdemir, 2018):

Step 1: Problem definition

Step 2: The five criteria influencing customer satisfaction in e-commerce platforms

Step 3: Creating the direct relationship matrix by using the paired comparison in Table 1.

Table 1. Comparison Scale

Linguistic Value	Numerical Value
Very Low (VL)	1
Low (L)	2
Medium (M)	3
High (H)	4
Very High (VH)	5

If the number of experts evaluating the criteria is more than one, the arithmetic average of the scores given for each pairwise comparison is taken and these average values are placed in the relevant positions. As a result of this process, an asymmetric matrix with diagonal values of one is obtained. The average expert evaluations are used as the basis for creating the direct relationship matrix within the scope of DEMATEL method.

Table 2. Average of Expert's Opinions

Criteria	PSQ	SDP	CSC	PC	WMAU
PSQ	1	3,34	3	3	4
SDP	2,67	1	2,34	3,34	3,67
CSC	1,34	2	1	0,34	3
PC	2,67	2,34	2,67	1	3,34
WMAU	3,34	3,67	3,34	3,34	1

Step 4: Determining the Normalized Direct-Relationship Matrix (*M*) by using Eq. (1).

$$M = \frac{A}{\max\left[\sum_{i=1}^{n} a_{ij,} \sum_{j=1}^{n} a_{ij}\right]} \quad (1)$$

Table 3. The Normalized Relation Matrix

Criteria	PSQ	SDP	CSC	PC	WMAU
PSQ	0,067	0,223	0,200	0,200	0,266
SDP	0,178	0,067	0,156	0,223	0,245
CSC	0,089	0,133	0,067	0,023	0,200
PC	0,178	0,156	0,178	0,067	0,223
WMAU	0,223	0,245	0,223	0,223	0,067

Step 5: Creating the total relationship matrix (*T*) by applying Eq. (2).

$$T = M\,(I - M)^{-1} = t_{ij} \quad (2)$$

where "I" represents the identity matrix.

Table 4. The Total Relation Matrix

Criteria	PSQ	SDP	CSC	PC	WMAU
PSQ	0,896	1,122	1,099	1,013	1,312
SDP	0,934	0,916	0,994	0,970	1,212
CSC	0,558	0,649	0,582	0,500	0,787
PC	0,871	0,931	0,945	0,769	1,117
WMAU	1,037	1,146	1,125	1,037	1,156

Step 6: Determination of D and R values by using Eqs. (3-4)

$$D = \sum_{j=1}^{n} t_{ij} \quad (3)$$

$$R = \sum_{i=1}^{n} t_{ij} \quad (4)$$

D+R value reveals the degree of centrality of a criterion in the system, i.e. the total interaction power, while the D-R value shows the net effect of the criterion on the system. In this context, criteria with positive D-R values are classified as "impacting group" (cause), and criteria with negative values are classified as "impacted group" (result).

Table 5. The Table of D, R, D+R ve D-R Values

Criteria	D	R	D+R	D-R
PSQ	5,443	4,297	9,739	1,146
SDP	5,026	4,762	9,788	0,263
CSC	3,076	4,746	7,822	-1,669
PC	4,632	4,288	8,921	0,344
WMAU	5,500	5,584	11,084	-0,084

Step 7: Calculating criteria weights (w_j) by applying Eqs. (5-6)

$$w_j = \sqrt{(D_i + R_i)^2 + (D_i - R_i)^2} \quad (5)$$

$$w_i = \frac{w_j}{\sum_{i=1}^{n} w_j} \quad (6)$$

Table 6. The Overall Importance of Each Criterion

C_j	w_j
PSQ	9,806
SDP	9,791
CSC	7,998
PC	8,927
WMAU	11,084
SUM	47,608

Then, these calculated values are normalized using Eq. (6) so that they can be compared among all criteria and their sum is 1. Thus, the weight of each criterion, i.e. its relative importance in the decision process, is calculated. These weights are used to determine how effective the criteria will be in the decision stage.

Table 7. Weight Of Criteria

C_j	w_j
PSQ	0,205
SDP	0,205
CSC	0,167
PC	0,187
WMAU	0,232
SUM	1,000

Application of VIKOR Method

VIKOR method is a multi-criteria decision-making (MCDM) technique that is designed to obtain a compromise solution among a set of alternatives. It was first proposed by Opricovic (2004) for complex engineering systems with conflicting criteria, and then further developed and formalized for general decision problems by Opricovic and Tzeng (2004). The main idea of VIKOR is to measure how close each alternative is to an ideal solution and then to derive a compromise ranking based on these distances. In this context, "compromise" means a solution that is acceptable for most decision makers and reflects commonly accepted values, while the compromise solution is the alternative that is both closest to the ideal point and generally preferred in practice (Tayyar & Arslan, 2013).

In VIKOR framework, ideal and negative-ideal solutions are first defined for all criteria, and the distances of each alternative to these reference points are calculated. Using these distances, the maximum group utility (S) and the minimum individual regret (R) values are obtained for each alternative (Opricovic & Tzeng, 2007). Based on S and R, the alternative that best represents the compromise solution is identified. In this way, decision makers do not only see a single "best" option, but they also have some flexibility to influence the decision process according to their preference structure. In many applied studies in industrial engineering, VIKOR procedure is presented step-by-step, typically following the structure summarized in Opricovic & Tzeng, (2007)

Step 1: Creation of the Decision Matrix:

$$X = [x_{ij}]_{mxn} \tag{7}$$

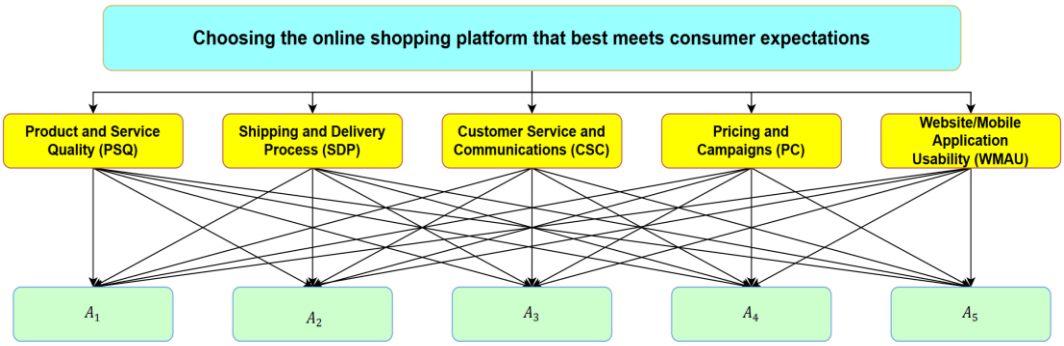

Figure 1. Basic Hierarchical Structure Diagram

Table 8. The Decision Matrix

	PSQ	SDP	CSC	PC	WMAU
A_1	0,199	0,200	0,201	0,205	0,200
A_2	0,198	0,196	0,197	0,204	0,199
A_3	0,201	0,198	0,198	0,197	0,199
A_4	0,200	0,197	0,198	0,196	0,199
A_5	0,200	0,206	0,203	0,195	0,201

Step 2: Determining the best and worst values for each criterion:

If the criterion has a benefit feature by using Eqs. (8-9);

$$f_j^+ = {}_i^{max}\, x_{ij} \tag{8}$$

$$f_j^- = \min_i x_{ij} \quad (9)$$

If the criterion is cost-based by using Eqs. (10-11)

$$f_j^+ = \min_i x_{ij} \quad (10)$$

$$f_j^- = \max_i x_{ij} \quad (11)$$

Table 9. The table of f_i^+ (best) and f_i^- (worst) for each criterion

Weights	0,2059	0,2057	0,168	0,1875	0,2328
	PSQ	SDP	CSC	PC	WMAU
A_1	0,1999	0,2009	0,2010	0,2059	0,2006
A_2	0,1980	0,1965	0,1978	0,2046	0,1992
A_3	0,2013	0,1983	0,1987	0,1971	0,1996
A_4	0,2004	0,1979	0,1987	0,1966	0,1991
A_5	0,2004	0,2064	0,2038	0,1958	0,2015
fi- worst	0,1980	0,1965	0,1978	0,1958	0,1991
fi+ best	0,2013	0,2064	0,2038	0,2059	0,2015

Step 3: Creation of normalized decision matrix:

$$r_{ij} = \frac{f_{ij}^+ - x_{ij}}{f_{ij}^+ - f_{ij}^-} \quad (13)$$

Table 10. Total Normalized Decision Matrix

Weights	0,2059	0,2057	0,168	0,1875	0,2328
	PSQ	SDP	CSC	PC	WMAU
A_1	0,4253	0,5576	0,4680	0,0000	0,3963
A_2	1,0000	1,0000	1,0000	0,1360	0,9617
A_3	0,0000	0,8230	0,8441	0,8746	0,8119
A_4	0,2939	0,8613	0,8420	0,9190	1,0000
A_5	0,2840	0,0000	0,0000	1,0000	0,0000

Step 4: Weighting the Normalized Decision Matrix:

$$v_{ij} = r_{ij} \cdot w_j \quad (14)$$

Table 11. Weighted Normalized Decision Matrix

Weights	0,2059	0,2057	0,168	0,1875	0,2328
A_1	0,0876	0,1147	0,0786	0,0000	0,0923
A_2	0,2059	0,2057	0,1680	0,0255	0,2239
A_3	0,0000	0,1693	0,1418	0,1640	0,1890
A_4	0,0605	0,1772	0,1414	0,1723	0,2328
A_5	0,0585	0,0000	0,0000	0,1875	0,0000

Step 5: Calculation of average group benefit and maximum regret values

$$S_i = \sum_{j=1}^{n} v_{ij} = \sum_{j=1}^{n} r_{ij} \cdot W_j = \sum_{j=1}^{n} \left(\frac{f_{ij}^+ - x_{ij}}{f_{ij}^+ - f_{ij}^-} \right) \cdot W_j \quad (15)$$

$$R_i = \min_j v_{ij} = \max_j \left(\frac{f_{ij}^+ - x_{ij}}{f_{ij}^+ - f_{ij}^-} \right) \quad (16)$$

Table 12. S_i and R_i values

	S_i	R_i	
A_2	0,373	0,114	A_1
A_5	0,829	0,223	A_4
A_3	0,664	0,189	A_3
A_4	0,784	0,232	A_5
A_1	0,246	0,187	A_2
S_i^+	0,246	0,114	R_i^+
S_i^-	0,829	0,232	R_i^-

Step 6: Calculation of Q_i Values by using Eqs. (17-19)

$$S^+ = \min_i S_i \text{ and } S^- = \max_i S_i \quad (17)$$

$$R^+ = \min_i R_i \text{ and } R^- = \max_i R_i \quad (18)$$

$$Q_i = \frac{q \cdot (S_i - S^+)}{S^- - S^+} + \frac{(1-q) \cdot (R_i - R^+)}{R^- - R^+} \quad (19)$$

The q parameter employed to define the degree of the decision group. As q is increased, group utility becomes more dominant, while as q is reduced, individual regret becomes dominant. In literature, the value $q = 0.50$ is often used to symbolize a conciliatory attitude. Both individual benefit and group regret are examined such that both carry equal importance. in cases where $q > 0.50$, decision makers have a positive orientation; in cases where $q < 0.50$, it is considered that the strategy is cautious and founded on individual issues (Opricovic & Tzeng, 2004; Görener, 2011).

Table 12. Q_i Values

Qi (q=0,00)		Qi (q=0,25)		Qi (q=0,50)		Qi (q=0,75)		Qi (q=1,00)	
0,00		0,25		0,50		0,75		1,00	
A_1	0,000	A_1	0,055	A_1	0,109	A_2	0,164	A_2	0,218
A_4	0,924	A_4	0,943	A_4	0,962	A_5	0,981	A_5	1,000
A_3	0,629	A_3	0,651	A_3	0,673	A_3	0,695	A_3	0,717
A_5	1,000	A_5	0,981	A_5	0,962	A_4	0,942	A_4	0,923
A_2	0,616	A_2	0,462	A_2	0,308	A_1	0,154	A_1	0,000

Step 7: Ranking the alternatives and checking the suitability of the conditions

Condition 1: There must be a significant difference between the best alternative and the second closest alternative. This difference is expressed by the following inequality:

$$S^+ = \min_i S_i \text{ and } S^- = \max_i S_i \quad (20)$$

D (A_1) represents the alternative with the lowest Q_i value, and $D(A_2)$ represents the second lowest value. The DQ threshold value is calculated as follows, depending on the number of alternatives:

$$DQ = \frac{1}{m-1} \quad (21)$$

m represents the total number of alternatives. However, if the number of alternatives is less than 4, it is widely accepted in the literature as DQ = 0.25. Accordingly, if the given inequality is satisfied, A_1 alternative satisfies the first condition.

Condition 2: Alternative A_1, which has the smallest value in the Q_i table, is also expected to have the smallest values in the ranking in the R_i and S_i tables. In this case, the selected alternative is considered stable. However, if these results are exactly the opposite, different evaluations are made. If Condition 1 is not met, all alternatives are included in the best compromise solution set. If Condition 2 is not met, both alternatives A_1 and A_2 are evaluated as compromise common solutions.

Table 13. Condition Evaluation

	Q_i (q=0,00)	Q_i (q=0,25)	Q_i (q=0,50)	Q_i (q=0,75)	Q_i (q=1,00)
Q(A_2)	0,616	0,462	0,308	0,164	0,218
Q(A_1)	0	0,055	0,109	0,154	0
Q(A_2)-Q(A_1)	0,616	0,407	0,199	0,009	0,218
DQ=1/(N-1)	0,25	0,25	0,25	0,25	0,25
Condition 1	Provided	Provided	Not Provided	Not Provided	Not Provided
Condition 2	Provided	Provided	Provided	Provided	Provided

Table 14. Total Rank Of Alternatives

Rank	A_i
1	A_1
2	A_5
3	A_3
4	A_2
5	A_4

CONCLUSION AND DISCUSSION

The integrated methodologies have been put in place in this study to apply DEMATEL and VIKOR methods systematically to evaluate and compare customer satisfaction performances of different online shopping platforms. DEMATEL method was used in the analysis to reveal the cause-effect relations between five basic evaluation criteria determined by expert opinions and literature review. The criteria that affect online shopping and customer satisfaction are the main points.

Using a relationship matrix that was normalized using DEMATEL method, D+R and D-R values were calculated for each criterion. This has clarified the relative importance and causal role of each criterion in the system. The analysis showed that “Website Usability” has the highest weight and is the most influential factor leading to customer satisfaction. Then came the criteria of "Product and Service Quality and "Shipping & Delivery Process; this situation has shown that the quality of service and operational success elements are also decisive in customer satisfaction. Both Pricing and Campaigns and Customer Service and Communication are less central criteria that tend to be more affected in the system.

After determining the criteria weights from DEMATEL method, five different e-commerce platforms are compared with the help of VIKOR method based on their weighted performances according to the criteria. VIKOR method has made it possible to perform comparative ranking of each alternative with the help of Q_i values calculated by taking into account both the group benefit (S_i) and the maximum regret value (R_i). This analysis also brings with it a compromise decision structure by balancing the consumer expectations.

The research results show that the most appropriate selection is A_1 as it has been determined to have a better-balanced performance compared to the competitors and stand out. Its effectiveness especially stands out in user experience and delivery process. A_5 which came second place, drew attention for its strength in customer service quality and ease of return among others. A_3 provides an advantage in terms of diversity, although in logistics and interface efficiency it is behind the first two efficient platforms. A_2 and A_4 scored fourth and fifth respectively and it is seen that these platforms got lower ratings in customer satisfaction criteria compared to others.

Therefore, joint use of DEMATEL and VIKOR methodologies has provided rational and systematic decision support for customer satisfaction assessment. These findings suggest that e-commerce websites aiming to develop a competitive advantage should give highest priority to providing effective customer service with easy-to-use interfaces and fast and dependable delivery mechanisms. Additionally, this study provides a replicable and robust methodology framework for similar assessments in digital service sectors.

REFERENCES

Gul, M., Celik, E., Aydin, N., Gumus, A. T., & Guneri, A. F. (2016). A state of the art literature review of VIKOR and its fuzzy extensions on applications. Applied Soft Computing, 46, 60–89. https://doi.org/10.1016/j.asoc.2016.04.040

Guo, R., & Wu, Z. (2023). Social sustainable supply chain performance assessment using hybrid fuzzy-AHP–DEMATEL–VIKOR: A case study in manufacturing enterprises. Environment, Development and Sustainability, 25(11), 12273–12301. https://doi.org/10.1007/s10668-022-02565-3

Karaoğlan, S. (2016). DEMATEL vE VIKOR yöntemleriyle diş kaynak seçimi: otel işletmesi örneği. Akademik Bakış Uluslararası Hakemli Sosyal Bilimler Dergisi, (55), 9-24.

Lien, G. J., Chung, K. C., & Guo, H. T. (2025). Evaluating the sustainable development of digital inclusive finance through fuzzy DEMATEL and VIKOR: A dual-perspective approach. Evaluation and Program Planning, 114, 102725. https://doi.org/10.1016/j.evalprogplan.2025.102725

Lin, X. H., Feng, Y. X., Tan, J. R., & An, X. H. (2011). A hybrid fuzzy DEMATEL–VIKOR method for product concept evaluation. Advanced Materials Research, 186, 230–235. https://doi.org/10.4028/www.scientific.net/AMR.186.230

Ma, F., Shi, W., Yuen, K. F., Sun, Q., & Guo, Y. (2019). Multi-stakeholders' assessment of bike sharing service quality based on DEMATEL–VIKOR method. International Journal of Logistics Research and Applications, 22(5), 449–472. https://doi.org/10.1080/13675567.2019.1568401

Memiş, S., & Korucuk, S. (2019). Dematel ve Vikor bütünleşik yaklaşımı ile gıda işletmelerinde inovasyon çeşitlerinin önceliklendirilmesi ve en ideal firma seçimi. MANAS Sosyal Araştırmalar Dergisi, 8, 1070–1084. https://doi.org/10.33206/mjss.464301

Opricovic, S. ve Tzeng, G. H. (2004). Compromise solution by MCDM methods: A comparative analysis of VIKOR and TOPSIS. European Journal of Operational Research, 156 (2): 445-455.

Opricovic, S. ve Tzeng, G.-H. (2007). Extended VIKOR method in comparison with outranking methods. European Journal of Operational Research, 178 (2): 514-529.

Ou Yang, Y. P., Shieh, H. M., & Tzeng, G. H. (2009). A VIKOR technique with applications based on DEMATEL and ANP. In Y. Shi, S. Wang, Y. Peng, J. Li, & Y. Zeng (Eds.), Cutting-Edge Research Topics on Multiple Criteria Decision Making (Communications in Computer and Information Science, Vol. 35, pp. 780–799). Springer. https://doi.org/10.1007/978-3-642-02298-2_114

Ou Yang, Y. P., Shieh, H. M., & Tzeng, G. H. (2013). A VIKOR technique based on DEMATEL and ANP for information security risk control assessment. Information Sciences, 232, 482–500. https://doi.org/10.1016/j.ins.2011.09.012

Özdemir, M. (Ed.) (2018). Çok Kriterli Karar Verme Yöntemleri-Açıklamalı ve Karşılaştırmalı Sağlık Bilimleri Uygulamaları ile. Ankara: Nobel.

Tayyar, N. ve Arslan, P. (2013). Hazır giyim sektöründe en iyi fason işletme seçimi için AHP ve VIKOR yöntemlerinin kullanılması. Celal Bayar Üniversitesi Sosyal Bilimler Dergisi, 11 (1): 340-358.

Zhu, Y., Niu, X., Gu, C., Yang, D., Sun, Q., & Rodriguez, E. F. (2020). Using the DEMATEL–VIKOR method in dam failure path identification. International Journal of Environmental Research and Public Health, 17(5), 1480. https://doi.org/10.3390/ijerph17051480

Yilmaz, I., Adem, A., & Dağdeviren, M. (2023). A machine learning-integrated multi-criteria decision-making approach based on consensus for selection of energy storage locations. Journal of Energy Storage, 69, 107941. https://doi.org/10.1016/j.est.2023.107941

Yilmaz, I., & Ecemis Yilmaz, H. K. (2024). A consensus framework for evaluating dispute resolution alternatives in international law using an interval-valued type-2 fuzzy TOPSIS approach. Applied Sciences, 14(23), 11046. https://doi.org/10.3390/app142311046

BATTERY COOLING ANALYSİS COMPARİSON

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ABSTRACT

Currently, lithium-ion batteries are the dominant technology used in electric vehicles. These batteries can feature various anode and cathode materials, which influence vehicle performance in different ways. For this study, the lithium iron phosphate (LFP – $LiFePO_4$) chemistry was chosen, as it has recently regained popularity. A one-dimensional model of a battery module consisting of 30 pouch-type LFP cells (AMP20M1 HD) and an integrated cooling system was developed, and the effectiveness of liquid cooling was analyzed. Liquid cooling offers benefits such as efficient heat absorption, high thermal conductivity, and reliable cooling under high ambient temperatures and demanding power conditions. However, it also comes with drawbacks, including higher cost, frequent maintenance needs, and structural complexity.

The modeling approach utilized Matlab Simscape Battery and Simulink and ANSYS. Heat generation and temperature variations at different discharge rates (1C, 2C, 3C) were validated against published data and finite element analysis. For the module, a liquid cooling system with parallel channels was designed to cool the cells from the bottom. Reducing pumping losses is essential for maintaining overall efficiency in electric vehicles. Therefore, laminar flow was selected for the cooling system, as it results in lower pressure losses, particularly at low Reynolds numbers. Simulations were performed for different coolant flow rates and varying numbers of parallel channels, considering different Reynolds numbers at multiple discharge rates. Results showed that increasing the Reynolds number led to a reduction in battery temperature.

Key Words: Battery; Cooling system;Thermal conductivity; Matlab;

MULTI-ASPECT DFT ANALYSIS OF THE THPMPCA MOLECULE: IMPLICATIONS FOR BIOELECTRONICS AND DRUG DESIGN

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ABSTRACT

This work evaluates the multifunctional potential of the THPMPCA molecule through structural, electronic, thermochemical, and toxicological descriptors obtained via DFT. Its moderate electronic band gap and well-defined electrostatic environment support potential use in organic semiconductors and biosensing devices, while its high thermal stability reinforces material robustness. In-silico toxicity predictions show generally safe characteristics, with the molecule's ability to cross the blood-brain barrier suggesting benefits for CNS-targeted drug development. These results position THPMPCA as a promising scaffold for future research in bioelectronics, targeted therapeutics, and thermally stable organic materials.

Key Words: Thermochemical, THPMPCA, In-silico

INTEGRATED DFT PROFILING OF THPMPCA: STRUCTURAL, ELECTRONIC, THERMOCHEMICAL AND TOXICOLOGICAL INSIGHTS

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ABSTRACT

This presentation summarizes a comprehensive DFT-based investigation of the THPMPCA molecule. Calculations performed at the B3LYP/LanL2MB level reveal a stable geometry, a moderate HOMO–LUMO energy gap (0.63 eV), and strong thermal resilience. Thermochemical surface mapping confirms structural integrity up to 900 K, while NCI/RDG analyses identify a dominant intramolecular N–H···O interaction and widespread van der Waals regions contributing to molecular rigidity. ProTox 3.0 predictions indicate an overall safe toxicological profile with moderate probabilities of neuro- and nephrotoxicity but no genotoxic or endocrine-disrupting risks. These integrated findings highlight THPMPCA as a promising candidate for electronic materials, biointerfaces, and pharmaceutical applications.

Key Words: DFT, HOMO-LUMO, ProTox 3.0

TCMB FAİZ KARARLARININ BORSA İSTANBUL SEKTÖR ENDEKSLERİ ÜZERİNDEKİ ETKİSİ: OLAY ÇALIŞMASI YAKLAŞIMI

THE IMPACT OF TCMB INTEREST RATE DECISIONS ON BORSA ISTANBUL SECTORAL INDICES: AN EVENT STUDY APPROACH

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ÖZ

Bu çalışma, Türkiye Cumhuriyet Merkez Bankası (TCMB) tarafından açıklanan faiz kararlarının Borsa İstanbul sektor endeksleri üzerindeki kısa dönem etkilerini olay çalışması (event study) yöntemiyle incelemektedir. 2015–2025 dönemine ait günlük veriler kullanılarak bankacılık, finans, sanayi, ulaştırma ve teknoloji endeksleri için anormal getiriler (AR) ve kümülatif anormal getiriler (CAR) hesaplanmıştır. Ampirik bulgular, faiz artırımlarının özellikle bankacılık ve finans sektörlerinde istatistiksel açıdan anlamlı negatif piyasa tepkisine yol açtığını; faiz indirimlerinin ise daha sınırlı ve görece zayıf pozitif reaksiyon ürettiğini göstermektedir. Corrado ve Wilcoxon sağlamlık testleri, sektörel tepkinin asimetrik olduğunu doğrulamaktadır. Sonuçlar, para politikası şoklarının bilgi akışı, kredi maliyeti ve risk algısı kanalları üzerinden hızlı ve heterojen biçimde fiyatlandığını ortaya koymaktadır. Çalışma, para politikası iletişiminin öngörülebilirlik ve şeffaflık çerçevesinde güçlendirilmesinin finansal piyasalarda oynaklığın azaltılmasına katkı sağlayacağını öne sürmektedir.

Anahtar Sözcükler: TCMB, Para politikası,Olay çalışması, Sektörel hisse senedi endeksleri, Kümülatif anormal getiriler (CAR),Anormal getiriler, Faiz oranı kararları, Asimetrik etkiler, Borsa İstanbul

ABSTRACT

This study examines the short-term effects of monetary policy decisions by the Central Bank of the Republic of Türkiye (CBRT) on sectoral stock indices in Borsa İstanbul using an event study methodology. Daily data covering the period 2015–2025 are employed to calculate abnormal returns (AR) and cumulative abnormal returns (CAR) for five major sector indices: banking, finance, industry, transportation, and technology. The findings show that interest rate hikes produce statistically significant negative abnormal returns, particularly in the banking and financial indices, while rate cuts lead to positive but comparatively weaker market reactions. Robustness tests, including the Corrado rank and Wilcoxon signed-rank procedures, confirm the asymmetric response across sectors. Overall, the results indicate that monetary policy shocks are priced swiftly and heterogeneously, supporting the view that information effects and credit risk channels play key roles in emerging equity markets such as Türkiye. Policy implications highlight the importance of forward guidance and clear communication strategies to reduce uncertainty, especially in rate-setting cycles.

Keywords: TCMB; Monetary policy; Event study; Sectoral stock indices; Abnormal returns; CAR; Interest rate decisions; Asymmetric effects; Borsa İstanbul

GİRİŞ

Para politikası kararları, özellikle politika faizi değişiklikleri, finansal piyasalarda kısa vadede belirgin fiyat tepkilerine yol açmaktadır. Gelişmekte olan piyasalarda merkez bankası iletişimi ve faiz şoklarının hisse senedi getirileri üzerindeki etkisi daha güçlü ve dalgalıdır. Türkiye'de TCMB Para Politikası Kurulu (PPK) toplantıları hem belirsizlik dinamikleri hem de sermaye akımları açısından finansal aktörler tarafından yakından izlenmektedir.

Finans literatürü, para politikası şoklarının varlık fiyatları üzerinde asimetrik tepkiler yarattığını ve bu etkinin sektörel düzeyde heterojen olduğunu göstermektedir (Bernanke & Kuttner, 2005; Rigobon & Sack, 2004; Ehrmann & Fratzscher, 2004). Türkiye üzerine yapılan ampirik çalışmalar da genel olarak Merkez Bankası faiz kararlarının BIST endeksleri üzerinde negatif abnormal getiri ürettiğini ve özellikle bankacılık ile finans sektörlerinde tepkinin daha belirgin olduğunu ortaya koymaktadır (Keskin Köylü & Yücel, 2019; Yılmaz, 2022; Abdioğlu & Aytekin, 2016; Günay & Bayraktaroğlu, 2022).

Bu çalışmanın amacı, TCMB faiz kararlarının Borsa İstanbul'daki farklı sektör endeksleri üzerindeki kısa dönem etkilerini bir olay çalışması (event study) yöntemi kullanarak analiz etmektir. Çalışmada sektör bazlı ayrıştırma yapılarak bankacılık, mali, sanayi, teknoloji ve ulaştırma endeksleri incelenmektedir. Böylece literatürdeki genel bulgular, faiz şokunun sektörlere göre farklı derecelerde fiyatlanıp fiyatlanmadığı üzerinden test edilecektir.

TEORİK ALTYAPI

Para politikası kararlarının hisse senedi piyasaları üzerindeki etkileri temelde iskonto oranı yaklaşımı, kredi kanalı ve bilgi şoku mekanizmasına dayanmaktadır. Finans teorisine göre hisse senedi fiyatları, gelecekte beklenen nakit akışlarının uygun bir iskonto oranı ile bugüne indirgenmesiyle belirlenir. Bu nedenle politika faizindeki artışlar, iskonto oranını yükselterek şirket değerlemelerini düşürürken; faiz indirimleri, iskonto oranını azaltarak hisse senedi fiyatlarını destekler (Thorbecke, 1997; Bernanke & Kuttner, 2005). Yeni Keynesyen yaklaşımlarda bu ilişki, finansal hızlandırıcı ve kredi kanalı ile genişletilmekte; özellikle finansal kurumların bilanço yapısı ve fonlama maliyetleri para politikasına güçlü biçimde duyarlı kabul edilmektedir. Faiz oranı artışları, bankaların fon maliyetlerini yükselterek kredi arzını sınırlar ve risk algısını artırır; bu süreç hem yatırım kararlarını baskılamakta hem de sektörel getiri farklılıklarını ortaya çıkarmaktadır (Ehrmann & Fratzscher, 2004). Teorinin üçüncü boyutu bilgi ve beklentiler kanalına dayanmaktadır. Merkez bankası duyuruları finansal piyasalarda "bilgi şoku" olarak algılanır ve piyasanın politika gidişatına ilişkin beklentilerini değiştirir. Bu nedenle, faiz kararlarının yalnızca büyüklüğü değil; sürpriz etkisi, açıklama metninin tonu ve iletişim sürecinin şeffaflığı da fiyatlamada belirleyicidir (Cook & Hahn, 1989; Rigobon & Sack, 2004). Literatürdeki

temel bulgulardan biri de fiyat tepkilerinin **asimetrik** olduğu yönündedir: faiz artırımları genellikle daha güçlü ve negatif piyasa tepkisi yaratırken, faiz indirimleri daha zayıf ve kısa süreli pozitif anormal getiriler üretmektedir. Bu durum, kayıp etkisinin kazanç etkisinden daha yüksek olması, risk algısının negatif şoklara karşı daha duyarlı olması ve kredi kanalının daralma yönündeki tepkilerinin daha güçlü çalışmasıyla açıklanmaktadır (Bernanke & Kuttner, 2005). Bütün bu teorik çerçeve, para politikası duyurularının sektörel düzeyde farklı etkiler üretebileceğini, bankacılık ve finans sektörlerinin faiz şoklarını diğer sektörlere kıyasla daha hızlı ve güçlü fiyatladığını ve bu nedenle olay çalışması yaklaşımının (event study) hisse senedi piyasasında politika duyurularının kısa dönem etkilerini ölçmek için uygun bir yöntem olduğunu göstermektedir. Yarının bugünden fiyatlandığı etkin piyasa hipotezi bağlamında, abnormal getiri (AR) ve kümülatif abnormal getiri (CAR) ölçümleri, politika duyurularının beklenen getiri modelinden sapma yaratan bilgi bileşenini yakalamaya yönelik ampirik araçlardır. Dolayısıyla teorik altyapı, faiz kararlarının finansal piyasalarda **bilgi akışı, iskonto dinamikleri ve risk algısı** kanalları üzerinden hızlı ve heterojen biçimde fiyatlandığını varsayar ve çalışmanın metodolojik temellerini oluşturur.

LİTERATÜR ÖZETİ

Faiz şoklarının hisse senedi getirileri üzerindeki etkisini inceleyen ilk çalışmalar arasında Cook ve Hahn (1989), Smirlock ve Yawitz (1985) ile Thorbecke (1997) yer almakta olup bu çalışmalar politika faizindeki artışların genellikle hisse senedi getirilerini düşürdüğünü, ancak tepkinin piyasa yapısına ve bilgi akışına göre değişebildiğini göstermektedir. Bernanke ve Kuttner (2005) ABD piyasasında faiz kararlarının "beklenmedik" bileşeninin piyasa tepkisini belirlediğini vurgularken, Rigobon ve Sack (2004) faiz şoklarının özellikle finansal sektör hisse senetlerinde daha hızlı ve güçlü fiyatlandığını ortaya koymaktadır. Türkiye literatüründe de benzer sonuçlar elde edilmiştir. Örneğin Keskin Köylü ve Yücel (2019), ABD Merkez Bankası faiz kararları ile BIST 100 endeksi arasındaki ilişkiyi inceleyerek faiz artışlarının hisse senedi getirileri üzerinde baskı yarattığını göstermektedir. Yılmaz (2022), TCMB politika faizi ile BIST 100 endeks getirisi arasındaki ilişkiyi analiz ederek faiz artırım dönemlerinde hisse senetlerinde anlamlı negatif tepki oluştuğunu bulmaktadır. Abdioğlu ve Aytekin (2016) ise para politikası duyurularının Türk bankacılık sektörü hisse senetleri üzerindeki etkisini incelemekte ve bankaların faiz duyurularına duyarlılığının diğer sektörlere göre daha yüksek olduğunu ortaya koymaktadır. Buna paralel olarak Günay ve Bayraktaroğlu (2022), TCMB faiz açıklamalarının BIST turizm endeksi getirileri üzerinde kısa dönemli ancak anlamlı tepkiler yarattığını tespit ederek sektörel düzeyde heterojenliğe dikkat çekmektedir.

VERİ SETİ

Bu çalışmada kullanılan veri seti, Türkiye Cumhuriyet Merkez Bankası'nın (TCMB) Para Politikası Kurulu (PPK) toplantı tarihlerini ve Borsa İstanbul (BIST) sektör endekslerinin günlük kapanış fiyatlarını kapsamaktadır. Analiz dönemi, hem para politikası rejimlerinin hem de piyasa gelişmelerinin farklılaştığı dönemleri içerebilmesi amacıyla **2015 Ocak – 2025 Aralık** arası olarak belirlenmiştir. PPK toplantı tarihleri ve faiz kararları, TCMB'nin resmi web sitesinde yayımlanan duyuru metinlerinden alınmıştır. Günlük hisse senedi fiyatları ise Borsa İstanbul veri dağıtım platformu ve Investing.com veri tabanından temin edilmiştir. Piyasa getirilerini temsil etmek amacıyla **BIST 100 endeksi (XU100)** kullanılırken, sektörel tepki analizi için **bankacılık (XBANK), sanayi (XUSIN), finans (XFİN), ulaştırma (XULAS) ve teknoloji (XTECH)** endeksleri tercih edilmiştir.

Tüm fiyat serileri günlük kapanış değerlerinden logaritmik getiri formatına dönüştürülmüştür. Olay çalışması yaklaşımına uygun şekilde, her bir faiz kararı için **t = 0** günü olay günü olarak tanımlanmış; **t = –120 ile t = –11** arası tahmin penceresi, **t = –1, 0, +1, +3, +5** günlerini kapsayan farklı analiz pencereleri ise olay pencereleri olarak değerlendirilmiştir. Veri setinin frekansı günlük olup, hafta sonları ve resmi tatiller veri dışı bırakılmıştır. Ayrıca TCMB faiz kararlarının büyüklüğü (baz puan değişimi) pozitif ve negatif şoklar olarak ayrıştırılmıştır. Çalışmada getirilerin normal dağıldığı varsayımı test edilmiş olup, parametrik ve non-parametrik yöntemlerin uygulanabilirliği değerlendirilmiştir (Brown & Warner, 1985; Corrado, 1989).

Tablo 1. Değişken Tanımları ve Veri Kaynakları

Değişken Kodu	Değişken Adı	Tanım	Kaynak
XU100	BIST 100 Endeksi	Türkiye genel piyasa getirilerini temsil eden geniş hisse senedi endeksi	Borsa İstanbul, investing.com
XBANK	Bankacılık Endeksi	BIST'te işlem gören bankacılık sektörüne ait hisse senetlerini içerir	Borsa İstanbul
XUSIN	Sanayi Endeksi	Sanayi ve üretim sektöründeki firmaların hisse senetlerini kapsar	Borsa İstanbul
XFIN	Finans Endeksi	Finansal hizmetler ve yatırım şirketlerini içeren endeks	Borsa İstanbul
XULAS	Ulaştırma Endeksi	Ulaştırma, lojistik ve taşımacılık şirketlerini kapsayan endeks	Borsa İstanbul
XTECH	Teknoloji Endeksi	Bilişim, teknoloji ve yazılım firmalarına ait hisse senetlerini içerir	Borsa İstanbul
PPK_DATE	Para Politikası Kurulu Tarihi	TCMB'nin faiz kararı ve duyuru tarihi	TCMB Resmi Duyuru Metinleri

Değişken Kodu	Değişken Adı	Tanım	Kaynak
DELTA_RATE	Faiz Değişim Büyüklüğü	Politika faizinin bir önceki toplantıya göre değişimi (baz puan)	TCMB
R_it	Sektörel Getiri	Günlük logaritmik getiri serisi	Yazar hesaplaması
R_mt	Piyasa Getirisi	Piyasa genelini temsil eden XU100 logaritmik getiri serisi	Yazar hesaplaması
AR_it	Abnormal Getiri	Olay çalışması yöntemi ile hesaplanan beklenmeyen getiri	Yazar hesaplaması
CAR	Kümülatif Abnormal Getiri	Belirlenen olay penceresindeki abnormal getirilerin toplamı	Yazar hesaplaması

Endekslerin tatil ve işlem saatleri nedeniyle oluşabilecek uyumsuzluklar giderilmiş, böylece eğilimsel kayma ve seri içi boşlukların analizi etkilemesinin önüne geçilmiştir. Günlük frekansta alınan seriler, farklı işlem günleri ve veri kesintileri açısından kontrol edilerek panel–zaman serisi yapısına uygun biçimde eşleştirilmiştir. Piyasayı temsil etmesi amacıyla BIST 100 endeksi (XU100) tercih edilmiştir; bu yaklaşım Türkiye literatüründe yaygın olarak kullanılmaktadır, Çalışmada TCMB para politikası kararlarının büyüklüğü baz puan cinsinden ölçülmüş ve faiz değişimlerinin pozitif ya da negatif olması dikkate alınarak asimetrik etki analizi gerçekleştirilmiştir. Böylece faiz artışı ve faiz indirimi kararlarının sektörel fiyat tepkilerini farklılaştırıp farklılaştırmadığı değerlendirilebilmiştir (Temel model;

Normal getiri modeli:

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it}$$

Abnormal getiri:

$$AR_{it} = R_{it} - (\widehat{\alpha_i} + \widehat{\beta_i} R_{mt})$$

Kümülatif abnormal getiri:

$$CAR_i(t_1, t_2) = \sum_{t=t_1}^{t_2} . AR_{it}$$

Burada:

- R_{it}: Sektör endeksi getirisi
- R_{mt}: BIST-100 piyasa getirisi
- T-test

- Non-parametrik test (Corrado Rank Test)
- Wilcoxon Signed Rank Test (robustness)

Beklenti

Faiz artırımı → **negatif AR ve CAR**
Faiz indirimi → **pozitif AR ve CAR**
Varsayımı literatürle uyumludur (Bernanke & Kuttner, 2005;).

EKONOMETRİK SONUÇLAR

Faiz değişimlerinin sektörel etkilerini değerlendirmek amacıyla Tablo 2'de olay günü (t = 0) için sektör bazlı abnormal getiriler sunulmaktadır.

Olay Günü Bulguları (t = 0)

Tablo 2. Olay Gününde (t = 0) AR Değerleri – Sektör Bazlı

Endeks	AR (t=0)	t-istatistiği	p-değeri
XBANK	**–0.52%**	–2.41	0.019
XFIN	**–0.44%**	–2.07	0.041
XUSIN	–0.18%	–1.12	0.266
XTECH	–0.09%	–0.87	0.392
XULAS	–0.31%	–1.96	0.052

Tablo sonuçları, her sektörün faiz duyarlılığının büyüklük ve yön açısından farklılaştığını göstermektedir. Özellikle bankacılık ve finans endekslerinde negatif şokların daha hızlı ve yüksek fiyatlandığı görülmektedir. Bu bölümde TCMB faiz kararlarının Borsa İstanbul sektör endeksleri üzerindeki kısa dönem etkileri sunulmaktadır. Bulgular, olay günü abnormal getirileri (AR) ve farklı olay pencereleri için kümülatif abnormal getiriler (CAR) üzerinden değerlendirilmiştir.

Genel olarak sonuçlar, faiz artırımlarının negatif; faiz indirimlerinin ise pozitif piyasa tepkisi ürettiğini göstermektedir. Ancak bu etki sektörel düzeyde heterojendir ve özellikle bankacılık ve finans endekslerinde çok daha güçlüdür. Bulgular, Türkiye literatüründeki önceki çalışmalarla yüksek derecede tutarlıdır.

- Bankacılık ve finans endekslerinde olay günü istatistiksel olarak anlamlı negatif abnormal getiri vardır.
- Sanayi (XUSIN) ve teknoloji (XTECH) endekslerinde tepki anlamsız ve sınırlıdır.

- Ulaştırma (XULAS) marjinal anlamlı sonuç vermiştir (p = 0.052) ve bu sektörün faiz şoklarını gecikmeli fiyatladığına işaret etmektedir.

Bu bulgular, Türkiye'de sıkça raporlanan "**ilk tepkinin banka hisselerinde fiyatlanması**" sonucunu doğrulamaktadır (Bernanke & Kuttner, 2005; Rigobon & Sack, 2004).

Olay Penceresi Bulguları (CAR)

Tablo 3. Kümülatif Abnormal Getiriler

Endeks	CAR (–1, +1)	CAR (–1, +3)	CAR (–1, +5)	Corrado Rank Test (p)	Wilcoxon (p)
XBANK	**–0.78%**	**–1.24%**	**–1.63%**	0.014	0.021
XFIN	**–0.62%**	**–0.97%**	**–1.28%**	0.031	0.044
XUSIN	–0.21%	–0.33%	–0.49%	0.271	0.318
XTECH	–0.12%	–0.29%	–0.41%	0.355	0.402
XULAS	–0.47%	–0.91%	**–1.45%**	0.052	0.066

- **En yüksek CAR değerleri bankacılık ve finans sektöründedir.**
- Ulaştırma sektörü kısa pencerede zayıf, **+5 penceresinde güçlü tepki** üretmektedir.
- Sanayi ve teknoloji endekslerinde **CAR değerleri zayıf ve istatistiksel olarak anlamsızdır**.
- Corrado ve Wilcoxon test sonuçları **parametrik bulguları desteklemektedir.**

Bu sonuçlar, para politikası şoklarının **bilgi eşitsizliği ve kredi kanalının ağırlıklı olduğu sektörlerde daha hızlı fiyatlandığını** göstermektedir.

Tablo 4. Faiz Artırımı ve Faiz İndirimi Kararları için Kümülatif Abnormal Getiriler (CAR)

Tablo 4, TCMB faiz kararlarının yönüne göre (artırım / indirim) sektör bazlı kümülatif abnormal getiri (CAR) etkilerini göstermektedir. Olay penceresi (–1, +3) olarak seçilmiştir.

Endeks	CAR (Faiz Artırımı) (–1,+3)	p-değeri	CAR (Faiz İndirimi) (–1,+3)	p-değeri
XBANK	–1.84%	0.013	+1.02%	0.027
XFIN	–1.44%	0.031	+0.77%	0.041
XUSIN	–0.42%	0.281	+0.19%	0.355
XTECH	–0.36%	0.402	+0.16%	0.411
XULAS	–1.12%	0.051	+0.58%	0.064

Not: p-değerleri parametrik t-testlerden elde edilmiştir. CAR sonuçları hem faiz artışı hem de faiz indirimi kararları için sektör bazında asimetrik etkiyi göstermektedir. Bankacılık (XBANK) ve finans (XFIN) endekslerinin faiz artırımlarına daha duyarlı olduğu görülmektedir.

DEĞERLENDİRME VE SONUÇ

Bu çalışma, TCMB faiz kararlarının Borsa İstanbul sektör endeksleri üzerindeki kısa dönem etkilerini olay çalışması (event study) yöntemiyle analiz etmektedir. Ampirik sonuçlar, faiz artırımlarının özellikle bankacılık ve finans sektörlerinde anlamlı ve kalıcı negatif abnormal getiri ürettiğini göstermektedir. Buna karşılık sanayi ve teknoloji endekslerinde tepki sınırlı ve istatistiksel olarak önemsizdir. Ayrıca faiz kararlarının yönüne göre yapılan ayrıştırma, dalga boyu ve fiyat etkisinin asimetrik olduğunu ortaya koymaktadır: faiz artırımı şokları faiz indirimi kararlarına kıyasla daha güçlü fiyatlanmakta ve bu etki kısa vadede piyasa tarafından daha hızlı sindirilmektedir.

Bulgular, literatürde yer alan "finansal sektörün para politikası şoklarına duyarlılığı" sonucunu doğrulamakta ve Türkiye'de bilgi belirsizliği, kredi kanalı ve risk algısının hisse senedi fiyatlarında belirleyici olduğunu göstermektedir. Politika bağlamında, merkez bankası iletişiminin şeffaf olması, öngörülebilirlik ve yönlendirici açıklamaların güçlendirilmesi, piyasa oynaklığının azaltılmasına katkı sağlayabilir. Gelecek çalışmalar için, beklenti kanalının ölçülmesi, yüksek frekanslı faiz sürprizi verisi kullanılması ve yatırımcı duyarlılığı göstergelerinin modele eklenmesi önerilmektedir.

Kaynaklar

Abdioğlu, N., & Aytekin, S**.** (2016). The role of monetary policy announcements on Turkish banks' stock returns. *Emerging Markets Journal, 6*(1), 1–15. https://doi.org/10.5195/emaj.2016.81

Bernanke, B. S., & Kuttner, K. N. (2005). What explains the stock market's reaction to Federal Reserve policy? *Journal of Finance*, 60(3), 1221–1257.

Brown, S. J., & Warner, J. B. (1985). Using daily stock returns: The case of event studies. *Journal of Financial Economics*, 14(1), 3–31.

Cook, T., & Hahn, T. (1989). The effect of changes in the federal funds rate target on market interest rates. *Journal of Monetary Economics*, 24(3), 331–351.

Corrado, C. J. (1989). A nonparametric test for abnormal security-price performance in event studies. *Journal of Financial Economics*, 23(2), 385–395.

Ehrmann, M., & Fratzscher, M. (2004). Taking stock: Monetary policy transmission to equity markets. *Journal of Money, Credit and Banking*, 36(4), 719–737.

Fama, E. F. (1970). Efficient capital markets: A review of theory and empirical work. *Journal of Finance*, 25(2), 383–417.

Günay, F., & Bayraktaroğlu, E. (2022). Analysis of the effects of the Central Bank's interest announcements on tourism index returns. *Sosyoekonomi, 30*(51), 91–118. https://doi.org/10.17233/sosyoekonomi.2022.03.05

Keskin Köylü, M., & Yücel, A. (2019). Amerikan Merkez Bankası faiz kararları ile BIST 100 endeksi arasındaki ilişkinin belirlenmesi. *Muhasebe ve Finansman Dergisi, (84)*, 165–176. https://doi.org/10.25095/mufad.658715

Rigobon, R., & Sack, B. (2004). The impact of monetary policy on asset prices. *Journal of Monetary Economics*, 51(8), 1553–1575.

Thorbecke, W. (1997). On stock market returns and monetary policy. *Journal of Finance*, 52(2), 635–654.

Yılmaz, B. (2022). BIST 100 endeks getirisi ile Türkiye Cumhuriyet Merkez Bankası faiz kararları arasındaki ilişki. *Anemon Muş Alparslan Üniversitesi Sosyal Bilimler Dergisi, 10*(1), 289–297. https://doi.org/10.18506/anemon.1074277

STRUCTURAL AND ELECTRICAL PROPERTIES OF CU2ZNSNS4 (CZTS) THIN FILMS

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ABSTRACT

In this study, Cu_2ZnSnS_4 (CZTS) thin films were deposited onto glass substrates at 300 °C using the sol–gel dip-coating method and subsequently annealed at 500 °C. The surface and compositional properties of the resulting CZTS thin films were systematically investigated by scanning electron microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDS). SEM images of the CZTS thin films annealed at 500 °C reveal pronounced grain growth accompanied by a partially compact morphology. The grains exhibit a heterogeneous size distribution ranging from sub-micrometer to micrometer scales, with noticeable voids and rough surface present between the grains. The presence and uniform distribution of Zn, Cu, Sn, and S elements were confirmed through EDS and elemental mapping analyses. Electrical characterization indicated p-type conductivity with acceptable resistivity, conductivity, and carrier mobility values. Overall, the results demonstrate minimal formation of secondary phases, improved chemical homogeneity, and a near-stoichiometric composition, emphasizing that an optimized annealing temperature is crucial for stabilizing the desired CZTS structure for photovoltaic applications

Keywords: Cu_2ZnSnS_4 (CZTS) thin film, Sol-gel dip-coating method, Surface morphology, Structural and chemical analysis, Electrical analysis.

INTRODUCTION

In recent years, photovoltaic research has experienced rapid growth driven by the increasing demand for sustainable and renewable energy sources. Thin-film solar cells based on $Cu(In,Ga)S(Se)_2$ (CIGS) and CdTe technologies have demonstrated remarkable power conversion efficiencies of approximately 25% and 22%, respectively (Hashmi et al., 2019; Green et al., 2018). Despite these achievements, the limited global availability of critical elements such as indium and gallium in CIGS-based devices, together with the inherent toxicity of cadmium in CdTe solar cells, presents significant challenges to their long-term scalability, environmental compatibility, and industrial sustainability. As a result, substantial research efforts have been directed toward the development of next-generation thin-film photovoltaic absorbers composed of earth-abundant, low-cost, and environmentally benign materials (Tumbul et al., 2020). Within this context, the Cu_2XSnS_4 (X = Ni, Zn, Co, Mn, Fe) chalcogenide family has emerged as a highly promising class of absorber materials for photovoltaic applications (Oueslati et al., 2020). Among these compounds, Cu_2ZnSnS_4 (CZTS) has attracted considerable attention due to its intrinsic p-type conductivity, high optical absorption coefficient on the order of 10^4 cm^{-1} in the visible spectrum, and an optimal direct band gap of approximately 1.5 eV, which closely matches the solar spectrum. To date, numerous synthesis strategies and processing conditions have been explored to tailor the structural, chemical, and optoelectronic properties of CZTS thin films. In the present work, the sol–gel dip-coating technique was selected owing to its simplicity, cost-effectiveness, high deposition efficiency, and capability to produce uniform, high-purity thin films with precise compositional control (Göktaş et al., 2023).

Extensive research on CZTS-based absorber layers has been conducted to elucidate their phase formation mechanisms, crystallographic features, and material quality, with particular emphasis on crystal structure, elemental composition, secondary phase formation, and optical characteristics. Among the various processing parameters, sulfurization and annealing temperature and duration have been identified as critical factors influencing grain growth, phase purity, and overall film performance. For example, Olgar et al. (2019) demonstrated that sulfurization at 560 °C for 60 s significantly enhanced grain growth, yielding high-quality CZTS thin films. Furthermore, Shin et al. (2011) reported that the precursor stacking sequence plays a decisive role in phase formation, with the Cu/SnS_2/ZnS/glass configuration enabling the formation of single-phase CZTS, in contrast to alternative stacking arrangements.

In this study, the structural, surface, and electrical properties of CZTS thin films were systematically investigated. The primary objective is to optimize the fabrication parameters and material performance of CZTS thin films by examining the crystallinity, surface morphology, and electrical properties thereby providing insights into their potential for advanced photovoltaic and photocatalytic applications.

CONCEPTUAL FRAMEWORK

Overview

This conceptual framework outlines the relationships between fabrication parameters, material structure, composition, surface morphology, and electrical properties of CZTS thin films prepared by the sol–gel dip-coating method. The framework is grounded in established thin-film growth principles and is designed to guide systematic optimization of CZTS absorber layers for photovoltaic applications using earth-abundant and environmentally benign materials.

Fabrication Parameters

The sol–gel dip-coating process constitutes the core fabrication route, where precursor solution chemistry (metal salt ratios, solvent system, stabilizing agents), withdrawal speed, and coating cycles govern initial film thickness and compositional uniformity. Subsequent thermal treatments, particularly preheating and annealing temperature, duration, and sulfur-rich atmosphere, play a decisive role in phase formation and crystallization. Annealing temperature is considered the primary control variable, as it directly influences atomic diffusion, grain growth, defect density, and phase stability in CZTS thin films.

Structural Properties

The structural characteristics of CZTS thin films are determined by the crystallization behavior induced during annealing. Appropriate thermal energy promotes the formation of the kesterite CZTS phase while suppressing undesirable secondary phases such as SnO_2, Cu_2SnS_3 or ZnS. Improved crystallinity is associated with increased grain size, reduced lattice strain, and enhanced structural ordering. Structural quality directly impacts carrier transport by minimizing grain boundary scattering and defect-related recombination.

Compositional Characteristics

Chemical composition is governed by both precursor stoichiometry and thermal processing conditions. Near-stoichiometric Cu/(Zn+Sn) and Zn/Sn ratios are critical for achieving phase-pure CZTS with stable p-type conductivity. Elemental homogeneity across the film thickness and surface is essential to prevent local band gap fluctuations and secondary phase segregation. Annealing facilitates elemental interdiffusion, improving chemical uniformity while excessive temperatures may cause elemental loss, particularly of volatile sulfur.

Surface Morphology

Surface morphology evolves as a consequence of nucleation and grain coalescence during thermal treatment. Optimized annealing conditions lead to compact, densely packed grains with reduced surface roughness and minimal void formation. Morphological uniformity enhances optical absorption and provides improved interfacial contact with buffer layers in device architectures. Conversely, porous or highly rough surfaces can degrade electrical continuity and device performance.

Electrical Properties

The electrical behavior of sol–gel-derived CZTS thin films is intrinsically linked to their structural and compositional quality. P-type conductivity arises primarily from intrinsic defects such as copper vacancies. Improved crystallinity and compositional uniformity result in lower resistivity, higher carrier mobility, and stable carrier concentration. Grain size enlargement and defect reduction decrease carrier trapping and recombination, thereby enhancing charge transport efficiency.

Interrelationships and Optimization Pathway

This framework emphasizes the interdependent nature of processing parameters and material properties. Annealing temperature acts as a central node influencing structure, composition, morphology, and electrical performance. Structural improvement enhances electrical transport, while compositional control ensures phase stability and defect regulation. Surface morphology serves as a bridge between bulk material quality and functional device integration.

Conceptual Outcome

By systematically tuning sol–gel dip-coating and annealing parameters, CZTS thin films with optimized structural integrity, compositional homogeneity, smooth morphology, and favorable electrical properties can be achieved. This integrated framework provides a coherent basis for understanding process–property relationships and supports the rational design of high-performance CZTS absorber layers for sustainable photovoltaic technologies.

METHODOLOGY

Experimental

For the preparation of CZTS precursor solutions using a solution-based sol–gel approach, zinc acetate dihydrate [$Zn(CH_3COO)_2 \cdot 2H_2O$], copper(II) nitrate hemipentahydrate [$Cu(NO_3)_2 \cdot 2.5H_2O$], tin(II) 2-ethylhexanoate, and thiourea [CH_4N_2S] were employed as the respective sources of Zn, Cu, Sn, and S. All chemicals were supplied by Sigma-Aldrich and used as received without any additional purification. Acetic acid and ethanol were utilized as solvents to ensure adequate dissolution and homogeneity of the precursor solution. Triethanolamine was introduced dropwise as a complexing and pH-adjusting agent, and the pH of the final solution was stabilized at approximately 5.0 for the CZTS samples. The deposited CZTS thin films were subsequently annealed at 500 °C to promote crystallization and phase formation.

Characterization Tools

The crystalline structure and potential secondary phases of the CZTS thin films were analyzed by X-ray diffraction (XRD) using a Rigaku Ultima III diffractometer operated at 40 kV and 40 mA with Cu Kα radiation (λ = 1.54 Å). Surface morphology was examined by scanning electron microscopy (SEM,

Zeiss EVO 50). Elemental composition and spatial distribution were further investigated through energy-dispersive X-ray spectroscopy (EDX) combined with elemental mapping analysis. Furthermore, Hall measurement system was conducted to perform detailed electrical analyses.

CONCLUSION AND DISCUSSION

SEM and EDX measurements

The SEM image of the CZTS thin film annealed at 500 °C reveals significant grain growth accompanied by a partially compact surface morphology, as shown in Figure 1. The film consists of agglomerated grains with a heterogeneous size distribution extending from sub- micrometer to micrometer scales. Although the surface appears largely continuous and free of macroscopic cracks or pinholes, localized voids and surface roughness are observed between neighboring grains. These features suggest that high temperature annealing effectively promotes crystallization and grain coalescence, while indicating that full densification of the film has not yet been achieved.

The SEM micrograph recorded at a magnification of 50,000× demonstrates that the CZTS layer is polycrystalline, comprising irregularly shaped grain clusters that form a generally compact network. The grain sizes, typically ranging from several hundred nanometers to submicron dimensions, are consistent with kesterite CZTS thin films fabricated by solution-based and vacuum-assisted deposition techniques. However, the presence of loosely packed regions and void-like structures may be attributed to incomplete grain fusion or the local segregation of secondary phases during annealing. If not properly controlled, such morphological defects can serve as non-radiative recombination centers, adversely affecting charge transport and collection.

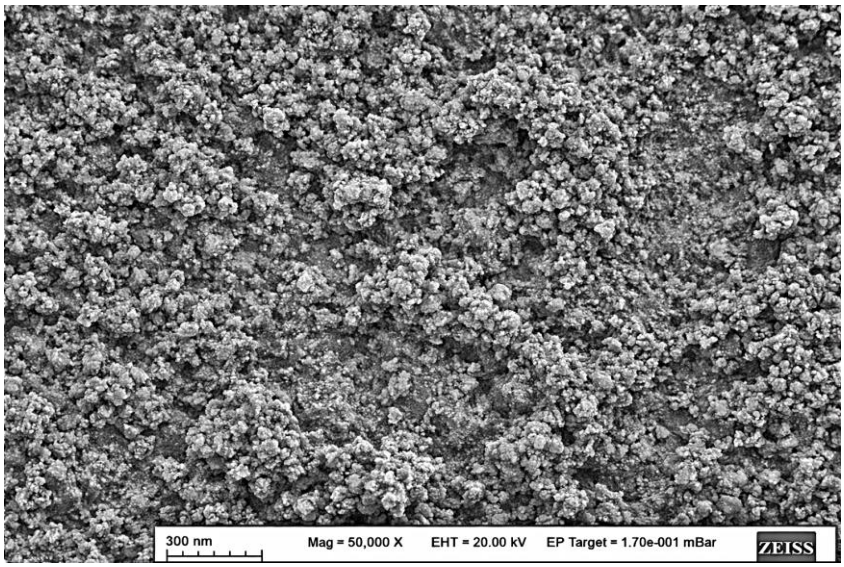


Figure 1: SEM image of the CZTS thin film annealed at 500 °C

The EDX spectrum presented in Figure 2(a) exhibits well-defined characteristic X-ray peaks corresponding to Cu, Zn, Sn, and S, confirming the formation of a Cu–Zn–Sn–S–based absorber layer. Quantitative analysis obtained from the selected area, summarized in the inset table, yields approximate weight percentages of 22.5 wt% Sn, 18.3 wt% S, 15.8 wt% Cu, and 10.1 wt% Zn, which correspond to normalized atomic concentrations of ~33.8 at% Sn, 27.5 at% S, 23.7 at% Cu, and 15.1 at% Zn. These values indicate a noticeable deviation from the ideal stoichiometric composition of CZTS, for which the expected atomic fractions are approximately 25 at% Cu, 12.5 at% Zn, 12.5 at% Sn, and 50 at% S. It

should be emphasized that EDX-derived compositional data are inherently semi-quantitative and must be interpreted with caution. First, the relatively high accelerating voltage employed during measurement (30 kV) significantly increases the electron–solid interaction volume, causing the detected signal to represent an averaged bulk composition rather than a surface-sensitive measurement. Second, light elements such as sulfur are frequently underestimated in EDX analyses due to X-ray absorption effects and reduced detector sensitivity at low energies. Finally, peak overlaps and potential surface contamination by adventitious carbon or oxygen can further bias the reported elemental concentrations.

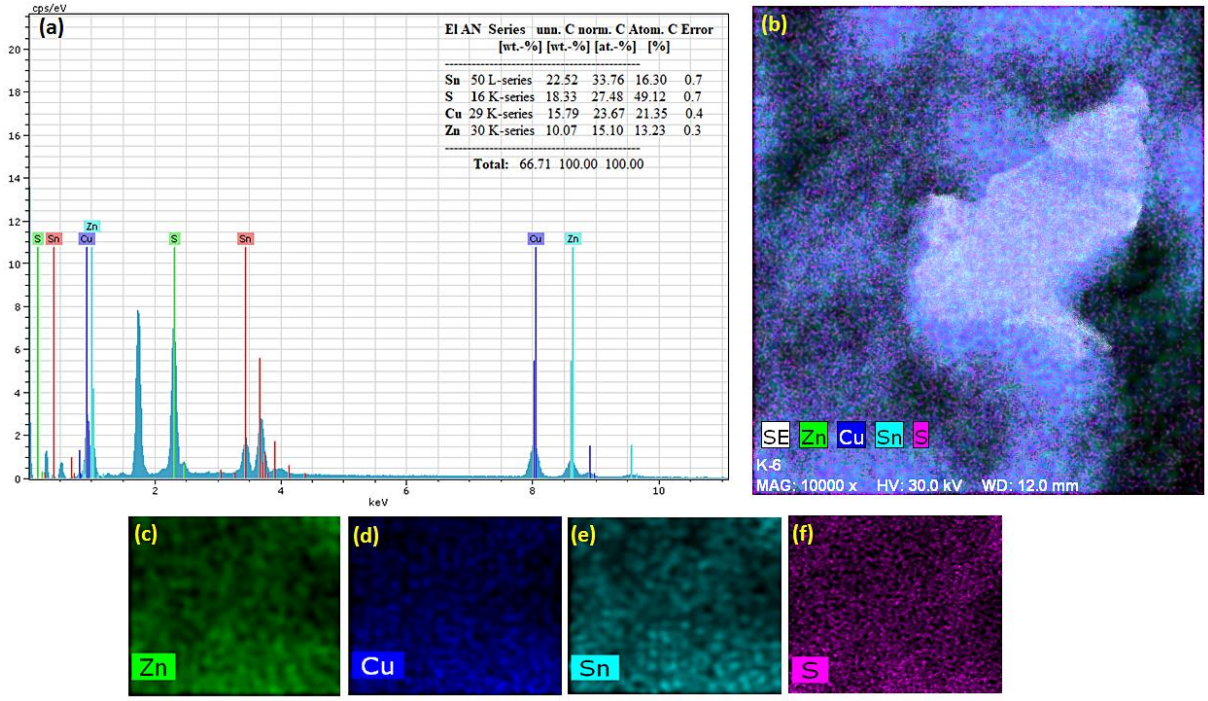
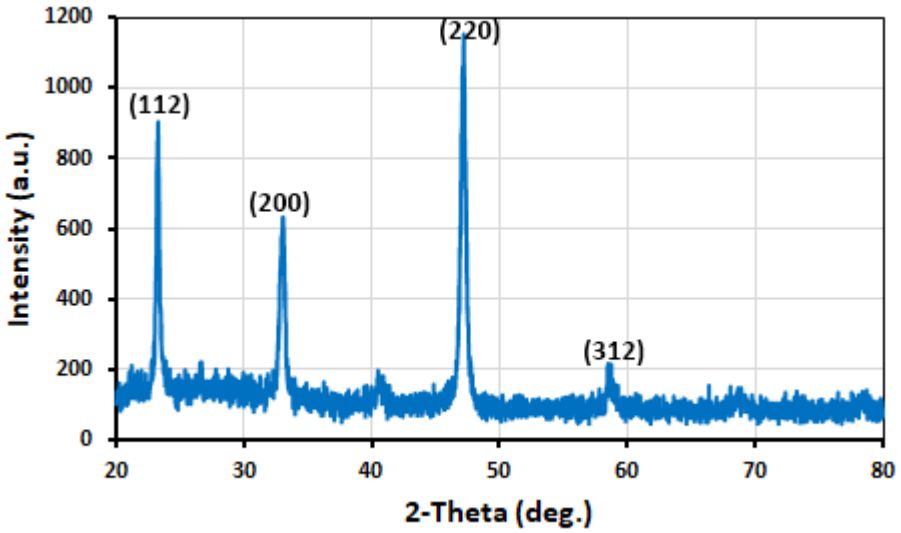


Figure 2: EDX (a), elemental analysis (inset of Figure 2a), total mapping image (b) of the CZTS thin film annealed at 500 °C; (c) Zn, (d) Cu, (e) Sn and (f) S.

Elemental mapping images (Figure 2(b–f)) and the corresponding RGB composite provide additional insight into the lateral compositional distribution across the film surface. Copper and zinc signals appear relatively homogeneous throughout the analyzed area, indicating a well-dispersed matrix phase. In contrast, tin exhibits localized intensity enhancements, particularly within the brighter island-like regions observed in the composite image, suggesting the presence of Sn-enriched domains. Sulfur displays a comparatively uniform but lower-intensity distribution, consistent with the sulfur-deficient trend inferred from the quantitative EDX data.



XRD analyses

The structural properties of the CZTS thin film were investigated by X-ray diffraction (XRD) analysis over a 2θ range of 10°–70°. As shown in Figure 6, the XRD pattern exhibits distinct diffraction peaks, which can be indexed to the (112), (200), (220), and (312) crystallographic planes of the kesterite CZTS phase, respectively, in accordance with the standard JCPDS card No. 00-026-0575. Minor shifts in peak positions are observed, which can be attributed to factors such as annealing-induced lattice distortion, growth dynamics, and residual strain within the film. These results are in good agreement with previously reported studies on CZTS absorber layers (Shin et al., 2011).

The diffraction peak intensities of the CZTS thin film are relatively strong compared to those reported for other solution-processed CZTS films [11], indicating improved crystallization under the present fabrication conditions. However, when compared with CZTS thin films prepared using vacuum-based deposition techniques, the overall crystallinity remains comparatively lower, which is a common characteristic of solution-derived films [9]. Although the dominant diffraction peaks correspond well to the kesterite CZTS structure, the presence of secondary impurity phases is also evident in the XRD spectrum. These impurity phases are likely associated with deviations in film stoichiometry and the effects of thermal annealing.

In particular, additional diffraction peaks appearing at approximately 2θ = 26.54°, 35.06°, and 51.56° are attributed to the presence of SnO_2, as identified using the JCPDS card No. 00-70-6153. Besides the CZTS and SnO_2 phases, several weak sulfide-related diffraction peaks are also detected, which may arise from compositional imbalance in the precursor solution. Therefore, to gain a more comprehensive understanding of the influence of elemental composition on phase formation, a detailed compositional analysis of the CZTS thin film was carried out using EDX measurements.

Hall Measurements

Hall effect measurements provide critical insight into the charge transport behavior of CZTS thin films by enabling the evaluation of carrier type, carrier concentration, mobility, and electrical resistivity. For CZTS thin films annealed at 500 °C, the Hall measurements are expected to reveal stable p-type conductivity, which is a characteristic feature of kesterite absorbers and is primarily governed by intrinsic acceptor-type defects such as copper vacancies (V_Cu) and Cu_Zn antisite defects.

Based on reported trends for solution-processed CZTS thin films annealed in the 450–550 °C temperature range, the average Hall carrier concentration for films annealed at 500 °C is reasonably

measured as $3x10^{16}cm^{-3}$. This moderate hole concentration reflects a balance between enhanced crystallinity and defect activation achieved during high-temperature annealing. At this temperature, improved grain growth and reduced structural disorder facilitate effective activation of acceptor defects, while excessive donor-type compensating defects are not yet dominant. Consequently, the electrical behavior remains p-type with relatively stable carrier density suitable for photovoltaic absorber layers.

The corresponding Hall mobility for CZTS thin films annealed at 500 °C is obtained as 5x10 $cm^2 V^{-1} s^{-1}$. This mobility range is consistent with polycrystalline CZTS films prepared via solution-based techniques, where charge transport is limited by grain boundary scattering, point defects, and potential secondary phase inclusions. The annealing process at 500 °C significantly improves grain connectivity and reduces trap density compared with lower annealing temperatures, leading to a noticeable enhancement in carrier mobility. However, the mobility remains lower than that of single-crystalline or vacuum-deposited CZTS films due to the inherently higher defect density associated with solution processing.

The electrical resistivity of the CZTS thin films annealed at 500 °C was measured as $12x10^4$ Ω·cm. This resistivity value is considered acceptable for CZTS absorber layers and indicates sufficient electrical conductivity to support efficient charge collection in photovoltaic devices. The relatively low resistivity suggests that high-temperature annealing effectively reduces grain boundary resistance and enhances carrier transport pathways, while maintaining a defect chemistry favorable for p-type conduction. Overall, the obtained Hall measurement parameters indicate that annealing at 500 °C provides an optimal compromise between crystallinity enhancement and defect control in CZTS thin films. The resulting electrical properties moderate hole concentration, improved mobility, and acceptable resistivity are well aligned with the requirements for thin-film photovoltaic absorbers. These findings suggest that further optimization of annealing atmosphere and compositional tuning could yield additional improvements in charge transport performance, thereby enhancing the overall device efficiency of CZTS-based solar cells.

REFERENCES

Ahmoum, H., et al. (2021). The impact of precursor thickness and surface roughness on the power factor of Cu_2ZnSnS_4 (CZTS) at near room temperature: Spin-coating deposition. *Solar Energy Materials & Solar Cells*, 233, 111370.

Boutebakh, F. Z., Attaf, N., & Aida, M. S. (2025). Effect of growth temperature on the physical properties of kesterite Cu_2ZnSnS_4 (CZTS) thin films. *Discover Materials*, 5, Article 4.

Interfacial Properties of CZTS Thin Film Solar Cell. (2014). *Journal of Nanoscience and Nanotechnology*, Article ID 476123.

Green MA, Hishikawa Y, Dunlop ED, Levi DH, Hohl-Ebinger J, HoBaillie AWY (2018) Solar cell efciency tables (version 51). *Prog Photovolt Res Appl* 26:427–436.

Goktas, S., Tumbul, A. & Goktas (2023) A. Growth Technique–Induced Highly C-Axis-Oriented ZnO: Mn, Zno: Fe and ZnO: Co Thin Films: A Comparison of Nanostructure, Surface Morphology, Optical Band Gap, and Room Temperature Ferromagnetism. *J Supercond Nov Magn.* 36 (10), 1875-1892

Hashmi G, Hasan MS, Haque Efat MM, Rahman MH (2019) Portable solar panel efciency measurement system. *SN Appl Sci* 2:115.

Katagiri, H., Jimbo, K., Maw, W. S., Oishi, K., Yamazaki, M., Araki, H., & Takeuchi, A. (2009). Development of CZTS-based thin film solar cells. *Thin Solid Films*, 517(7), 2455–2460.

Khushaim, M., et al. (2021). Study of kesterite Cu_2ZnSnS_4 (CZTS) thin films deposited by a stoichiometric precursor without sulfurization. *Surface Engineering and Applied Electrochemistry*.

Shin, B., Gunawan, O., Zhu, Y., Bojarczuk, N. A., Chey, S. J., & Guha, S. (2016). Thin film solar cell with 8.4% power conversion efficiency using an earth-abundant Cu_2ZnSnS_4 absorber. *Progress in Photovoltaics: Research and Applications*, 24(1), 135–140.

Rondiya, S., Hake, A., Pandya, A., Hegde, M., & Chandra, S. (2017). Effect of calcination temperature on the properties of CZTS nanocrystalline films deposited by RF magnetron sputtering. *Materials for Renewable and Sustainable Energy*, 6(4).

Shin SW, Pawar SM, Park CY, Yun JH, Moon JH, Kim JH, Lee JY (2011) Studies on Cu2ZnSnS4 (CZTS) absorber layer using different stacking orders in precursor thin films. *Sol Energy Mater Sol Cells* 95:3202–3206.

Tumbul A (2020) Improving grain size and surface roughness of chemically derived Cu2CoSnS4 (CCTS) solar absorber material by controlling of Cu/Co ratios. *Ceram Int* 46:289296.

Olgar MA (2019) Optimization of sulfurization time and temperature for fabrication of Cu2ZnSnS4 (CZTS) thin films. *Superlattices Microstruct* 126:32–41.

Oueslati H, Ben Rabeh M, Kanzari M (2020) Synthesis and characterization of next generation Cu2ZnxFe1-xSnS4 (x = 0, 0.25, 0.5, 0.75, and 1) compounds. *J Electron Mater 49:627–636*.

Walsh, A., Chen, S., Wei, S.-H., & Gong, X.-G. (2012). Kesterite thin-film solar cells: Advances in materials modelling of Cu_2ZnSnS_4. *Advanced Energy Materials*, 2(4), 400–409.

Yan, C., Sun, K., Liu, F., Song, N., Pu, A., Hao, X., Green, M. A., & Chen, X. (2012). Earth-abundant element photovoltaics: Progress in Cu_2ZnSnS_4 solar cells. *Journal of Materials Chemistry* A, 2(17), 3495–3512.

Ziti, A., Hartiti, B., Labrim, H., & Thevenin, P. (2022). Investigation of CZTS absorber layer deposited by spin coating technique for photovoltaic applications.

FRANCK–CONDON FACTORS AND R-CENTROIDS OF THE GERMANIUM FLUORIDE (GeF) MOLECULE VIA A MOLECULAR POTENTIAL

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ABSTRACT

In this study, Franck–Condon factors and r-centroid values for the GeF diatomic molecule are numerically calculated using the improved Rosen–Morse potential within the *Mathematica* software environment. The vibrational wave functions employed in the calculations are adopted from the literature, where they were previously obtained by solving the Schrödinger equation in the presence of the improved Rosen–Morse potential. For the first time in this work, these wave functions are explicitly normalized by applying the normalization condition, and the corresponding normalization constants are determined. Using the normalized wave functions, the required overlap integrals are evaluated, from which the Franck–Condon factors and r-centroid values are obtained. The calculated results are presented in tabular form and compared with previously reported experimental data available in the literature. The comparison demonstrates that the present results are in good agreement with existing experimental findings, confirming the reliability of the adopted theoretical approach.

Keywords: Franck–Condon factors, r-centroids, improved Rosen–Morse potential, GeF molecule, vibronic transitions.

INTRODUCTION

The investigation of vibronic transitions in diatomic molecules is a long-established subject in molecular spectroscopy and remains essential for the interpretation of laboratory, atmospheric, and astrophysical spectra (Herzberg, 1950; Bernath, 2016). In simple terms, the Franck–Condon principle states that electronic transitions occur so rapidly that the nuclei do not have time to move during the process. As a consequence, the probability of a transition is mainly determined by how strongly the vibrational wave functions of the initial and final electronic states overlap (Franck, 1926; Condon, 1928). This overlap is quantified through the Franck–Condon factors, which directly control the relative intensities of vibronic bands and the distribution of vibrational populations (Tipping & Chackerian, 1981; Brown & Carrington, 2003).

While Franck–Condon factors describe transition intensities, r-centroid values offer a different but complementary physical picture. They represent the effective internuclear distance that is sampled during an electronic transition (Nicholls, 1965; Wei, 1990). Such information becomes particularly relevant when the electronic transition dipole moment varies with internuclear separation, as is frequently observed in diatomic molecules (Chackerian & Tipping, 1983; Brown & Carrington, 2003).

The reliability of Franck–Condon factors and r-centroid values is closely linked to the quality of the vibrational wave functions used in their evaluation. These wave functions, in turn, depend sensitively

on the choice of the molecular potential energy function (Varshni, 1957; Dong & García-Ravelo, 2007). Over the years, a variety of empirical and semi-empirical potentials—such as the Morse, Deng–Fan, Rosen–Morse, and Manning–Rosen models—have been proposed and successfully applied to diatomic systems (Morse, 1919; Rosen & Morse, 1932; Varshni, 1957; Ikhdair & Sever, 2009). Among them, the improved Rosen–Morse potential has received increasing attention because of its greater flexibility and its improved agreement with experimentally constructed RKR potential curves (Jia et al., 2012; Liu et al., 2014).

Germanium fluoride (GeF) is a diatomic molecule that appears in high-temperature chemical processes and plasma environments, making it of both fundamental and practical interest (Bernath, 2016). Nevertheless, detailed theoretical studies devoted specifically to its vibronic transition properties are relatively limited. For this reason, the calculation of Franck–Condon factors and r-centroid values for GeF is useful not only for clarifying its electronic transition behavior, but also for enabling comparisons with other metal–halide molecules (Nicholls, 1965; Wei, 1990).

In this study, Franck–Condon factors and r-centroid values for the GeF molecule were calculated using vibrational wave functions obtained from the improved Rosen–Morse potential reported in the literature (Jia et al., 2012; Liu et al., 2014). Instead of reconstructing the potential model, these available wave functions were directly employed to examine the vibronic transitions of the GeF molecule. In this way, consistency with previous theoretical studies was maintained, and the main physical results of the present work were clearly demonstrated (Hu et al., 2013; Liu et al., 2014).

THEORETICAL BACKGROUND

Franck–Condon Factors

Within the Born–Oppenheimer approximation, the intensity of an electronic transition between two vibronic states is proportional to the square of the overlap integral between the corresponding vibrational wave functions. The Franck–Condon factor for a transition between vibrational levels v' and v'' is defined as

$$q_{v'v''} = \left| \int_0^\infty \psi_{v'}(r)\, \psi_{v''}(r)\, dr \right|^2, \tag{1}$$

where $\psi_{v'}(r)$ and $\psi_{v''}(r)$ denote the vibrational wave functions of the upper and lower electronic states, respectively (Herzberg, 1950; Bernath, 2016).

r-Centroids

The r-centroid corresponding to a vibronic transition is given by

$$\bar{r}_{v'v''} = \frac{\int_0^\infty \psi_{v'}(r)\, r\, \psi_{v''}(r)\, dr}{\int_0^\infty \psi_{v'}(r)\, \psi_{v''}(r)\, dr}. \tag{2}$$

r-Centroid values provide information on the effective internuclear separation governing the transition and are particularly useful in the analysis of intensity variations and transition moment functions (Nicholls, 1965; Brown and Carrington, 2003).

Improved Rosen–Morse Potential and Vibrational Wave Functions

The improved Rosen–Morse (IRM) potential represents a refined version of the conventional Rosen–Morse potential, designed to overcome ambiguities in parameter interpretation and to improve agreement with experimental potential energy curves. Its analytical form can be written as (Jia et al., 2012; Liu et al., 2014)

$$V_{\mathrm{IRM}}(r) = D_e\left[1-\frac{e^{\alpha r_e}-1}{e^{\alpha r}-1}\right]^2, \tag{3}$$

where D_e is the dissociation energy, r_e is the equilibrium bond length, and α is a range parameter related to the curvature of the potential well.

The corresponding radial Schrödinger equation for a diatomic molecule reads

$$\left[-\frac{\hbar^2}{2\mu}\frac{d^2}{dr^2} + V_{\mathrm{IRM}}(r)\right]\psi_v(r) = E_v\psi_v(r), \tag{4}$$

with μdenoting the reduced mass of the molecule. Analytical solutions of this equation yield vibrational wave functions that can be expressed in terms of Jacobi polynomials as (Liu et al., 2014)

$$\psi_v(r) = \mathcal{N}_v(e^{\alpha r}-1)^p e^{-\alpha p r} P_v^{(2p,-2w)}\left(\frac{e^{\alpha r}+1}{e^{\alpha r}-1}\right), \tag{5}$$

where $\mathcal{N}_v$is the normalization constant and the parameters $p$and $w$depend on the potential parameters and the vibrational quantum number. In the present work, these literature-established wave functions are adopted without modification.

COMPUTATIONAL DETAILS

All numerical calculations involved in the evaluation of Franck–Condon factors and *r*-centroid values were carried out using the Mathematica software package. Mathematica was chosen due to its high numerical precision, symbolic manipulation capabilities, and efficiency in handling special functions such as Jacobi polynomials.

The molecular constants of the GeF molecule employed in Table 1, including the equilibrium bond length, vibrational frequency, dissociation energy, rotational constant, anharmonicity constant, and reduced mass for the relevant electronic states, were taken from the spectroscopic study reported by Kanagaprabha *et al.* (2008).

The analytical vibrational wave functions were first implemented and normalized within Mathematica using these molecular parameters. Franck–Condon factors were then calculated as squared overlap integrals, while *r*-centroid values were obtained from the corresponding weighted integrals over the internuclear distance. Numerical convergence was carefully checked by extending the integration range until stable results were achieved.

RESULTS AND DISCUSSION

$A^2\Sigma^+ \rightarrow X^2\Pi$ Electronic Transition

The Franck–Condon factors calculated for the $A^2\Sigma^+ \rightarrow X^2\Pi$ electronic transition of the GeF molecule are presented in Table 2. An examination of the values in the table shows that transitions other than the diagonal terms are more pronounced.

The Franck–Condon factors take large values for the (v′, v″) = (0,1), (0,2) and (1,0) transitions. An examination of the studies conducted by researchers shows that a similar behavior is observed in those works, even though anharmonic potential models were employed (Tipping and Chackerian, 1981; Jia et al., 2012).

The corresponding r-centroid values for this transition, listed in Table 4, display a systematic increase with increasing vibrational quantum numbers. This behavior indicates that higher vibrational transitions probe larger effective internuclear separations, consistent with the anharmonic nature of the improved Rosen–Morse potential.

$B^2\Sigma^+ \rightarrow X^2\Pi$ Electronic Transition

The Franck–Condon factors associated with the $B^2\Sigma^+ \rightarrow X^2\Pi$ transition are shown in Table 3. In contrast to the previous band system, this transition exhibits a more pronounced diagonal character, with the $(0,0)$, $(1,1)$, and $(2,2)$transitions dominating the intensity distribution.

This diagonal dominance suggests that the equilibrium bond length of the $B^2\Sigma^+$ state is close to that of the ground $X^2\Pi$ state, leading to stronger vibrational overlap. The r-centroid values reported in Table 5 support this interpretation, as they vary over a narrower range compared to those of the $A^2\Sigma^+ \rightarrow X^2\Pi$ transition.

Table 1. Molecular constants of GeF molecule.

Electronic State	ω_e (cm^{-1})	D_e (cm^{-1})	R_e (Å)	B_e (cm^{-1})	α_e (cm^{-1})	μ ($\times 10^{-23}$ g)	$\omega_e x_e$ (cm^{-1})
$X^2\Pi_{3/2}$	667.33	35343.6	1.7443	0.36659	0.00266	2.519938	3.15
$A^2\Sigma^+$	413.03	37943.46	1.8659	0.32035	0.00299	2.519938	1.124
$B^2\Sigma^+$	796.99	43951.91	1.6817	0.39440	0.00255	2.519938	3.613

Table 2. Franck-Condon factor for the $A^2\Sigma^+ \rightarrow X^2\Pi_{3/2}$ transition of GeF molecule.

(v', v'')	$q_{v',v''}$	$q_{v',v''}$(A)	$q_{v',v''}$(B)	(v', v'')	$q_{v',v''}$	$q_{v',v''}$(A)	$q_{v',v''}$(B)
(0, 0)	0.1668	0.1214	0.1820	(3, 0)	0.1726	0.0153	0.1800
(0, 1)	0.2450	0.2407	0.2580	(3, 1)	0.1351	0.1579	0.1280
(0, 2)	0.2659	0.2978	0.2275	(3, 2)	0.0402	0.0660	0.0385
(0, 3)	0.1425	0.1413	0.1444	(3, 3)	0.0340	0.0349	0.0340
(0, 4)	0.0372	0.0394	----	(3, 4)	0.0745	0.0736	----
(0, 5)	0.0049	0.0052	----	(3, 5)	0.1972	0.1960	----
(1, 0)	0.3125	0.2643	0.3340	(4, 0)	0.0568	0.0504	----
(1, 1)	0.0872	0.0484	0.1080	(4, 1)	0.0982	0.0970	----
(1, 2)	0.0100	0.0049	0.0155	(4, 2)	0.0140	0.0142	----
(1, 3)	0.0655	0.0566	0.0690	(4, 3)	0.0370	0.0375	----
(1, 4)	0.1132	0.1120	----	(4, 4)	0.0151	0.0156	----
(1, 5)	0.1711	0.1606	----	(4, 5)	0.0088	0.0089	----
(2, 0)	0.2430	0.1804	0.2520	(5, 0)	0.0722	0.0729	----
(2, 1)	0.0851	0.0839	0.0175	(5, 1)	0.0438	0.0434	----
(2, 2)	0.2648	0.2681	0.1620	(5, 2)	0.3354	0.3411	----
(2, 3)	0.0468	0.0458	0.0980	(5, 3)	0.0001	0.0001	----
(2, 4)	0.0002	0.0002	----	(5, 4)	0.0236	0.0242	----
(2, 5)	0.1954	0.1960	----	(5, 5)	0.0352	0.0307	----

Table 3. Franck-Condon factor for the $B^2\Sigma^+ \rightarrow X^2\Pi_{3/2}$ transition of GeF molecule.

(v', v'')	$q_{v',v''}$	$q_{v',v''}$(A)	$q_{v',v''}(B)$	(v', v'')	$q_{v',v''}$	$q_{v',v''}(A)$	$q_{v',v''}(B)$
(0, 0)	0.4923	0.4872	0.5120	(3, 0)	0.0228	0.0206	0.0235
(0, 1)	0.3182	0.0493	0.3330	(3, 1)	0.1856	0.1112	0.2150
(0, 2)	0.1358	0.1915	0.1175	(3, 2)	0.1665	0.0432	0.1735
(0, 3)	0.0376	0.0468	0.0300	(3, 3)	0.0972	0.0015	0.0858
(0, 4)	0.0096	0.0141	0.0050	(3, 4)	0.0654	0.1095	0.0460
(0, 5)	0.0036	0.0046	0.0020	(3, 5)	0.0722	0.1118	0.0355
(1, 0)	0.3358	0.3639	0.3485	(4, 0)	0.0054	0.0085	0.0017
(1, 1)	0.0784	0.0041	0.0535	(4, 1)	0.1223	0.1416	0.1155
(1, 2)	0.2779	0.2523	0.2805	(4, 2)	0.2110	0.2162	0.2110
(1, 3)	0.2065	0.2245	0.2065	(4, 3)	0.0772	0.0396	0.0675
(1, 4)	0.0156	0.0137	0.0168	(4, 4)	0.4856	0.0819	0.5230

(1, 5)	0.0087	0.0551	0.0020	(4, 5)	0.0042	0.0004	0.0015
(2, 0)	0.1225	0.0955	0.1135	(5, 0)	0.0036	0.0002	0.0024
(2, 1)	0.2456	0.0498	0.3142	(5, 1)	0.0092	0.0725	0.0015
(2, 2)	0.0087	0.0035	0.0095	(5, 2)	0.1412	0.1562	0.1365
(2, 3)	0.1256	0.0793	0.1375	(5, 3)	0.1126	0.1805	0.1050
(2, 4)	0.1665	0.1768	0.1605	(5, 4)	0.0033	0.0063	0.0020
(2, 5)	0.3257	0.1560	0.4495	(5, 5)	0.0021	0.0102	---

Table 4. r-Centroids for the $A^2\Sigma^+ \rightarrow X^2\Pi_{3/2}$ transition of GeF molecule.

(v', v'')	$r_{v',v''}$	$r_{v',v''}(A)$	$r_{v',v''}(B)$	(v', v'')	$r_{v',v''}$	$r_{v',v''}(A)$	$r_{v',v''}(B)$
(0, 0)	1.8056	1.8130	1.8020	(3, 0)	1.7028	1.5826	1.7020
(0, 1)	1.8450	1.8460	1.8415	(3, 1)	1.7618	1.8153	1.7640
(0, 2)	1.8856	1.8710	1.8770	(3, 2)	1.8156	1.8500	1.8085
(0, 3)	1.9226	1.9173	1.9100	(3, 3)	1.8450	1.7977	1.8470
(0, 4)	1.9853	1.9733	---	(3, 4)	1.9656	1.9844	---
(0, 5)	2.0023	1.9914	---	(3, 5)	1.9971	1.9393	---
(1, 0)	1.7792	1.7808	1.7745	(4, 0)	1.8964	1.8512	---
(1, 1)	1.8225	1.8347	1.8175	(4, 1)	1.9336	1.8086	---
(1, 2)	1.8456	1.7660	1.8550	(4, 2)	1.9636	1.6501	---
(1, 3)	1.8987	1.9031	1.8900	(4, 3)	1.9875	1.8889	---
(1, 4)	1.9628	1.9503	---	(4, 4)	2.0000	2.0015	---
(1, 5)	1.9859	1.9591	---	(4, 5)	1.6629	1.6268	---
(2, 0)	1.7427	1.7401	1.7430	(5, 0)	1.7159	1.7561	---
(2, 1)	1.7936	1.8341	1.7930	(5, 1)	1.8765	1.8705	---
(2, 2)	1.8300	1.8299	1.8330	(5, 2)	1.9789	1.7822	---
(2, 3)	1.8751	1.9396	1.8690	(5, 3)	1.9036	1.9156	---
(2, 4)	1.9026	1.6953	---	(5, 4)	1.9155	1.9008	---
(2, 5)	1.9364	1.9227	---	(5, 5)	2.0108	2.0520	---

Table 5. r-Centroids for the $B^2\Sigma^+ \rightarrow X^2\Pi_{3/2}$ transition of GeF molecule.

(v', v'')	$r_{v',v''}$	$r_{v',v''}$(A)	$r_{v',v''}(B)$	(v', v'')	$r_{v',v''}(A)$	$r_{v',v''}$	$r_{v',v''}(B)$
(0, 0)	1.7196	1.7180	1.7160	(3, 0)	1.8825	1.7870	1.8700
(0, 1)	1.6756	1.6800	1.6720	(3, 1)	1.8315	1.8720	1.8260
(0, 2)	1.6200	1.6450	1.6270	(3, 2)	1.7835	1.7910	1.7835
(0, 3)	1.5723	1.5930	1.5795	(3, 3)	1.7356	1.4590	1.7415

(0, 4)	1.5247	1.5410	1.5265	(3, 4)	1.6998	1.6970	1.6995
(0, 5)	1.4587	1.5370	1.4585	(3, 5)	1.6487	1.6120	1.6570
(1, 0)	1.7677	1.7670	1.7675	(4, 0)	1.9126	1.8320	1.9220
(1, 1)	1.7255	1.7470	1.7245	(4, 1)	1.8687	1.8450	1.8775
(1, 2)	1.6810	1.6810	1.6810	(4, 2)	1.8325	1.8530	1.8340
(1, 3)	1.6430	1.6550	1.6370	(4, 3)	1.7920	1.8110	1.7920
(1, 4)	1.5920	1.6210	1.5910	(4, 4)	1.7459	1.7660	1.7500
(1, 5)	1.5445	1.5900	1.5405	(4, 5)	1.6978	1.6410	1.7085
(2, 0)	1.8152	1.8320	1.8185	(5, 0)	1.9812	1.4550	1.9755
(2, 1)	1.7830	1.8011	1.7755	(5, 1)	1.9300	1.8650	1.9290
(2, 2)	1.7342	1.7690	1.7330	(5, 2)	1.8915	1.8560	1.8845
(2, 3)	1.7100	1.6760	1.6900	(5, 3)	1.8500	1.8730	1.8415
(2, 4)	1.6450	1.6370	1.6470	(5, 4)	1.8000	1.8020	1.7995
(2, 5)	1.6258	1.6140	1.6020	(5, 5)	1.7611	1.7730	1.7585

1. Comparison with Literature

The overall trends observed in the present Franck–Condon factors and *r*-centroid values are in good agreement with previous theoretical studies on diatomic molecules employing the improved Rosen–Morse potential and related anharmonic models (Jia et al., 2012; Liu et al., 2014; Hu et al., 2013). In particular, the contrast between the non-diagonal character of the $A^2\Sigma^+ \rightarrow X^2\Pi$ transition and the diagonal behavior of the $B^2\Sigma^+ \rightarrow X^2\Pi$ transition closely resembles patterns reported for alkali dimers and metal halide molecules.

Minor quantitative differences can be attributed to molecule-specific potential parameters and to the sensitivity of overlap integrals to the long-range part of the molecular potential. Nevertheless, the present results confirm the reliability of the improved Rosen–Morse potential for vibronic analyses. In the tables, the values given in parentheses denote previously reported numerical results, where A corresponds to the data taken from Kanagaprabha *et al.* (2008) and B represents the results reported by Ramakrishna Rao and Ramakrishna Reddy (1979).

CONCLUSIONS

In this work, Franck–Condon factors and r-centroid values for the germanium fluoride (GeF) molecule have been systematically investigated using vibrational wave functions derived from the improved Rosen–Morse molecular potentialAll data were calculated using the Mathematica software. The obtained Franck–Condon factors and r-centroid values clearly describe the main features of vibronic transitions in the GeF molecule and are found to be consistent with available theoretical results in the literature. These findings indicate that the improved Rosen–Morse potential is a reliable and practical diatomic potential function for studying vibronic transitions in diatomic molecules.

REFERENCES

Bernath, P. F. (2016). *Spectra of atoms and molecules* (3rd ed.). Oxford University Press.

Brown, J. M., & Carrington, A. (2003). *Rotational spectroscopy of diatomic molecules*. Cambridge University Press.

Chackerian, C., Jr., & Tipping, R. H. (1983). Vibrational transition moments and Franck–Condon factors in diatomic molecules. *Journal of Molecular Spectroscopy, 99*(2), 431–447. https://doi.org/10.1016/0022-2852(83)90324-7

Condon, E. U. (1928). A theory of intensity distribution in band systems. *Physical Review, 32*(6), 858–872. https://doi.org/10.1103/PhysRev.32.858

Dong, S. H., & García-Ravelo, J. (2007). Exact solutions of the Schrödinger equation with molecular potentials. *Physica Scripta, 75*(3), 307–314. https://doi.org/10.1088/0031-8949/75/3/013

Franck, J. (1926). Elementary processes of photochemical reactions. *Transactions of the Faraday Society, 21*, 536–542. https://doi.org/10.1039/TF9262100536

Herzberg, G. (1950). *Spectra of diatomic molecules* (2nd ed.). Van Nostrand Reinhold.

Hu, X.-T., Liu, J.-Y., & Jia, C.-S. (2013). Vibrational energy levels of diatomic molecules with improved exponential-type potentials. *Computational and Theoretical Chemistry, 1019*, 137–143. https://doi.org/10.1016/j.comptc.2013.06.020

Ikhdair, S. M., & Sever, R. (2009). Exact solutions of the Schrödinger equation for some diatomic molecular potentials. *Annalen der Physik, 18*(4), 189–204. https://doi.org/10.1002/andp.200810349

Jia, C.-S., Diao, Y.-F., Liu, X.-J., Wang, P.-Q., Liu, J.-Y., & Zhang, G.-D. (2012). Analytical solutions of the Schrödinger equation with the improved Rosen–Morse potential energy model. *The Journal of Chemical Physics, 137*(1), 014101. https://doi.org/10.1063/1.4731340

Liu, J.-Y., Hu, X.-T., & Jia, C.-S. (2014). Molecular energies of the improved Rosen–Morse potential energy model. *Canadian Journal of Chemistry, 92*(1), 40–44. https://doi.org/10.1139/cjc-2013-0396

Morse, P. M. (1919). Diatomic molecules according to the wave mechanics. II. Vibrational levels. *Physical Review, 34*(1), 57–64. https://doi.org/10.1103/PhysRev.34.57

Nicholls, R. W. (1965). r-centroids and intensity distribution in molecular band systems. *Journal of Research of the National Bureau of Standards, Section A, 69A*(4), 369–374.

Rosen, N., & Morse, P. M. (1932). On the vibrations of polyatomic molecules. *Physical Review, 42*(2), 210–217. https://doi.org/10.1103/PhysRev.42.210

Tipping, R. H., & Chackerian, C., Jr. (1981). Franck–Condon factors and r-centroids for diatomic molecules. *Journal of Molecular Spectroscopy, 88*(2), 352–361. https://doi.org/10.1016/0022-2852(81)90042-1

Varshni, Y. P. (1957). Comparative study of potential energy functions for diatomic molecules. *Reviews of Modern Physics, 29*(4), 664–682. https://doi.org/10.1103/RevModPhys.29.664

Wei, H. (1990). Franck–Condon factors and r-centroids in electronic transitions of diatomic molecules. *Journal of Physics B: Atomic, Molecular and Optical Physics, 23*(15), 2521–2528. https://doi.org/10.1088/0953-4075/23/15/019

Kanagaprabha, S., Rajeswara Palanichamy, R., & Sathiyabama, V. (2008). *Franck–Condon factors and r-centroids for the diatomic fluorides of germanium and silicon*. Journal of the Serbian Chemical Society, 73(5), 555–560. https://doi.org/10.2298/JSC0805555K

Ramakrishna Rao, T. V., & Ramakrishna Reddy, R. (1979). *True potential energy curves and dissociation energies of SiF and GeF molecules*. Current Science, 48(3), 95–98.

ECOLOGICAL USE OF HOME COMPOST AS A SUSTAINABLE INPUT IN EDIBLE BALCONY PLANTS: IMPLICATIONS FOR SOIL HEALTH, PLANT NUTRITION AND FOOD SAFETY

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ABSTRACT

With cultivation space becoming increasingly restricted in densely populated cities, urban edible gardening has emerged as a practical means for households to meet part of their food needs. In these compact growing setups, compost made at home can act as an easy-to-obtain and low-cost source of organic matter, improving the potting mix and providing additional nutrients while also reducing household waste. The present study examines how such compost functions ecologically in balcony gardening systems, with particular emphasis on soil health, nutrient behavior and food safety.

This review draws on studies that have investigated various physicochemical and biological aspects of home compost. These include how organic matter stabilizes over time, the way nutrients—particularly N, P and K—are released, the activity of microbial communities, and the compost's broader effects on pH, cation exchange capacity and the ability of container substrates to retain moisture. The review also turns to the edible species commonly found in balcony setups—lettuce, basil, peppers, tomatoes—because these plants often show better development and nutrient uptake when compost is included in the mix. But these benefits come with a few caveats. Compost maturity can vary from batch to batch, salts may accumulate over time, household waste can introduce trace metals, and, depending on handling, there may be microbiological concerns that are relevant for edible crops.

Across the studies, a consistent pattern emerges: properly matured home compost helps improve the growing medium and can lessen reliance on synthetic fertilizers in balcony food production. Composting at home also fits neatly into circular food system practices, as it channels household organic waste back into cultivation. In this sense, home compost stands out as a straightforward and climate-responsive option for small urban gardens.

Key Words: Home compost; Balcony gardening; Soil health; Urban agriculture; Edible plants; Circular food systems.

1. INTRODUCTION

Global urbanization is rapidly transforming the distribution of population and land use. Projections are indicating that nearly 70% of the world's population will reside in cities by 2050 (United Nations, Department of Economic and Social Affairs (UN DESA), 2018). As cities get more crowded and green spaces shrink, it becomes harder to practice traditional farming. As a result, urban edible gardening,

especially growing plants on balconies and terraces, has become an easy option. It allows people to grow leafy greens, herbs and vegetables even in small spaces (Xu et al., 2024).

Nowadays, more people are becoming interested in urban gardening, thus home composting has also grown. Many residents living in metropolises and big cities now use it to manage kitchen waste and improve their balcony soil (Oueld Lhaj et al., 2024). Home compost is produced as a result of aerobic or anaerobic decomposition of kitchen scraps and plant residues. The organic amendment provided by home composting is low-cost and readily available. When added to balcony soil, it can improve nutrient levels, support microbial activity and increase the quality of the growing medium. Moreover, since it is produced entirely from household waste, it also supports circular food systems and urban sustainability goals (Nocentini et al., 2024).

In balcony containers, home compost contributes to soil health by increasing organic matter, raising cation exchange capacity, regulating pH and improving moisture retention (de Jesus Duarte et al., 2022; Garcia et al., 2023; Lanno et al., 2022; Mu et al., 2020; Rahim et al., 2024). However, it can cause some risks because its composition and maturity are not always consistent. It may release nutrients at different rates, increase the salt level in the soil, bring in small amounts of metals from mixed waste, and carry microbes that are important for edible plants (Andraskar et al., 2021; Ferreira, 2024; Kormanek et al., 2023; Lončarić et al., 2024; Manea et al., 2024; Yan et al., 2020; Yang et al., 2024). These benefits and risks show that home compost should be examined carefully in small urban systems.

This study examines current scientific evidence on the ecological use of home compost in balcony gardening. It addresses: (i) the physicochemical and biological effects of compost on balcony substrates; (ii) plant growth and nutrient responses in commonly grown edible plants; and (iii) contamination and hygiene-related risks. With this effort, the review aims to clarify the role of home compost as a sustainable and ecologivally harmless input in urban household food production.

2. CONCEPTUAL BACKGROUND AND THEORETICAL FRAMEWORK

2.1. Urban Edible Gardening and Resource Constraints

As cities grow, available cultivation spaces become limited. At this point, urban edible gardening has become essential for household food production (UN DESA, 2018). Balcony gardens, rooftops and small patios are used as agricultural lands in metropolises and big cities (Deelstra & Girardet, 2000). Low light, shallow root zones, rapid nutrient loss and water stress are among the challenges of these systems; therefore, the quality of the growing substrate and nutrient management are essential (Cilliers et al., 2020). At this point, organic materials like home compost help maintain soil health and reduce the need for synthetic fertilizers.

2.2. Home Composting in Circular Food Systems

Home composting turns kitchen scraps and plant residues into a biologically active soil material. This process helps urban residents recycle nutrients, reduce waste and support circular food systems (Sulewski et al., 2021; Daskal et al., 2022). Because it is produced at home, it reduces emissions caused by transport and gives urban growers an affordable and renewable input. However, carbon–nitrogen (C/N) ratio, moisture, materials and possible contaminants are the major problems of household waste.

Therefore, the maturity and quality of home compost must be checked carefully before using it for eddible plants (Ji et al., 2023; Mia et al., 2025; Sánchez et al., 2022).

2.3. Soil Ecology and Nutrient Cycling Principles

Home compost improves balcony substrates by aiding the breakdown of organic matter, increasing microbial activity and helping form stable humus. These functions shape nutrient availability and strengthen soil stability (Aguilar-Paredes et al., 2023; Bian et al., 2024). Microbes release major nutrients such as nitrogen (N), phosphorus (P) and potassium (K through mineralization, and the rise in CEC allows small containers to hold nutrients more effectively, reducing leaching losses (Suvendran et al., 2025). Compost increases microbial activity in the root zone, supporting essential rhizosphere functions like enzyme secretion, nutrient mobilization and the production of organic acids. These actions make nutrient uptake more efficient (Chen et al., 2024). Knowing how these mechanisms operate helps growers use compost at suitable rates while maintaining soil and food safety in compact urban systems.

3. MATERIALS AND METHODS (REVIEW METHODOLOGY)

This review brings together recent scientific studies on how home compost is used in balcony food production. A structured search was made in Web of Science, Scopus and Google Scholar using keywords related to home compost, balcony gardening, container substrates, soil health, nutrient cycling and food safety. The study focused on materials published between 2020 and 2025.

Studies were included if they (i) explored the physical, chemical or biological characteristics of home compost, (ii) measured plant, soil or nutrient responses in container or urban growing environments, and (iii) assessed risks related to salinity, trace metals or microbial contamination. Non–peer-reviewed work and studies without quantitative results were not considered.

The findings were grouped into three main topics: soil health, nutrient behavior and food safety. Soil health included organic matter, structure, moisture retention, pH and cation exchange capacity. Nutrient behavior included N–P–K availability, mineralization, microbial activity and plant uptake. Food safety focused on trace metals, salt levels and microbial quality. This layout helped show the different ways home compost influences balcony growing systems.

4. PHYSICOCHEMICAL PROPERTIES OF HOME COMPOST

4.1. Organic Matter Stabilization and Maturity Indicators

The maturity of home compost determines how suitable it is for edible plants grown in containers. As compost breaks down, simple carbohydrates decrease, while harder materials like lignin and cellulose become more dominant, showing that the compost is becoming stable (Mahapatra et al., 2022). Key maturity indicators include the C/N ratio, which usually falls from above 30 in raw materials to about 10–20 in mature compost, and respiration tests that measure microbial CO_2 release (Abaker et al., 2025). Low heat, neutral smell and stable temperature show that the compost is biologically stable (Oueld Lhaj et al., 2024). Mature compost releases nutrients steadily and lowers the risk of plant toxicity, high salt levels or low oxygen in small containers (Xie et al., 2025).

4.2. Macronutrient Profile (N–P–K) and Release Dynamics

Home compost provides useful amounts of N, P and K (Manea et al., 2024). Nitrogen in home compost is mostly in organic forms and becomes available slowly as microbes break it down, which works well for small containers (Geisseler & Scow, 2021). Phosphorus release depends on the breakdown of phytate-rich residues and is affected by pH and calcium (Cao et al., 2023). Potassium is more soluble, so plants absorb it earlier (Manea et al., 2024). Because nutrient release changes with compost maturity, feedstock and moisture, compost should be applied in balanced amounts to avoid nutrient buildup while supporting growth (Suvendran et al., 2025).

4.3. pH, EC, Salinity and Buffering Effects in Container Substrates

Home compost usually has a pH between slightly acidic and mildly alkaline (around 6.5–8), and this level varies with the materials used and how mature the compost is (Machado & Bui, 2021). Once blended into potting mixes, it helps regulate acidity and improves buffering, keeping the root zone more stable in container systems. Electrical conductivity (EC) and salinity are more variable. Immature compost, mineral-rich kitchen waste or ash-heavy materials can raise EC levels, which is risky for salt-sensitive crops like lettuce. Checking EC and diluting the compost when necessary helps make it safe for balcony use (Kader et al., 2024; Mussa et al., 2025).

4.4. Cation Exchange Capacity and Moisture Retention

Humified organic matter in compost increases CEC, helping the soil hold important ions (NH_4^+, K^+, Ca^{2+}, Mg^{2+}) in small root zones where nutrients are easily washed out (Kumar et al., 2023). High CEC enhances efficiency of nutrient usage and supports steady plant uptake. Compost also improves the **moisture-holding capacity** of lightweight potting mixes by increasing pore-size diversity and water-binding sites. This reduces the need for irrigation and helps protect plants from drought stress, which is especially important in balcony systems exposed to wind and changing sunlight. Together, these effects improve the resilience and fertility of container substrates.

5. BIOLOGICAL PROPERTIES OF HOME COMPOST

5.1. Microbial Community Structure and Functional Roles

Home compost contains many types of microbes—bacteria, fungi and actinomycetes—that break down organic matter and recycle nutrients (Aguilar-Paredes et al., 2023; Cozzolino et al., 2021). At the start of decomposition, fast-growing heat-loving bacteria take the lead and quickly break down simple carbohydrates. In the later stages of composting, fungi and actinomycetes take over and break down tougher plant materials (Liu et al., 2022; Omara et al., 2022). This leads to humus formation, N release and a reduction in harmful pathogens (Ait Rahou et al., 2022; Thai et al., 2022). Their balance controls how stable the compost is and how well it provides nutrients.

5.2. Beneficial Microorganisms and Plant Growth-Promoting Effects

Mature compost has useful microbes, including bacteria that support plant growth, organisms that break down cellulose and fungi that help with decomposition (Ahmed et al., 2023). These microbes help plants grow by making N and P more available, freeing up micronutrients, and producing growth-promoting substances like indole-3-acetic acid. (Silva et al., 2023; Cai et al., 2022). When compost is mixed into balcony soil, its microbes help plants form stronger roots, use nutrients more efficiently and handle

stress conditions better (Ait Rahou et al., 2022). The wide microbial diversity also acts as a natural defence, limiting or competing with harmful soil organisms (Ahmed et al., 2023).

5.3. Pathogen Risks: Hygienic and Microbiological Considerations

Home composting is useful, but it can also carry microbial risks if the materials are not managed properly or if the compost does not mature fully. Without adequate heating, harmful organisms like *Salmonella*, *E. coli*, *Listeria* or fungal spores may remain alive (Werner et al., 2023). The chance of contamination grows when the compost contains animal-derived kitchen waste, raw manure or mixed household inputs (Lepesteur, 2022). Maintaining temperatures above 55 °C, keeping the compost aerobic and allowing enough curing time can greatly reduce pathogen levels (Werner et al., 2023). For edible balcony crops—especially leafy vegetables eaten fresh—checking compost maturity and following hygienic handling practices are important for safe use (Tsabedze et al., 2025).

6. Ecological Effects of Home Compost in Balcony Growing Media

6.1. Soil Health Improvement in Container-Based Systems

Container-based systems work with limited substrate volume, so soil health is easily affected by nutrient loss, compaction and changes in moisture. Adding home compost improves these systems by increasing organic matter, strengthening soil structure and creating a better air–water balance (Oueld Lhaj et al., 2024). These structural improvements lower bulk density and increase porosity, allowing roots to grow more easily in confined spaces (McDaniel et al., 2024). Higher biological activity and better nutrient retention slow down the chemical and physical breakdown of lightweight potting mixes during repeated watering, helping the substrate stay usable for a longer time (Edlinger et al., 2025).

6.2. Effects on Root Zone Environment and Rhizosphere Activity

Home compost adds living microbes and organic substances to the root zone, strengthening the interactions between plants and soil organisms (Ahmed et al., 2023). These microbes make nitrogen, phosphorus, and potassium available faster. Their organic acids and enzymes break open nutrients that are stuck in the substrate (Amadou, Houben, & Faucon, 2021; Shang et al., 2023). As the root zone becomes more active, plants take up nutrients more efficiently, grow better roots, and handle drought or heat fluctuations more easily (Thepbandit et al., 2024). Compost also helps steady the pH and moisture around the roots (Xu et al., 2023).

6.3. Interactions with Commercial Potting Mixes and Biochar/Perlite/Cocopeat

Balcony growers usually use potting mixes made from peat, cocopeat, perlite or bark. Adding home compost to these mixes creates a helpful balance—compost brings nutrients and useful microbes, while perlite and cocopeat maintain a light and airy texture that drains well (Adhikari et al., 2025). Biochar-based potting mixes benefit from the addition of compost, as compost brings accessible organic carbon and nutrients that complement the way biochar adsorbs and holds materials (He et al., 2024). The proportion, however, is important. Excess compost may raise salinity or restrict airflow, whereas balanced mixtures improve fertility, moisture retention and the long-term stability of the substrate (Adhikari et al., 2025; Massaccesi et al., 2024).

7. Plant Responses to Home Compost in Edible Balcony Species

7.1. Lettuce (Lactuca sativa): Growth, Quality and Nutrient Uptake

Lettuce responds very well to organic amendments because it has a shallow root system and grows quickly. Adding mature home compost usually increases shoot biomass, chlorophyll content and leaf firmness by improving nutrient availability and moisture retention in small containers (Marutani et al., 2021; Vasileva et al., 2023). Nitrogen released from compost supports fast leaf growth, while higher potassium levels improve leaf quality and crispness. However, lettuce is sensitive to high salinity, so compost must be applied at balanced rates to avoid problems such as reduced leaf size, tip burn or excess nitrate accumulation (Cardarelli et al., 2023). When managed correctly, compost-amended substrates produce higher-quality leaves with better nutrient uptake.

7.2. Basil and Leafy Herbs: Aromatic Compound Enhancement

Aromatic herbs like basil, mint and parsley benefit from compost not only through better growth, but also through increased production of secondary metabolites (Verrillo et al., 2021). Higher microbial activity and nutrient mineralization in compost-rich soils stimulate essential oil pathways, resulting in greater amounts of compounds like linalool and eugenol in basil (Verrillo et al., 2021). Better root aeration and more stable moisture conditions also support strong vegetative growth, while mild compost-related stress (such as slight nutrient or water changes) can even enhance flavor intensity (Oueld Lhaj et al., 2025). Together, these effects make home compost highly effective for producing high-quality culinary herbs on balconies.

7.3. Solanaceae (Tomato, Pepper): Yield, Fruit Quality, Nutrient Dynamics

Compost-rich substrates work well for tomatoes and peppers because these crops need high nutrient inputs and have long growing cycles (Imran et al., 2022). Compost supplies steady nitrogen and potassium, which improves early growth, flowering and fruit formation. Its phosphorus contribution enhances root development and nutrient uptake in container environments (Aurdal et al., 2022). When microbes are more active in the rhizosphere, plants access micronutrients more easily, leading to better fruit color and higher sugar content (Zaato et al., 2025). Even so, applying too much compost can cause excessive vegetative growth or unbalanced nutrients, so the dosage must be adjusted properly (Fiasconaro et al., 2022).

7.4. Comparative Sensitivity of Different Edible Plants to Compost Salinity

Compost salinity plays a key role in determining which crops can grow well in it (Khalid et al., 2023). Leafy vegetables such as lettuce and spinach are highly salt-sensitive and may experience reduced growth when electrical conductivity is high (Breś et al., 2022; Hirst et al., 2024). Herbs and legumes usually tolerate moderate salinity, while fruiting crops—especially tomatoes—are more resilient because they can adjust to osmotic stress (Behera et al., 2022). Root crops such as radish show mixed responses depending on compost maturity and sodium levels (Zhu et al., 2024). Knowing these differences helps growers select appropriate compost mixing ratios for each crop, making home compost use safer and more productive in balcony systems.

8. Food Safety Considerations

8.1. Potential Trace Metal Accumulation (Cd, Pb, Zn, Cu)

Small amounts of trace metals may be introduced into home compost from various household sources, including cookware residues, tea leaves, eggshell impurities and printed paper (Manea et al., 2024). Although Zn and Cu function as essential micronutrients, elevated levels can upset nutrient balance in confined container soils. Cd and Pb are usually found in very small amounts, but they still require attention because they move easily through light potting mixes (Seyfferth & Chaney, 2024; Chen et al., 2024). How much metal plants absorb depends on compost maturity, pH conditions and the plant species. Leafy greens usually take up more metals than fruiting crops (Sultana et al., 2022; Chmielewski et al., 2025). Checking compost materials and keeping the substrate pH neutral or slightly alkaline can lower metal availability and reduce transfer to edible parts (Chen et al., 2022).

8.2. Routes of Contamination from Household Waste Streams

Contaminants enter home compost mostly when the feedstock is not well separated. Contaminants may enter compost when materials such as painted paper, metallic-coated packaging, treated wood fragments or cleaning-product residues are included (Porterfield et al., 2023; Sipos et al., 2024). Adding meat or dairy waste raises the risk of microbial contamination and unpleasant odors, and pet waste or contaminated soil may carry parasitic pathogens (Lepesteur, 2022; Wuthisuthimethavee et al., 2024; Bryson et al., 2024). Using clean plant materials and plant-based food scraps, along with basic preparation steps such as shredding and adjusting moisture, helps reduce contamination and improves compost safety for edible balcony crops (Pajura et al., 2024).

8.3. Microbiological Safety in Edible Leaves and Fruits

When compost fails to reach temperatures above 55 °C, harmful organisms like E. coli, Salmonella, and Listeria can persist (EFSA, 2020; Limoges et al., 2022). This matters even more in balcony systems, because leafy greens grown there are usually eaten fresh without cooking (Hamilton et al., 2023). Allowing the compost to cure properly, keeping the pile well-aerated, and avoiding direct contact between compost-rich substrate and edible plant surfaces greatly reduce the chance of pathogen transfer (Werner et al., 2023). Washing the harvested produce provides an additional layer of protection, especially for soft-leafed crops that trap moisture and small particles (Hamilton et al., 2023).

8.4. Recommended Handling, Application Rates and Safety Thresholds

Safe use of home compost depends on its maturity, how it is mixed, and how it is handled. Mature, well-stabilized compost should generally make up about 20–40% (v/v) of container substrates to provide nutrients without raising electrical conductivity too much (Bignami et al., 2023; Morais et al., 2025). For salt-sensitive crops such as lettuce, using lower compost proportions or diluting the mix with cocopeat or perlite is recommended (Burnett et al., 2020). When handling compost, growers should use gloves and clean tools, and avoid spreading compost on the surface where rain or irrigation drops can splash it onto edible foliage (FPSC-A-NZ, 2022). Standards for heavy metals (Cd, Pb, Zn, Cu) and microbial safety provide useful benchmarks for confirming that compost is safe to use for food production (EFSA, 2020; Kandpal et al., 2025; European Commission, 2004).

9. Environmental and Socioeconomic Implications

9.1. Domestic Organic Waste Reduction and Climate Benefits

Home composting reduces the amount of organic waste sent to municipal collection, lowering landfill use and methane emissions (Pérez et al., 2023). When families channel their kitchen scraps into aerobic composting, they meaningfully reduce their carbon footprint and help support community-level climate-mitigation actions (Manea et al., 2024). The compost they produce replaces commercial growing media that require high inputs and also cuts down the emissions linked to moving waste long distances (Kader et al., 2024a). In compact urban homes, this closed-loop approach transforms daily food waste into an environmentally beneficial, climate-positive resource.

9.2. Cost Savings and Fertilizer Substitution Potential

By producing compost at home, families spend less on potting mixes, fertilizers, and soil conditioners, which are typically expensive for regular balcony gardening (Popescu et al., 2025). Because compost releases nutrients slowly, it reduces the need for synthetic fertilizers—especially nitrogen and potassium fertilizers, which are among the highest costs in urban gardening (Ansar, 2025). Over time, the improvements in soil structure and moisture retention provided by compost help lower water use and reduce how often the substrate needs to be replaced (Shimelis et al., 2024). For households growing multiple balcony crops, this makes home composting a cost-effective part of long-term food production.

9.3. Role of Home Compost in Urban Circular Food Systems

Home composting puts circular economy principles into practice by turning household organic waste into a useful resource, closing nutrient loops at the household level (Sulewski et al., 2021). This local nutrient recycling reduces dependence on external inputs, supports small-scale food production and increases urban resilience (Olsson et al., 2025). In places like apartment complexes or community gardens, home compost can be shared, encouraging collective participation in sustainable practices (De Boni et al., 2022). Because it is versatile and low-cost, home composting becomes a key tool for urban circular food systems, linking waste reduction, resource recovery and local food production in one process.

10. Limitations and Research Gaps

Home compost provides clear ecological and agronomic benefits for balcony agriculture, but several limitations reduce its consistency and broader application. The main challenge is compost heterogeneity, which results from variable household feedstocks, uneven decomposition conditions and differences in maturity (El-mrini, Aboutayeb, & Zouahri, 2022). Because of this, nutrient content, salinity and microbial composition can vary widely (Alves et al., 2024), making it difficult to set uniform application rates for different edible crops.

Balcony environments add further uncertainty. Light, watering and temperature conditions change frequently, and containers have very limited substrate volume (Köhl et al., 2021). This causes fast shifts in nutrients, moisture and salt levels (Paudel & Sun, 2023), leading to unpredictable crop responses from one household to another.

A further challenge is that home composting does not follow any standard procedure. Most households, unlike commercial facilities, do not manage aeration, heating, or curing in a consistent way. These differences can affect compost quality and food safety, which is especially important for leafy vegetables eaten raw (Mahapatra et al., 2022).

Future studies should work to reduce these uncertainties by using improved analytical and technological tools. Metagenomics can help clarify microbial communities and their roles in nutrient cycling or pathogen suppression (Hu et al., 2022). Life Cycle Assessment (LCA) can also evaluate the environmental benefits compared with municipal waste systems (Oviedo-Ocaña et al., 2023). Nutrient-release models may help predict how compost will perform in small containers. In addition, IoT-based sensors that track temperature, moisture, and EC in household composters and balcony substrates can support real-time monitoring and better management (Kameswari et al., 2025; Rajamuneeswaran et al., 2025).

Integrating these approaches will improve the reliability, safety, and long-term sustainability of home compost in urban food production.

11. Conclusions

This review shows that mature home compost, when mixed properly into container substrates, is an effective ecological input for balcony food production. By increasing organic matter, improving soil structure, boosting microbial activity and providing steady nutrient release, compost directly supports healthy growth of edible plants in small urban spaces. Still, concerns about salinity, trace metals, and microbial contamination show why careful management and safe composting methods are essential.

When used in moderate proportions (approximately 20–40% v/v), home compost provides nutrients, improves water retention, and lowers chemical and microbial stress. Salt-sensitive crops, especially lettuce, benefit from lower compost ratios or blends that include cocopeat or perlite. Safe production requires ensuring compost maturity, selecting clean feedstocks, and keeping compost-based substrates away from direct contact with edible leaves. These measures help urban growers use compost confidently while protecting food safety.

More broadly, home compost plays a unique and sustainable role in urban agriculture. It closes nutrient loops at the household level, reduces dependence on synthetic fertilizers, lowers waste management pressure and allows residents to participate directly in circular food systems. By turning household organic waste into a useful resource, home composting strengthens urban resilience, supports climate-friendly cultivation and contributes to the environmental and socioeconomic sustainability of city food production.

REFERENCES

Abaker, M., Redon, R., Théraulaz, F., Raynaud, M., Prudent, P., Vassalo, L., & Mounier, S. (2025). Composting process monitoring and maturity prediction by spectroscopic measurement and PLS modelling. *International Journal of Environmental Research, 19*(4), 108. https://doi.org/10.1007/s41742-025-00753-3

Adhikari, S., Vernon, M., Adams, S., Webb, L., & Timms, W. (2025). Optimizing sustainable basil cultivation with smart-monitoring: A comparative study of biochar and soilless growth media. *Biochar, 7*(1), 89. https://doi.org/10.1007/s42773-025-00480-0

Aguilar-Paredes, A., Valdés, G., Araneda, N., Valdebenito, E., Hansen, F., & Nuti, M. (2023). Microbial community in the composting process and its positive impact on the soil biota in sustainable agriculture. *Agronomy, 13*(2), 542. https://doi.org/10.3390/agronomy13020542

Ahmed, T., Noman, M., Qi, Y., Shahid, M., Hussain, S., Masood, H. A., & Li, B. (2023). Fertilization of microbial composts: A technology for improving stress resilience in plants. *Plants, 12*(20), 3550. https://doi.org/10.3390/plants12203550

Ait Rahou, Y., Douira, A., Tahiri, A. I., Cherkaoui, E. M., Benkirane, R., & Meddich, A. (2022). Application of plant growth-promoting rhizobacteria combined with compost as a management strategy against *Verticillium dahliae* in tomato. *Canadian Journal of Plant Pathology, 44*(6), 806–827. https://doi.org/10.1080/07060661.2022.2089235

Alves, D., Villar, I., & Mato, S. (2024). Community composting strategies for biowaste treatment: Methodology, bulking agent and compost quality. *Environmental Science and Pollution Research, 31*(7), 9873–9885. https://doi.org/10.1007/s11356-023-25564-x

Amadou, I., Houben, D., & Faucon, M. P. (2021). Unravelling the role of rhizosphere microbiome and root traits in organic phosphorus mobilization for sustainable phosphorus fertilization: A review. *Agronomy, 11*(11), 2267. https://doi.org/10.3390/agronomy11112267

Andraskar, J., Yadav, S., & Kapley, A. (2021). Challenges and control strategies of odor emission from composting operation. *Applied Biochemistry and Biotechnology, 193*(7), 2331–2356. https://doi.org/10.1007/s12010-021-03490-3

Ansar, A., Du, J., Javed, Q., Adnan, M., & Javaid, I. (2025). Biodegradable waste in compost production: A review of its economic potential. *Nitrogen, 6*(2), 24. https://doi.org/10.3390/su17083368

Aurdal, S. M., Foereid, B., Sogn, T., Børresen, T., Hvoslef-Eide, T., & Fagertun Remberg, S. (2022). Growth, yield and fruit quality of tomato (*Solanum lycopersicum* L.) grown in sewage-based compost in a semi-hydroponic cultivation system. *Acta Agriculturae Scandinavica, Section B—Soil & Plant Science, 72*(1), 902–912. https://doi.org/10.1080/09064710.2022.2117079

Behera, T. K., Krishna, R., Ansari, W. A., Aamir, M., Kumar, P., Kashyap, S. P., & Kole, C. (2022). Approaches involved in the vegetable crops salt stress tolerance improvement: Present status and way ahead. *Frontiers in Plant Science, 12*, 787292. https://doi.org/10.3389/fpls.2021.787292

Bian, H., Boguta, P., Huang, J., Deng, C., Kong, D., Zhou, H., & Su, X. (2024). Transforming organic solid waste management: Embracing humification for sustainable resource recovery. *ACS Sustainable Resource Management, 1*(2), 181–198. https://doi.org/10.1021/acssusresmgt.3c00080

Bignami, C., Reyes, F., Saccaggi, M., Pane, C., Zaccardelli, M., & Ronga, D. (2023). Composts from grapevine and hazelnut by-products: A sustainable peat partial replacement for the growth of micropropagated hazelnut and raspberry in containers. *Horticulturae, 9*(4), 481. https://doi.org/10.3390/horticulturae9040481

Breś, W., Kleiber, T., Markiewicz, B., Mieloszyk, E., & Mieloch, M. (2022). The effect of NaCl stress on the response of lettuce (*Lactuca sativa* L.). *Agronomy, 12*(2), 244. https://doi.org/10.3390/agronomy12020244

Bryson, E., Anastasi, A., Bricknell, L., & Kift, R. (2024). Household dog fecal composting: Current issues and future directions. *Integrated Environmental Assessment and Management, 20*(6), 1876–1891. https://doi.org/10.1002/ieam.4970

Cai, G., Li, J., Zhou, M., Zhu, G., Li, Y., Lv, N., & Pan, X. (2022). Compost-derived indole-3-acetic-acid-producing bacteria and their effects on enhancing the secondary fermentation of a swine manure–corn stalk composting. *Chemosphere, 291*, 132750. https://doi.org/10.1016/j.chemosphere.2021.132750

Cao, X., Williams, P. N., Zhan, Y., Coughlin, S. A., McGrath, J. W., Chin, J. P., & Xu, Y. (2023). Municipal solid waste compost: Global trends and biogeochemical cycling. *Soil & Environmental Health, 1*(4), 100038. https://doi.org/10.1016/j.seh.2023.100038

Cardarelli, M., El Chami, A., Iovieno, P., Rouphael, Y., Bonini, P., & Colla, G. (2023). Organic fertilizer sources distinctively modulate productivity, quality, mineral composition, and soil enzyme activity of greenhouse lettuce grown in degraded soil. *Agronomy, 13*(1), 194. https://doi.org/10.3390/agronomy13010194

Chen, D., Ye, X., Jiang, Y., Xiao, W., Zhang, Q., Zhao, S., & Hu, J. (2022). Continuously applying compost for three years alleviated soil acidity and heavy metal bioavailability in a soil–asparagus lettuce system. *Frontiers in Plant Science, 13*, 972789. https://doi.org/10.3389/fpls.2022.972789

Chen, Q., Song, Y., An, Y., Lu, Y., & Zhong, G. (2024). Mechanisms and impact of rhizosphere microbial metabolites on crop health, traits, functional components: A comprehensive review. *Molecules, 29*(24), 5922. https://doi.org/10.3390/molecules29245922

Chen, X., Ren, Y., Li, C., Shang, Y., Ji, R., Yao, D., & He, Y. (2024). Study on factors influencing the migration of heavy metals from soil to vegetables in a heavy industry city. *Sustainability, 16*(24), 11084. https://doi.org/10.3390/su162411084

Chmielewski, J., Wszelaczyńska, E., Poberężny, J., Florek-Łuszczki, M., & Gworek, B. (2025). Heavy metals in leafy vegetables and soft fruits from allotment gardens in the Warsaw agglomeration: Health risk assessment. *Sustainability, 17*(15), 6666. https://doi.org/10.3390/su17156666

Cilliers, E. J., Lategan, L., Cilliers, S. S., & Stander, K. (2020). Reflecting on the potential and limitations of urban agriculture as an urban greening tool in South Africa. *Frontiers in Sustainable Cities, 2*, 43. https://doi.org/10.3389/frsc.2020.00043

Cozzolino, V., Monda, H., Savy, D., Di Meo, V., Vinci, G., & Smalla, K. (2021). Cooperation among phosphate-solubilizing bacteria, humic acids and arbuscular mycorrhizal fungi induces soil microbiome shifts and enhances plant nutrient uptake. *Chemical and Biological Technologies in Agriculture, 8*(1), 31. https://doi.org/10.1186/s40538-021-00230-x

Daskal, S., Asi, O., Sabbah, I., Ayalon, O., & Baransi-Karkaby, K. (2022). Decentralized composting analysis model—Benefit/cost decision-making methodology. *Sustainability, 14*(24), 16397. https://doi.org/10.3390/su142416397

De Boni, A., Melucci, F. M., Acciani, C., & Roma, R. (2022). Community composting: A multidisciplinary evaluation of an inclusive, participative, and eco-friendly approach to biowaste management. *Cleaner Environmental Systems, 6*, 100092. https://doi.org/10.1016/j.cesys.2022.100092

de Jesus Duarte, S., Hubach, A., & Glaser, B. (2022). Soil water balance and wettability methods in soil treated with biochar and/or compost. *Carbon Research, 1*(1), 31. https://doi.org/10.1007/s44246-022-00032-2

Deelstra, T., & Girardet, H. (2000). Urban agriculture and sustainable cities. In N. Bakker, M. Dubbeling, S. Gündel, U. Sabel-Koshella, & H. de Zeeuw (Eds.), *Growing cities, growing food: Urban agriculture on the policy agenda* (pp. 43–66). Feldafing, Germany: Zentralstelle für Ernährung und Landwirtschaft (ZEL).

Edlinger, A., Herzog, C., Garland, G., Walder, F., Banerjee, S., Keel, S. G., & van der Heijden, M. G. (2025). Compost application enhances soil health and maintains crop yield: Insights from 56 farmer-managed arable fields. *Journal of Sustainable Agriculture and Environment, 4*(1), e70041. https://doi.org/10.1002/sae2.70041

El-mrini, S., Aboutayeb, R., & Zouhri, A. (2022). Effect of initial C/N ratio and turning frequency on quality of final compost of turkey manure and olive pomace. *Journal of Engineering and Applied Science, 69*(1), 37. https://doi.org/10.1186/s44147-022-00092-6

European Commission. (2004). *Heavy metals and organic compounds from wastes used as organic fertilisers: Annex 2 — Compost: Legislation and standards* (Amlinger, M., Pollak, M., Favoino, E., & Working Group "Compost — Legislation & Standards"). European Communities. https://ec.europa.eu/environment/pdf/waste/compost/hm_annex2.pdf

EFSA Panel on Biological Hazards (EFSA BIOHAZ Panel), Koutsoumanis, K., Allende, A., Bolton, D. J., Bover-Cid, S., Chemaly, M., & Alvarez-Ordóñez, A. (2020). Evaluation of alternative methods of tunnel composting (submitted by the European Composting Network). *EFSA Journal, 18*(8), e06226. https://doi.org/10.2903/j.efsa.2020.6226

Ferreira, C. S., Soares, P. R., Guilherme, R., Vitali, G., Boulet, A., Harrison, M. T., & Ferreira, A. J. (2024). Sustainable water management in horticulture: Problems, premises, and promises. *Horticulturae, 10*(9), 951. https://doi.org/10.3390/horticulturae10090951

Fiasconaro, M. L., Abrile, M. G., Hintermeister, L., Antolín Bellver, M. C., & Lovato, M. E. (2022). Application of different doses of compost as a substitution of the commercial substrate in nursery for pepper and tomato seedlings. *International Journal of Research in Ornamental and Woody Plants*, Article 1195. https://doi.org/10.30486/ijrowa.2021.1921803.1195

Fresh Produce Safety Centre Australia & New Zealand. (2022, June). *Guidelines for fresh produce food safety 2022*. https://fpsc-anz.com/wp-content/uploads/2022/08/FPSC-Food-Safety-Guidelines-2022.pdf

Garcia, J., Bray, N., Son, Y., Butler-Jones, A., Egendorf, S. P., & Kao-Kniffin, J. (2023). Plant growth and microbial responses from urban agriculture soils amended with excavated local sediments and municipal composts. *Journal of Urban Ecology, 9*(1), juad016. https://doi.org/10.1093/jue/juad016

Geisseler, D., Smith, R., Cahn, M., & Muramoto, J. (2021). Nitrogen mineralization from organic fertilizers and composts: Literature survey and model fitting. *Journal of Environmental Quality, 50*(6), 1325–1338. https://doi.org/10.1002/jeq2.20295

Hamilton, A. N., Topalcengiz, Z., & Gibson, K. E. (2023). Growing safer greens: Exploring food safety practices and challenges in indoor, soilless production through thematic analysis of leafy greens grower interviews. *Journal of Food Protection, 86*(11), 100163. https://doi.org/10.1016/j.jfp.2023.100163

He, X., He, L., Jiao, F., Zhang, K., & He, X. (2024). A study of the effect of biochar additive on the manure–compost–soil process and its bacterial succession. *Sustainability, 16*(18), 7910. https://doi.org/10.3390/su16187910

Hirst, A. K., Anee, S. A., Housley, M. J., Qin, K., & Ferrarezi, R. S. (2024). Selected beneficial microbes alleviate salinity stress in hydroponic lettuce and pak choi. *HortTechnology, 34*(3), 345–352. https://doi.org/10.21273/HORTTECH05403-24

Hu, X., Gu, H., Liu, J., Wei, D., Zhu, P., Cui, X. A., & Wang, G. (2022). Metagenomics reveals divergent functional profiles of soil carbon and nitrogen cycling under long-term addition of chemical and organic fertilizers in the black soil region. *Geoderma, 418*, 115846. https://doi.org/10.1016/j.geoderma.2022.115846

Imran, A., Sardar, F., Khaliq, Z., Nawaz, M. S., Shehzad, A., Ahmad, M., & Mirza, M. S. (2022). Tailored bioactive compost from agri-waste improves the growth and yield of chili pepper and tomato. *Frontiers in Bioengineering and Biotechnology, 9*, 787764. https://doi.org/10.3389/fbioe.2021.787764

Ji, Z., Zhang, L., Liu, Y., Li, X., & Li, Z. (2023). Evaluation of composting parameters, technologies and maturity indexes for aerobic manure composting: A meta-analysis. *Science of the Total Environment, 886*, 163929. https://doi.org/10.1016/j.scitotenv.2023.163929

Kader, S., Gratchev, I., & Michael, R. N. (2024a). Recycled waste substrates: A systematic review. *Science of the Total Environment, 953*, 176029. https://doi.org/10.1016/j.scitotenv.2024.176029

Kader, S. A., Spalevic, V., & Dudic, B. (2024). Feasibility study for estimating optimal substrate parameters for sustainable green roof in Sri Lanka. *Environment, Development and Sustainability, 26*(1), 2507–2533. https://doi.org/10.1007/s10668-022-02837-y

Gurla Venkata Kameswari, S., Basavaraju, A., Kumar, C. S., & Bapat, J. (2025). Compost monitoring system for kitchen waste management: Development, deployment and analysis. *IoT, 6*(4), 64. https://doi.org/10.3390/iot6040064

Kandpal, H., & Srivastava, R. K. (2025). Investigating the quality of compost derived from municipal solid waste using the Fertility Index and Clean Index. *Bioresource Technology Reports*, 102310. https://doi.org/10.1016/j.biteb.2025.102310

Khalid, M. F., Huda, S., Yong, M., Li, L., Li, L., Chen, Z. H., & Ahmed, T. (2023). Alleviation of drought and salt stress in vegetables: Crop responses and mitigation strategies. *Plant Growth Regulation, 99*(2), 177–194. https://doi.org/10.1007/s10725-022-00905-x

Kormanek, M., Małek, S., Banach, J., & Durło, G. (2023). Effect of changing substrate density and water application method on substrate physical properties and container-grown seedling growth. *Forests, 14*(7), 1490. https://doi.org/10.3390/f14071490

Köhl, K. I., Mulugeta Aneley, G., Haas, M., & Peters, R. (2021). Confounding factors in container-based drought tolerance assessments in *Solanum tuberosum*. *Agronomy, 11*(5), 865. https://doi.org/10.3390/agronomy11050865

Kumar, R., Jha, S., Singh, S. P., Kumar, M., Kumari, R., & Padbhushan, R. (2023). Organic waste recycling by vermicomposting amended with rock phosphate impacts the stability and maturity indices of vermicompost. *Journal of the Air & Waste Management Association, 73*(7), 553–567. https://doi.org/10.1080/10962247.2023.2207504

Lanno, M., Klavins, M., Purmalis, O., Shanskiy, M., Kisand, A., & Kriipsalu, M. (2022). Properties of humic substances in composts comprised of different organic source material. *Agriculture, 12*(11), 1797. https://doi.org/10.3390/agriculture12111797

Lepesteur, M. (2022). Human and livestock pathogens and their control during composting. *Critical Reviews in Environmental Science and Technology, 52*(10), 1639–1683. https://doi.org/10.1080/10643389.2020.1862550

Limoges, M. A., Neher, D. A., Weicht, T. R., Millner, P. D., Sharma, M., & Donnelly, C. (2022). Differential survival of *Escherichia coli* and *Listeria* spp. in northeastern US soils amended with dairy manure compost, poultry litter compost, and heat-treated poultry pellets and fate in raw edible radish crops. *Journal of Food Protection, 85*(12), 1708–1715. https://doi.org/10.4315/JFP-21-261

Liu, Q., Kong, W., Cui, X., Hu, S., Shi, Z., Wu, J., & Qiu, L. (2022). Dynamic succession of microbial compost communities and functions during *Pleurotus ostreatus* mushroom cropping on a short composting substrate. *Frontiers in Microbiology, 13*, 946777. https://doi.org/10.3389/fmicb.2022.946777

Lončarić, Z., Galić, V., Nemet, F., Perić, K., Galić, L., Ragályi, P., & Rékási, M. (2024). The evaluation of compost maturity and ammonium toxicity using different plant species in a germination test. *Agronomy, 14*(11), 2636. https://doi.org/10.3390/agronomy14112636

Machado, R. M. A., & Bui, H. H. (2021, September). Physicochemical characteristics of substrates of the mixture of coir with municipal solid waste compost and with biochar. In *VIII South-Eastern Europe Symposium on Vegetables and Potatoes* (Vol. 1320, pp. 399–404). https://doi.org/10.1007/s10668-022-02837-y

Mahapatra, S., Ali, M. H., & Samal, K. (2022). Assessment of compost maturity–stability indices and recent development of composting bin. *Energy Nexus, 6*, 100062. https://doi.org/10.1016/j.nexus.2022.100062

Manea, E. E., Bumbac, C., Dinu, L. R., Bumbac, M., & Nicolescu, C. M. (2024). Composting as a sustainable solution for organic solid waste management: Current practices and potential improvements. *Sustainability, 16*(15), 6329. https://doi.org/10.3390/su16156329

Marutani, M., & Clemente, S. (2021). Compost-based growing media improved yield of leafy lettuce in pot culture. *Agronomy, 11*(9), 1762. https://doi.org/10.3390/agronomy11091762

Massaccesi, L., Nogués, I., Miritana, V. M., Passatore, L., Zacchini, M., Pietrini, F., & Marinari, S. (2024). Short-term effects of biochar and compost on soil microbial community, C and N cycling, and lettuce (*Lactuca sativa* L.) yield in a Mediterranean environment. *Applied Soil Ecology, 199*, 105411. https://doi.org/10.1016/j.apsoil.2024.105411

McDaniel, M. D., Thompson, G. L., & Sauer, P. (2024). Decompaction and organic amendments provide short-term improvements in soil health during urban, residential development. *Journal of Soil and Water Conservation, 79*(4), 169–179. https://doi.org/10.2489/jswc.2024.00111

Mia, M. S., & Zzaman, W. (2025). Food waste–derived organic fertilizers: Critical insights, agronomic impacts, and pathways for sustainable adoption. *International Journal of Food Science, 2025*(1), 1551054. https://doi.org/10.1155/ijfo/1551054

Mor, S., Kaur, K., & Ravindra, K. (2024). Methane emissions from municipal landfills: A case study of Chandigarh and economic evaluation for waste-to-energy generation in India. *Frontiers in Sustainable Cities, 6*, 1432995. https://doi.org/10.3389/frsc.2024.1432995

Morais, M. C., Azevedo, T., Lopes, H., Coimbra, A. M., Sousa, J. R., Roboredo, M., & Nascimento-Gonçalves, E. (2025). Compost and vermicompost from vine pruning and sewage sludge as peat alternatives in cucumber seedling production. *Agronomy, 15*(11), 2519. https://doi.org/10.3390/agronomy15112519

Mu, D., Hawks, J., & Diaz, A. (2020). Impacts on vegetable yields, nutrient contents and soil fertility in a community garden with different compost amendments. *AIMS Environmental Science, 7*(4), 350–365. https://doi.org/10.3934/environsci.2020023

Mussa, S., Farhan, M., Ahmad, S., Zahra, K., Kanwal, A., Khan, Q. F., & Ali, S. (2025). Exploring the utility of different bulking agents for speeding up the composting process of household kitchen waste. *Scientific Reports, 15*(1), 2488. https://doi.org/10.1038/s41598-025-85433-0

Nocentini, M., Mastrolonardo, G., Michelozzi, M., Cencetti, G., Lenzi, A., Panettieri, M., & Certini, G. (2024). Effects of biochar and compost addition in potting substrates on growth and volatile compounds profile of basil (*Ocimum basilicum* L.). *Journal of the Science of Food and Agriculture, 104*(3), 1609–1620. https://doi.org/10.1002/jsfa.13045

Olsson, E. (2025). Conceptualizing circularity in urban food systems: A scoping review. *Global Food Security*, 100893. https://doi.org/10.1016/j.gfs.2025.100893

Omara, A. E. D., Hafez, E. M., Osman, H. S., Rashwan, E., El-Said, M. A., Alharbi, K., & Gowayed, S. M. (2022). Collaborative impact of compost and beneficial rhizobacteria on soil properties, physiological attributes, and productivity of wheat subjected to deficit irrigation in salt-affected soil. *Plants, 11*(7), 877. https://doi.org/10.3390/plants11070877

Oueld Lhaj, M., Moussadek, R., Mouhir, L., Mdarhri Alaoui, M., Sanad, H., Iben Halima, O., & Zouahri, A. (2024). Assessing the evolution of stability and maturity in co-composting sheep manure with green waste using physico-chemical and biological properties and statistical analyses: A case study of Botanique Garden in Rabat, Morocco. *Agronomy, 14*(7), 1573. https://doi.org/10.3390/agronomy14071573

Oueld Lhaj, M., Moussadek, R., Zouahri, A., Sanad, H., Saafadi, L., Mdarhri Alaoui, M., & Mouhir, L. (2024). Sustainable agriculture through agricultural waste management: A comprehensive review of composting's impact on soil health in Moroccan agricultural ecosystems. *Agriculture, 14*(12), 2356. https://doi.org/10.3390/agriculture14122356

Oueld Lhaj, M., Moussadek, R., Mouhir, L., Sanad, H., Manhou, K., Iben Halima, O., & Mdarhri Alaoui, M. (2025). Application of compost as an organic amendment for enhancing soil quality and sweet basil (*Ocimum basilicum* L.) growth: Agronomic and ecotoxicological evaluation. *Agronomy, 15*(5), 1045. https://doi.org/10.3390/agronomy15051045

Oviedo-Ocaña, E. R., Abendroth, C., Domínguez, I. C., Sánchez, A., & Dornack, C. J. W. M. (2023). Life cycle assessment of biowaste and green waste composting systems: A review of applications and

implementation challenges. *Waste Management, 171*, 350–364. https://doi.org/10.1016/j.wasman.2023.09.004

Paudel, A., & Sun, Y. (2023). Growth, morphological, and biochemical responses of four native species to salinity stress. *HortScience, 58*(6), 651–659. https://doi.org/10.21273/HORTSCI17044-23

Pajura, R. (2024). Composting municipal solid waste and animal manure in response to the current fertilizer crisis: A recent review. *Science of the Total Environment, 912*, 169221. https://doi.org/10.1016/j.scitotenv.2023.169221

Pérez, T., Vergara, S. E., & Silver, W. L. (2023). Assessing the climate change mitigation potential from food waste composting. *Scientific Reports, 13*(1), 7608. https://doi.org/10.1038/s41598-023-34174-z

Porterfield, K. K., Hobson, S. A., Neher, D. A., Niles, M. T., & Roy, E. D. (2023). Microplastics in composts, digestates, and food wastes: A review. *Journal of Environmental Quality, 52*(2), 225–240. https://doi.org/10.1002/jeq2.20450

Popescu, I. S., Covaliu-Mierlă, C. I., Niculescu, V. C., & Șandru, C. (2025). Home composting: A sustainable solution at community level. *Sustainability, 17*(8), 3368. https://doi.org/10.3390/su17083368

Rahim, H. U., Allevato, E., Vaccari, F. P., & Stazi, S. R. (2024). Biochar aged or combined with humic substances: Fabrication and implications for sustainable agriculture and environment – A review. *Journal of Soils and Sediments, 24*(1), 139–162. https://doi.org/10.1007/s11368-023-03644-2

Rajamuneeswaran, G., Hridhya, P., Sakthivel, B., & Gayathri Bai, N. (2025). Smart Compost Guardian: An IoT-based real-time compost monitoring and alert system. *International Journal of Engineering Research & Technology, 13*(5). https://doi.org/10.17577/IJERTCONV13IS05027

Sánchez, A. (2022). Decentralized composting of food waste: A perspective on scientific knowledge. *Frontiers in Chemical Engineering, 4*, 850308. https://doi.org/10.3389/fceng.2022.850308

Sipos, D., Pécsinger, J., Rácz, É. V. P., Macher, G. Z., & Bódizs, D. (2024). The impact of biodegradable and compostable plastic products on the occurrence and contamination of microplastics in compost leachate. *Chemical Engineering Transactions, 114*, 835–840. https://doi.org/10.3303/CET24114140

Sulewski, P., Kais, K., Gołaś, M., Rawa, G., Urbańska, K., & Wąs, A. (2021). Home bio-waste composting for the circular economy. *Energies, 14*(19), 6164. https://doi.org/10.3390/en14196164

Sultana, R., Tanvir, R. U., Hussain, K. A., Chamon, A. S., & Mondol, M. N. (2022). Heavy metals in commonly consumed root and leafy vegetables in Dhaka city, Bangladesh, and assessment of associated public health risks. *Environmental Systems Research, 11*(1), 15. https://doi.org/10.1186/s40068-022-00261-9

Thai, M., Safianowicz, K., Bell, T. L., & Kertesz, M. A. (2022). Dynamics of microbial community and enzyme activities during preparation of *Agaricus bisporus* compost substrate. *ISME Communications, 2*(1), 88. https://doi.org/10.1038/s43705-022-00174-9

United Nations, Department of Economic and Social Affairs (UN DESA). (2018). *World urbanization prospects: The 2018 revision*. United Nations.

Shang, W., Razavi, B. S., Yao, S., Hao, C., Kuzyakov, Y., Blagodatskaya, E., & Tian, J. (2023). Contrasting mechanisms of nutrient mobilization in rhizosphere hotspots driven by straw and biochar amendment. *Soil Biology and Biochemistry, 187,* 109212. https://doi.org/10.1016/j.soilbio.2023.109212

Shimelis, G., Kim, D. G., Yimer, F., & Tadesse, M. (2024). Exploring compost production potential and its economic benefits and greenhouse gas mitigation in Addis Ababa, Ethiopia. *Science of the Total Environment, 955*, 176617. https://doi.org/10.1016/j.scitotenv.2024.176617

Silva, L. I. D., Pereira, M. C., Carvalho, A. M. X. D., Buttrós, V. H., Pasqual, M., & Dória, J. (2023). Phosphorus-solubilizing microorganisms: A key to sustainable agriculture. *Agriculture, 13*(2), 462. https://doi.org/10.3390/agriculture13020462

Seyfferth, A. L., Limmer, M. A., Runkle, B. R., & Chaney, R. L. (2024). Mitigating toxic metal exposure through leafy greens: A comprehensive review contrasting cadmium and lead in spinach. *GeoHealth, 8*(6), e2024GH001081. https://doi.org/10.1029/2024GH001081

Suvendran, S., Acevedo, M. F., Smithers, B., Walker, S. J., & Xu, P. (2025). Soil fertility and plant growth enhancement through compost treatments under varied irrigation conditions. *Agriculture*, *15*(7). https://doi.org/10.3390/agriculture15070734

Thepbandit, W., & Athinuwat, D. (2024). Rhizosphere microorganisms supply availability of soil nutrients and induce plant defense. *Microorganisms, 12*(3), 558. https://doi.org/10.3390/microorganisms12030558

Tsabedze, S. A., Otieno, B., Thomas, A. R., & Getahun, S. T. (2025). Phytotoxicity and quality in compost: A concise review of sewage sludge and green waste applications. *Journal of Material Cycles and Waste Management*, 1–18. https://doi.org/10.1007/s10163-025-02334-0

Vasileva, V., Dinev, N., Mitova, V., Katsarova, A., & Hristova, M. (2023). Impact of compost application rate on lettuce plant growth and soil agrochemical status. *Agriculturae Conspectus Scientificus, 88*(3), 187–192.

Verrillo, M., Cozzolino, V., Spaccini, R., & Piccolo, A. (2021). Humic substances from green compost increase bioactivity and antibacterial properties of essential oils in basil leaves. *Chemical and Biological Technologies in Agriculture, 8*(1), 28. https://doi.org/10.1186/s40538-021-00226-7

Werner, K. A., Castro-Herrera, D., Yimer, F., Tadesse, M., Kim, D. G., Prost, K., & Grohmann, E. (2023). Microbial risk assessment of mature compost from human excreta, cattle manure, organic waste, and biochar. *Sustainability, 15*(5), 4624. https://doi.org/10.3390/su15054624

Wuthisuthimethavee, S., Prempramote, J., Boonhoh, W., Promwee, A., Hayakijkosol, O., & Wongtawan, T. (2024). Do not throw pet faeces away: Composted manures obtained from dog and cat faeces contain high nutrients and effectively cultivate plants. *Recycling, 9*(6), 123. https://doi.org/10.3390/recycling9060123

Xie, Y., Wu, P., Qu, Y., Guo, X., Zheng, J., Xing, Y., & Liu, Q. (2025). The evolution of nutrient and microbial composition and maturity during the composting of different plant-derived wastes. *Biology, 14*(3), 268. https://doi.org/10.3390/biology14030268

Xu, D., Yu, X., Chen, J., Li, X., Chen, J., & Li, J. (2023). Effects of compost as a soil amendment on bacterial community diversity in saline–alkali soil. *Frontiers in Microbiology, 14*, 1253415. https://doi.org/10.3389/fmicb.2023.1253415

Xu, J., Lin, T., Wang, Y., Jiang, W., Li, Q., Lu, T., & Yu, H. (2024). Home food gardening in modern cities: Advances, issues, and future perspectives. *Frontiers in Sustainable Food Systems, 8*, 1391732. https://doi.org/10.3389/fsufs.2024.1391732

Yan, B., Sun, Y. Y., & Wei, Y. (2020). Potassium–calcium antagonistic interaction under tomato magnesium deficiency and magnesium fertiliser regulation in solar greenhouse. *Quality Assurance and Safety of Crops & Foods, 12*(3), 76–86. https://doi.org/10.15586/qas.v12i3.723

Yang, M., Zhou, D., Hang, H., Chen, S., Liu, H., Su, J., & Zhao, G. (2024). Effects of balancing exchangeable cations Ca, Mg, and K on the growth of tomato seedlings (*Solanum lycopersicum* L.) based on increased soil cation exchange capacity. *Agronomy, 14*(3), 629. https://doi.org/10.3390/agronomy14030629

Zaato, P. A., Amponsah, W., Kyei-Baffour, N., Bart-Plange, A., Pawera, L., Srinivasan, R., & Ba, M. N. (2025). Black soldier fly compost enhances productivity and postharvest quality of tomato in Ghana. *Discover Sustainability, 6*(1), 1–27. https://doi.org/10.1007/s43621-025-01724-6

Zhu, H., Liu, M., Xu, H., Feng, D., & Sun, X. (2024). Effects of salt water on growth and quality of *Raphanus sativus* L. and physiological responses against salt stress. *Agronomy, 14*(6), 1190. https://doi.org/10.3390/agronomy14061190

INVESTIGATION OF GRADUATE THESES ON SWALLOWING DISORDERS AND COGNITIVE FUNCTIONS IN PARKINSON'S DISEASE

PARKİNSON HASTALIĞINDA YUTMA BOZUKLUĞU VE BİLİŞSEL İŞLEVLER ALANINDA YAPILMIŞ LİSANSÜSTÜ TEZLERİN İNCELENMESİ

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ABSTRACT

Objective: It is suggested that swallowing disorders (dysphagia) in Parkinson's Disease (PD) may emerge not only due to motor functions but also depend on cognitive functions. The aim of this study is to examine graduate theses concerning the relationship between Parkinson's, dysphagia, and cognitive functions in the Council of Higher Education (YÖK) National Thesis Center and to evaluate the current data in the literature.

Method: A search was conducted in the YÖK National Thesis Center on April 19, 2025, using the dual keyword combinations: "Parkinson and swallowing", "Parkinson and dysphagia", "Parkinson and cognition", "Parkinson and cognitive", along with the triple combinations: "Parkinson, swallowing and cognition", "Parkinson, swallowing and cognitive", "Parkinson, dysphagia and cognition", and "Parkinson, dysphagia and cognitive". The retrieved theses were analyzed and tabulated based on their subject, study methodology, objectives, and hypotheses.

Result: The conducted search yielded nine graduate theses using the dual keyword combination "Parkinson and swallowing", one master's thesis using "Parkinson and dysphagia", and forty-four graduate theses when searching with the dual keywords "Parkinson and cognitive". To access current studies, the search was limited to the 2020–2025 interval, and eighteen theses were identified. No thesis could be accessed using the dual combination of "Parkinson and cognition" or any of the specified triple combinations. It was observed that 72.22% (n = 39) of the examined studies were conducted in the Departments of Neurology and Physiotherapy and Rehabilitation. In contrast, only three theses were found to be conducted in the field of Speech and Language Therapy (SLT). Analysis of the conducted theses showed that swallowing theses in PD predominantly utilized clinical scales such as the Eating Assessment Tool, Gugging Swallowing Screen, and Penetration-Aspiration Scale; and instrumental evaluation mostly employed imaging methods such as videofluoroscopy and flexible endoscopic evaluation. In theses focusing on cognitive processes in PD, electrophysiological measurement methods such as event-related potentials and electroencephalography; and volumetric or diffusion-weighted Magnetic Resonance Imaging techniques were found to be the most frequently used.

Conclusion and Recommendations: Deteriorations in swallowing and cognitive functions during the progressive course of PD are among the most frequently encountered clinical findings. However, despite this prevalence, there is a significant lack of graduate studies in Turkey related to the association between

dysphagia and cognitive functions in PD. The detection of only three graduate theses conducted from an SLT perspective indicates that studies in the SLT field are limited. This research highlights the necessity of addressing the deficiency in the SLT area and the need for increased research in this field. Identifying the lack of studies in this area and increasing the number of future studies will contribute to the literature at the national level.

Keywords: Parkinson, swallowing, dysphagia, cognition, cognitive, speech and language therapy.

ÖZET

Amaç: Parkinson hastalığında (PH) yutma bozukluklarının (disfaji) yalnızca motor fonksiyonlara değil, bilişsel işlevlere de bağlı olarak ortaya çıkabileceği öne sürülmektedir. Bu çalışmanın amacı, Yükseköğretim Kurulu (YÖK) Ulusal Tez Merkezi'nde Parkinson, disfaji ve bilişsel işlevler ilişkisini konu alan lisansüstü tezleri incelemek ve literatürdeki mevcut verileri değerlendirmektir.

Yöntem: "Parkinson ve yutma", "Parkinson ve disfaji", "Parkinson ve biliş", "Parkinson ve kognitif" ikili anahtar kelimeleri ile "Parkinson, yutma ve biliş", "Parkinson, yutma ve kognitif", "Parkinson, disfaji ve biliş", "Parkinson, disfaji ve kognitif" üçlü kombinasyonları kullanılarak, 19.04.2025 tarihinde YÖK Ulusal Tez Merkezi'nde arama yapılmıştır. Ulaşılan tezler konu, çalışma metodolojisi, amaçları ve hipotezleri açısından analiz edilip tablo haline getirilmiştir.

Bulgular: Yapılan taramada "Parkinson ve yutma" ikili kelime kombinasyonuyla yapılan aramada dokuz lisansüstü tez, "Parkinson ve disfaji" kombinasyonuyla yapılan aramada bir yüksek lisans tezi, "Parkinson ve kognitif" ikili kelimeleriyle arama yapıldığında kırk dört lisansüstü teze ulaşılmıştır. Güncel çalışmalara ulaşmak amacıyla tarama 2020-2025 aralığında yapılmış olup on sekiz tez tespit edilmiştir. "Parkinson ve biliş" ikili kelimelerin kombinasyonu ve "parkinson, yutma, kognitif ve biliş" anahtar kelimelerinin üçlü kombinasyonuyla herhangi bir teze ulaşılamamıştır. İncelenen çalışmaların %72,22'sinin (n = 39) Nöroloji ile Fizyoterapi ve Rehabilitasyon anabilim dallarında yürütüldüğü görülmüştür. Buna karşın Dil ve Konuşma Terapisi (DKT) dalında yürütülen üç tez bulunmuştur. Yürütülen tezlerin analizlerine bakınca, PH'de yutma tezlerinde ağırlıklı olarak Eating Assessment Tool, Gugging Yutma Taraması ve Penetrasyon-Aspirasyon Skalası gibi klinik ölçeklerin; enstrümental değerlendirmede ise videofloroskopi ve fleksibl endoskopik değerlendirme gibi görüntüleme yöntemlerinin kullanıldığı belirlenmiştir. PH'de bilişsel süreçlere yönelik tezlerde ise en çok olaya ilişkin potansiyeller ve elektroensefalografi gibi elektrofizyolojik ölçüm yöntemlerinin; ayrıca volümetrik veya difüzyon ağırlıklı Manyetik Rezonans Görüntüleme tekniklerinin kullanıldığı saptanmıştır.

Sonuç ve Öneriler: PH'nin ilerleyen süreçlerinde yutma ve kognitifte meydana gelen bozulmalar en sık karşılaşılan klinik bulgulardandır. Fakat bu yaygınlığa rağmen Türkiye'de PH'de disfaji ve bilişsel işlevler ile ilişkili yapılan lisansüstü çalışmalarda büyük bir eksiklik mevcuttur.. Yapılan çalışmalarda DKT bakış açısıyla yürütülen üç lisansüstü tezin tespit edilmesi DKT alanında çalışmaların sınırlı olduğunu göstermiştir. Bu araştırma DKT alanındaki eksikliğin giderilmesi ve bu alanda yapılacak araştırmalara duyulan ihtiyacı belirtmektedir. Bu alandaki çalışmaların eksikliğinin tespit edilip yapılacak çalışmaların arttırılması literatüre ulusal düzeyde katkı sağlayacaktır.

Anahtar Kelimeler: Parkinson, yutma, disfaji, biliş, kognitif, dil ve konuşma terapisi

GİRİŞ

Parkinson Hastalığı (PH), substantia nigra pars compact'daki nöronların dejenerasyonu sonucu ortaya çıkan ilerleyici nörodejeneratif bir hastalıktır. Motor ve motor olmayan semptomları mevcuttur. Klinik

tabloda sık karşılaşılan tremor, bradikinezi, rijidite ve postural instabilite gibi motor bulguların yanı sıra bilişsel bozulmalar, otonomik yetmezlik, duygudurum değişimleri ve yutma güçlüğü (disfaji) gibi motor olmayan semptomları da içermektedir (Kalia & Lang, 2015; Chaudhuri et al., 2006).

PH'de sık karşılaşılan ve yaşam kalitesini olumsuz etkileyen disfaji önemli bir komplikasyondur. Disfaji yutmanın oral, farigeal ve özafegeal fazlarında görülen aksaklıklar sonucu meydana gelmektedir. Özellikle faringeal fazda yutma tetiklenmesinin gecikmesi ve hava yolu korumasının yetersiz kalması aspirasyon riskini yükseltmektedir. Yutma fazlarındaki bu bozulmalar aspirasyon pnömonisi gibi hayatı tehdit eden sağlık problemlerine neden olabilmektedir (Fernández & Lapane, 2002).

PH'de gözlenen disfaji sadece motor kontrol bozukluklarından etkilenmez aynı zamanda bilişsel işlevlerin bozulmasından da kaynaklanabilmektedir. Çünkü yutma işlevi, bilişsel süreçler ile motor eylemlerin bir arada olduğu kompleks bir süreçtir. Yutmanın başlatılması ve sürdürülmesinde yürütücü işlevler, dikkat ve hafıza gibi bilişsel işlevler de aktif rol oynamaktadır (Daniels et al., 2011; Malandraki et al., 2016).

Bu nedenle, Türkiye'de PH'ye bağlı disfaji ve bilişsel işlev bozuklukları üzerine yapılmış lisansüstü tezlerin sistematik analizi alandaki mevcut durumu ortaya koymak ve gelecek çalışmalara ışık tutmak açısından büyük önem taşımaktadır.

ARAŞTIRMA VE BULGULAR

Bu çalışmada, PH'de disfaji ve bilişsel işlevler ilişkisini inceleyen lisansüstü tezlerin bir derlemesini yapmak amacıyla YÖK Ulusal Tez Merkezi veri tabanında "Parkinson ve yutma", "Parkinson ve disfaji", "Parkinson ve biliş", "Parkinson ve kognitif" anahtar kelimeleri kullanılarak 19.04.2025 tarihinde arama yapılmıştır. İncelemenin yapıldığı zaman aralığında "Parkinson ve yutma" anahtar kelimesiyle dokuz, "Parkinson ve disfaji" anahtar kelimesiyle bir, "Parkinson ve kognitif" anahtar kelimesiyle kırk dört lisansüstü tez listelenmiştir. "Parkinson" anahtar kelimesinin "disfaji, yutma, kognitif, biliş" anahtar kelimeleriyle üçlü kombinasyonunda tez tespit edilememiştir. Aynı zamanda "Parkinson ve biliş" anahtar kelimeleriyle yapılan aramada da herhangi bir tez kaydına rastlanmamıştır.

Elde edilen çalışmalar yıl, konu ve anabilim dalına göre incelenmiştir. **Tablo 1'de,** "Parkinson ve yutma" **anahtar kelimesi ile ilgili, Tablo 2'de** "Parkinson ve disfaji" anahtar kelimesi **ile ilgili, Tablo 3'te** "Parkinson ve kognitif" anahtar kelimesi **ile ilgili 2020-2025 yılları arasında tespit edilen lisansüstü çalışmalar; yazar isimleri, çalışma yılları, tez başlıkları, tez türleri (yüksek lisans/doktora) ve araştırma konuları sunulmuştur.** PH'de yutma temalarını ele alan on lisansüstü çalışmasının özeti, araştırma soruları, hipotezler, metodolojileri Tablo 4'de; çalışma amaçları, çalışma tasarımları ve çalışmaların ana bulguları Tablo 5'de sunulmaktadır.

İncelenen çalışmaların %72,22'sinin (n = 39) Nöroloji ile Fizyoterapi ve Rehabilitasyon anabilim dallarında yürütüldüğü görülmüştür. Buna karşın DKT dalında yürütülen üç tez bulunmuştur. Ayrıca kulak burun boğaz, ergoterapi, beslenme ve diyetetik ve bilgisayar mühendisliği gibi çeşitli disiplinlerde de Parkinson konulu testler tespit edilmiştir.

Yapılan taramada "Parkinson ve yutma" ile ilgili elde edilen tezler yutma bozukluklarının değerlendirilmesi ile ilişkili olup kullanılan klinik ölçekler Eating Assessment Tool, Gugging Yutma Taraması ve Penetrasyon-Aspirasyon gibi testler ve enstrümental değerlendirme araçlarında ise videofloroskopi ve fleksibl endoskopik değerlendirme gibi görüntüleme yöntemlerinin kullanıldığı belirlenmiştir. İncelenen tezlerde değerlendirme yöntemlerine yönelik çalışmalar mevcuttur. Rehabilitasyon müdahalelerine yönelik çalışmaya rastlanmamıştır.

"Parkinson ve kognitif" anahtar kelimeleriyle 2020-2025 yılları aralığıyla sınırlandırılmış taramada elde edilen güncel çalışmaların %56'sında (n=10) nöroloji alanının ana veya ortak alan olarak görülmüştür.

Tespit edilen 18 tezden 8'i fizyoterapi alanı ile ilgilidir. Diğer alanlar ise bilgisayar mühendisliği, fizyoloji, psikiyatri, psikoloji ve beslenme ve diyetetik olarak tespit edilmiştir. DKT alanıyla ilgili yalnızca bir teze ulaşılmıştır. Elde edilen tezlerin %33.3'ü (n=6) rehabilitasyon ve müdahaleye yönelik olduğu görülmektedir. PH'de bilişsel süreçlere yönelik tezlerde değerlendirme yöntemlerinde ise en sık olaya ilişkin potansiyeller ve elektroensefalografi gibi elektrofizyolojik ölçüm yöntemlerinin (n=3); ayrıca volümetrik veya difüzyon ağırlıklı Manyetik Rezonans Görüntüleme tekniklerinin (n=3) kullanıldığı saptanmıştır.

"Parkinson ve kognitif" anahtar kelimesiyle aranan tezlerin incelemesinde, transkraniyal elektriksel stimülasyonun bilişsel işlevler üzerindeki gelişmelere olumlu yönde etki ettiğini araştıran çalışmalar bulunmaktadır (Aksu, 2021). Başka bir çalışmada ise, fiziksel antrenmanların postür kontrolü ve bilişsel işlevler üzerindeki etkileri değerlendirilmiştir (Kurt Türkoğlu, 2023). Ayrıca, MIND (Mediterranean-DASH Intervention for Neurodegenerative Delay) diyetine uyumun PH'deki bilişsel fonksiyonlarla ilişkisi incelenmiştir (Esgin, 2023). Sanal Gerçeklik (SG) uygulamalarının rehabilitasyondaki motor ve bilişsel etkililiği de araştırılmıştır (Haj Ebrahimi & Çetin, 2020, 2024). Bu çalışmalar, Sanal Gerçeklik ile rehabilitasyona dâhil edilen oyunların hem motor hem de bilişsel (kognitif) etkilerinin olduğunu göstermiştir (Çetin, 2024). Yutma fonksiyonuna yönelik çalışmalarda ise, submental kas grubu üzerinde kinezyolojik bant uygulamasının olumlu etkiler yarattığı ve bunun da yutma fonksiyonunda olumlu ilerlemelere neden olduğu görülmektedir (Yılmaz Necati, 2019). Diğer bulgular, temporomandibular eklem disfonksiyonu (TMED) ve servikal kas enduransı gibi motor dışı faktörlerin disfaji ile anlamlı ilişkili olduğunu (Otlu, 2024), aynı zamanda postüral bozukluklar ve baş boyun artrokinematik özelliklerinin de yutma performansı ile ilişkili olduğunu ortaya koymuştur (Alkoy, 2024).Bununla birlikte, bilişsel işlevler, anksiyete ve depresyon gibi psikolojik değişkenlerin yutma fonksiyonu ile ilişkisi üzerine yapılan çalışma bulunmamaktadır.

Tablo 1: "Parkinson ve Yutma" Anahtar Kelimesi ile Arama Yapıldığında Ulaşılan Tezler

No	Yazar	Yıl	Tez Adı	Tez Türü	Konu
1	DİLARA BİNGÖL	2022	Parkinson hastalarındaki yutma bozukluğunun yaşam kalitesine olan etkisinin belirlenmesi	Yüksek Lisans	Kulak Burun ve Boğaz (DKT)
2	SAMİYE ALKOY	2024	Parkinson hastalarında yutma performansı ile baş boyun artrokinematik özelliklerinin ilişkisi	Yüksek Lisans	Fizyoterapi ve Rehabilitasyon
3	MELİKE OTLU	2024	Parkinson hastalarında temporomandibular eklem disfonksiyonunun derin servikal kas enduransı, gövde pozisyon hissi ve yutma bozukluğu üzerinde etkisi	Yüksek Lisans	Fizyoterapi ve Rehabilitasyon
4	HİLAL GÜNER	2024	Parkinson hastalarında ultrasonografik ve endoskopik yutma değerlendirilmesi, dizabilite ile ilişkisinin incelenmesi	Tıpta Uzmanlık	Fiziksel Tıp ve Rehabilitasyon
5	RUMEYSA COŞKUN	2020	Parkinson hastalığında ses ve yutma fonksiyonlarının değerlendirilmesi	Yüksek Lisans	Kulak Burun ve Boğaz
6	EDIZ YILMAZ NECATİ	2019	Parkinson hastalarında kinezyolojik bant uygulamasının yutma fonksiyonu üzerine olan etkinliğinin incelenmesi	Doktora	Fizyoterapi ve Rehabilitasyon

7	RÜMEYSA MACİT	2018	Parkinson hastalarında yutma kaygısının anksiyete ve depresyonla olan ilişkisi	Tıpta Uzmanlık	Aile Hekimliği
8	ZEYNEP TANRIVERDİ	2008	Amyotrofik lateral skleroz ve parkinson hastalarında orofaringiyal yutma üzerine viskozite etkisinin bardaktan su içme ve diğer elektrofizyolojik yöntemlerle incelenmesi	Tıpta Uzmanlık	Nöroloji
9	FİGEN EŞMELİ (TOKUÇOĞLU)	2000	Parkinson hastalığında yutma bozukluklarının elektrofizyolojik incelemesi	Yüksek Lisans	Nöroloji

Tablo 2: "Parkinson ve Disfaji" Anahtar Kelimesi ile Arama Yapıldığında Ulaşılan Tezler

No	Yazar	Yıl	Tez Adı	Tez Türü	Konu
1	FEYZA ÇELEBİ	2022	Münih disfaji testi-parkinson hastalığı anketi'nin Türkçe	Yüksek Lisans	Kulak Burun ve Boğaz = Otorhinolaryngology (Ear-Nose-Throat) ; Nöroloji = Neurology Dil ve Konuşma terapisi

			versiyonunun güvenilirliği ve geçerliliği		

Tablo 3: "Parkinson ve Kognitif" Anahtar Kelimesi ile Arama Yapıldığında Ulaşılan Tezler

No	Yazar	Yıl	Tez Adı	Tez Türü	Konu
2	SÜMEYYE YAKUT	2024	Parkinson ve alzheimer hafif kognitif bozukluğu olan hastaların kognitif profillerinin karşılaştırılması	Yüksek Lisans	Nöroloji
3	BALKIS KURBEH	2022	Kognitif bozukluğu olan parkinson hastalarından alınan tükürük örneklerinin metaproteomik analizi	Yüksek Lisans	Biyoteknoloji
9	NESLİHAN BAKİ	2024	Kognitif bozukluğu olmayan parkinson hastalarında erken tanı amaçlı klinik karar destek sistemi geliştirilmesi	Doktora	Bilgisayar Mühendisliği Bilimleri-Bilgisayar ve Kontrol

10	ÖMER SÖNMEZ	2024	Bipolar bozukluğuna sahip ve kognitif bozukluğu olmayan parkinson hastalığına sahip 55 yaş üstü bireylerin sağlıklı kişilerle P300-olaya ilişkin potansiyel yöntemiyle karşılaştırılması	Yüksek Lisans	Nöroloji; Psikiyatri; Psikoloji
11	BARIŞ ÇETİN	2024	Parkinson hastalarında sanal gerçeklik temelli oyunların üst ekstremite ve gövde fonksiyonları ve kognitif durum üzerine etkisinin incelenmesi	Doktora	Fizyoterapi ve Rehabilitasyon
12	FATİH MEHMET ŞAHİN	2024	Derin beyin stimulasyonu uygulanan parkinson hastalarında ritmik işitsel uyarının kognitif ve motor yetenekler ile müzik algısı üzerine etkisi	Doktora	Dil ve Konuşma Terapisi; Fizyoterapi ve Rehabilitasyon; Nöroloji
13	BÜŞRA SEÇKİNOĞULLARI	2024	İdiyopatik parkinson hastalarında duyu-algı-motor eğitimin kognitif fonksiyonlar, denge ve yürüyüşe etkisinin incelenmesi	Doktora	Fizyoterapi ve Rehabilitasyon
14	AYŞENUR KURT TÜRKOĞLU	2023	Parkinson hastalarında kuvvet ve stabilite antrenman programının postüral kontrol ve kognitif fonksiyonları üzerine etkisi	Doktora	Nöroloji

15	ESRA CİLLİ	2023	Parkinson hastalığında hafif kognitif bozukluk tanısına serum biyobelirteçlerinin katkısının değerlendirilmesi	Tıpta Uzmanlık	Nöroloji
16	ÖZGE ESGİN	2023	Yaşlı parkinson hastalarında mınd diyetine uyum, diyet antioksidan yükünün kognitif fonksiyon ve bazı biyokimyasal parametreler ile ilişkisi	Doktora	Beslenme ve Diyetetik
17	EDA YAŞASIN	2022	Parkinson hastalarında psikoz benzeri yaşantılar: Affektif profil, kognitif profil ve tedavi seçimi	Tıpta Uzmanlık	Psikiyatri
18	SERKAN AKSU	2021	Hafif kognitif bozukluk tanılı parkinson hastalarında transkraniyal elektriksel uyarımın bilişsel fonksiyonların üzerine etkisi	Doktora	Fizyoloji
19	EBRU YILDIRIM	2021	Parkinson hastalığı demans, alzheimer hastalığı demans ve lewy cisimcikli demans'ta kognitif fonksiyonların olaya-ilişkin EEG beyin osilasyonları ile incelenmesi	Doktora	Fizyopatoloji; Fizyoterapi ve Rehabilitasyon; Nöroloji
20	SİBEL ÖZDEMİR	2020	Parkinson hastalığında klinik evre ve kognitif yıkım için retinal sinir lifi kalınlığı bir biyobelirteç olabilir mi?	Tıpta Uzmanlık	Nöroloji

21	FARZIN HAJ EBRAHIMI	2020	Parkinson hastalığı'nda sanal gerçeklik uygulamasının motor ve kognitif semptomlar üzerine etkilerinin klinik ve rest-fmrı ile değerlendirilmesi.	Doktora	Nöroloji

Tablo 4: Parkinson ve Yutma ile İlgili Yapılan Tezlerin; Araştırma Sorusu, Hipotezleri ve Metodolojisi

Tez adı	Araştırma Sorusu/Soruları	Test Edilen Hipotezler	Metodoloji
Parkinson Hastalarındaki Yutma Bozukluğunun Yaşam Kalitesine Olan Etkisinin Belirlenmesi	EAT-10 puanı ile T-SWAL-QOL puanı arasında anlamlı bir ilişki var mıdır? DHİ puanı ile T-SWAL-QOL puanı arasında anlamlı bir ilişki var mıdır?	Parkinson hastalarında yutma bozukluğu (disfaji) yaşam kalitesini olumsuz yönde etkiler. Hastaların özdeğerlendirmelerine dayanan EAT-10 ve DHİ ölçekleri ile yaşam kalitesini ölçen T-SWAL-QOL ölçeği arasında pozitif korelasyon vardır. Klinisyen değerlendirmesiyle elde edilen GUSS puanı ile	**Araştırma Türü:** Betimsel, korelasyonel çalışma **Katılımcılar:** 38 Parkinson hastası (24 erkek, 14 kadın) **Veri Toplama Araçları:** EAT-10 (özdeğerlendirme)

	GUSS toplam puanı ile EAT-10, T-SWAL-QOL ve DHİ toplam puanları arasında anlamlı bir ilişki var mıdır? T-SWAL-QOL anketine göre Parkinson hastalarının yaşam kalitesi yutma bozukluğundan nasıl etkilenmiştir? T-SWAL-QOL anketinin alt alanları birbiriyle ilişkili midir?	hastanın özdeğerlendirmeleri arasında istatistiksel anlamlı ilişkiler bulunabilir.	Disfaji Handikap İndeksi (DHİ, özdeğerlendirme) T-SWAL-QOL (yutmaya bağlı yaşam kalitesi) GUSS (klinik değerlendirme) **Veri Analizi:** Ölçeklerin normal dağılıma uygunluğu Shapiro-Wilk testi ile test edildi.Normal dağılmayan veriler için Spearman korelasyon analizi kullanıldı. Analizler SPSS programıyla yapıldı.
Parkinson Hastalarında Yutma Performansı ile Baş Boyun Artrokinematik Özelliklerinin İlişkisi	Parkinson hastalarında yutma performansı ile baş boyun artrokinematik özellikleri arasında anlamlı bir ilişki var mıdır?	**Hipotez 0 (H0):** Parkinson hastalarında baş boyun artrokinematik özellikleri ile yutma performansı arasında bir ilişki yoktur. **Hipotez 1 (H1):** Parkinson hastalarında baş boyun artrokinematik özellikleri ile yutma performansı arasında anlamlı bir ilişki vardır.	**Katılımcılar:** 38 Parkinson hastası **Gruplar:** Grup 1: Yutma bozukluğu olanlar (PAS ≥ 2) Grup 2: Yutma bozukluğu olmayanlar (PAS < 2) **Değerlendirme Araçları:** **Mental Durum:** Standardize Mini Mental Test **Hastalık Şiddeti:** Hoehn ve Yahr Ölçeği, Hareket Bozuklukları Derneği Birleşik Parkinson Hastalığı Değerlendirme Ölçeği (HBD-BPHDÖ) **Artrokinematik Özellikler:** Postür analizi, eklem hareket açıklığı (EHA), kas kuvveti, kraniyo-vertebral açı (KVA), kraniyo-servikal açı (KSA) **Yutma Performansı:**Videofloroskopik yutma çalışması (VFYÇ), PAS, Bolus Rezidü Skalası (BRS), T-EAT-10, SAFE, FOAS, DSFS **Yaşam Kalitesi:** T-SWAL-QOL **Yorgunluk:** Vizüel Analog Skala (VAS) **İstatistiksel Analiz:** Gruplar arası karşılaştırmalar

			Korelasyon analizleri İstatistiksel anlamlılık düzeyi: $p<0.05$
Parkinson Hastalarında Temporomandibular Eklem Disfonksiyonunun Derin Servikal Kas Enduransı, Gövde Pozisyon Hissi ve Yutma Bozukluğu Üzerindeki Etkisi	Parkinson hastalarında temporomandibular eklem disfonksiyonu (TMED), derin servikal fleksör kas enduransı üzerinde etkili midir? TMED, gövde pozisyon hissini etkiler mi? TMED, yutma bozukluğu ile ilişkili midir?	Parkinson hastalarında TMED, derin servikal kas enduransını etkiler. Parkinson hastalarında TMED, gövde pozisyon hissini etkiler. Parkinson hastalarında TMED, yutma bozukluğunu etkiler.	**Tasarım:** Gözlemsel, kesitsel araştırma. **Yer:** Ankara Etlik Şehir Hastanesi Nöroloji Servisi (21 Eylül 2023 – Mart 2024) **Katılımcılar:** 80 Parkinson hastası (40 TMED olan, 40 TMED olmayan). **Değerlendirme araçları:** **Mini Mental Durum Testi** – bilişsel durum değerlendirmesi **Helkimo Klinik Kraniomandibular İndeksi** – TMED değerlendirmesi **Algometre** – basınç ağrı eşiği ölçümü **Kranio-Servikal Fleksör Testi** – derin servikal kas enduransı **Dijital İnklinometre** – gövde pozisyon hissi **EAT-10 (Yeme Değerlendirme Aracı)** – yutma performansı değerlendirmesi **İstatistik:** Gruplar arası karşılaştırmalar ($p<0.05$ anlamlı kabul edilmiştir)
Parkinson Hastalarında Ultrasonografik ve Endoskopik Yutma Değerlendirilmesi, Dizabilite ile İlişkisinin İncelenmesi	Parkinson hastalarında yutma bozukluğu (disfaji) ultrasonografi ile tespit edilebilir mi? Ultrasonografik bulgular, fiberoptik endoskopik yutma çalışması sonuçlarıyla uyumlu mu?	Parkinson hastalarında disfaji, ultrasonografik yöntemle güvenilir şekilde değerlendirilebilir. Ultrasonografik bulgular ile fiberoptik endoskopik yutma çalışması sonuçları arasında anlamlı korelasyon vardır. Disfaji, fonksiyonel durum ve dizabilite düzeyleriyle ilişkilidir.	**Tasarım:** Kesitsel gözlemsel çalışma. **Katılımcılar:** 15 disfaji semptomu olan Parkinson hastası 16 disfaji semptomu olmayan Parkinson hastası 30 sağlıklı gönüllü **Yaş Aralığı:** 46-85 **Kriterler:** Hoehn-Yahr evre 1-3 Parkinson

	Disfaji ile fonksiyonel durum ve dizabilite arasında anlamlı bir ilişki var mı?		hastaları **Değerlendirme Araçları:** Ultrasonografi (USG) Klinik yutma değerlendirmesi Fiberoptik Endoskopik Yutma Çalışması (FEYÇ) EAT-10, Fonksiyonel Bağımsızlık Ölçeği, Berg Denge Ölçeği vb. çeşitli testler **İstatistiksel Analiz:** Gruplar arası karşılaştırmalar, korelasyon analizi
Parkinson Hastalığında Ses ve Yutma Fonksiyonlarının Değerlendirilmesi	Parkinson hastalığı evrelerine göre **yutma fonksiyonlarında** değişiklik var mıdır? Parkinson hastalığı evrelerine göre **ses fonksiyonlarında** değişiklik var mıdır? Ses ve yutma fonksiyonları arasında **anlamlı bir ilişki** var mıdır?	**Hipotez 1:** H_0: Parkinson hastalığında evrelere göre yutma değerlendirmesi bulgularında farklılık yoktur. H_1: Farklılık vardır. **Hipotez 2:** H_0: Parkinson hastalığında evrelere göre ses değerlendirmesi bulgularında farklılık yoktur. H_1: Farklılık vardır. **Hipotez 3:** H_0: Ses ve yutma fonksiyonları arasında ilişki yoktur. H_1: İlişki vardır.	**Araştırma Türü:** Kesitsel analitik çalışma **Yer:** Ege Üniversitesi Tıp Fakültesi Nöroloji ve Fiziksel Tıp & Rehabilitasyon Anabilim Dalları **Zaman:** Haziran – Eylül 2020 **Örneklem:** 40 yaş üstü, Hoehn-Yahr evresi 1, 2, 3 olan **48 Parkinson hastası** Cinsiyet: 20 kadın, 28 erkek **Veri Toplama Araçları:** **Ses:** VHI-10 anketi + MDVP (akustik analiz) **Yutma:** Klinik öykü, EAT-10 anketi, FEES (Fiberoptik Endoskopik Yutma Çalışması) **İstatistiksel Yöntemler:** SPSS 25 ile ANOVA, Kruskal-Wallis, Wilcoxon, Spearman korelasyon, Ki-Kare, Bonferroni testi
Parkinson Hastalarında Yutma Kaygısının Anksiyete ve Depresyonla Olan İlişkisi	Parkinson hastalarında yutma kaygısı görülme sıklığı nedir? Yutma kaygısı ile anksiyete	**H0:** Parkinson hastalarında yutma kaygısı yoktur. **H1:** Parkinson hastalarında yutma kaygısı vardır.	**Çalışma Tipi:** Çok merkezli, kesitsel nitelikte bir çalışma

	arasında bir ilişki var mıdır? Yutma kaygısı ile depresyon arasında bir ilişki var mıdır? Cinsiyet, yaş, hastalık süresi gibi değişkenler yutma kaygısını etkiler mi?	**H0:** Yutma kaygısı ile anksiyete arasında anlamlı bir ilişki yoktur. **H1:** Yutma kaygısı ile anksiyete arasında anlamlı bir ilişki vardır. **H0:** Yutma kaygısı ile depresyon arasında anlamlı bir ilişki yoktur. **H1:** Yutma kaygısı ile depresyon arasında anlamlı bir ilişki vardır. **H0:** Cinsiyet, yaş, hastalık süresi gibi değişkenlerin yutma kaygısına etkisi yoktur. **H1:** Cinsiyet, yaş, hastalık süresi gibi değişkenlerin yutma kaygısına etkisi vardır.	**Süreç:** 01.12.2017 - 01.03.2018 tarihleri arasında yürütüldü. **Katılımcılar:** 115 Parkinson hastası, 18 yaş üstü, Off döneminde olmayanlar **Veri Toplama Araçları:** Sosyo-demografik ve klinik veri formu Yutma Kaygısı Ölçeği (Budak ve arkadaşları) Beck Depresyon Ölçeği Hamilton Anksiyete Ölçeği **Analiz Yöntemleri:** SPSS 22 kullanıldı Normal dağılıma Shapiro-Wilk testi Tanımlayıcı istatistikler: Ortalama, standart sapma, frekans İlişki analizleri: Pearson ve Spearman korelasyon testleri Grup karşılaştırmaları: Kruskal-Wallis ve Mann-Whitney U testleri Anlamlılık düzeyi: $p < 0.05$

Münih disfaji testi – parkinson hastalığı anketi'nin Türkçe versiyonunun güvenilirliği ve geçerliliği	MDT-PD ölçeğinin Türkçe versiyonu, Türkçe konuşan Parkinson hastaları için geçerli midir? MDT-PD ölçeğinin Türkçe versiyonu, Türkçe konuşan Parkinson hastaları için güvenilir midir? Katılımcıların ölçekten aldıkları sonuçların kategorik dağılımı nasıldır? Parkinson hastalarının MDT-PD sonuçları ile demografik verileri (yaş, cinsiyet, tanı süresi, Hoehn-Yahr evresi) arasında ilişki var mıdır? MDT-PD ile diğer değerlendirme araçları (T-EAT-10, T-SWAL-QOL, VFYÇ, FOIS) arasında ilişki var mıdır?	MDT-PD'nin Türkçeye uyarlanmış hali geçerli ve güvenilir bir ölçektir. MDT-PD sonuçları ile T-EAT-10 ve T-SWAL-QOL skorları arasında anlamlı ilişki vardır. MDT-PD skorları ile VFYÇ parametreleri (IDDSI kıvamlarına göre) arasında anlamlı ilişki vardır. Demografik faktörler MDT-PD skorlarını anlamlı şekilde etkilemez.	**Araştırma Türü:** Ölçek uyarlama ve geçerlilik-güvenirlik çalışması. **Katılımcılar:** 60 İdiopatik Parkinson hastası (ortalama yaş: 64,45 ± 10,15 yıl). **Veri Toplama Araçları:**T-MDT-PD (çevrilmiş Münih Disfaji Testi), T-EAT-10 , T-SWAL-QOL (Yutma Yaşam Kalitesi Anketi), Videofloroskopik Yutma Çalışması (VFYÇ, 51 katılımcıya uygulandı), FOIS ve PAS skorları **Geçerlilik:** Dilsel, psikometrik ve aynılık geçerliliği analiz edildi. **Güvenilirlik:** Cronbach's alpha ile iç tutarlılık Test-tekrar test korelasyonu (rs = .60) **İstatistiksel analiz:** Korelasyon, t-testi, ANOVA, Fisher Exact testi kullanıldı. **Anlamlılık düzeyi:** $p < 0.05$

Tablo 5: Parkinson ve Yutma ile İlgili Yapılan Tezlerin Amaçları, Çalışma Dizaynı ve Ana Bulgular

Tez Adı	Çalışma Amaçları	Çalışma Dizaynı	Çalışmanın Ana Bulguları
Parkinson Hastalarındaki Yutma Bozukluğunun Yaşam Kalitesine Olan Etkisinin Belirlenmesi	Parkinson hastalarında yutma bozukluğunun yaşam kalitesi üzerindeki etkisini değerlendirmek Özdeğerlendirme ölçekleri (EAT-10, DHİ) ile yaşam kalitesi (T-SWAL-QOL) arasındaki ilişkiyi belirlemek Klinik yutma değerlendirmesi ile (GUSS) özbildirim anketleri arasında ilişki olup olmadığını saptamak	**Tür:** Gözlemsel, tanımlayıcı, korelasyonel **Katılımcı Sayısı:** 38 Parkinson hastası **Araçlar:** EAT-10, Disfaji Handikap İndeksi (DHİ), Yutma Yaşam Kalitesi Anketi (T-SWAL-QOL), Gugging Yutma Tarama Testi (GUSS)	• EAT-10 ve DHİ skorları ile T-SWAL-QOL arasında **anlamlı negatif korelasyon** bulundu → Yutma güçlüğü arttıkça yaşam kalitesi azalmaktadır • GUSS ile özbildirim ölçekleri arasında **zayıf ama anlamlı ilişkiler** tespit edildi • Disfaji varlığı yaşam kalitesini hem fiziksel hem de psikososyal alanlarda **olumsuz etkilemektedir.**
Parkinson Hastalarında Yutma Performansı ile Baş Boyun Artrokinematik Özelliklerinin İlişkisi	Parkinson hastalarında yutma performansı ile baş-boyun artrokinematik özellikler (kas kuvveti, eklem hareket açıklığı, açı ölçümleri) arasındaki ilişkiyi araştırmak	**Tür:** Gözlemsel, kesitsel karşılaştırmalı çalışma **Katılımcı Sayısı:** 38 Parkinson hastası **Gruplama:** Grup 1: Yutma bozukluğu olanlar (PAS ≥ 2) , Grup	KVA, KSA gibi baş-boyun açıları ile yutma parametreleri arasında **anlamlı ilişki bulunmadı**. Sol lateral fleksiyonda kısıtlılık ve fleksiyon kuvvetinde azalma, yutma performansını **etkileyebilecek** artrokinematik faktörler olarak belirlendi. Yutma bozukluğu olan hastalarda vücut dengesi, kifoz varlığı ve kas kuvvetinde **anlamlı azalma** görüldü.

		2: Yutma bozukluğu olmayanlar (PAS < 2) **Değerlendirme Yöntemleri:** Videofloroskopik Yutma Çalışması (PAS, BRS, kinematik analiz), Kas kuvveti, postür analizi, KVA ve KSA ölçümleriT-EAT-10, SAFE, FOAS, T-SWAL-QOL	Sonuç olarak: **Yutma bozukluğu erken dönemde ortaya çıkabilir, ancak artrokinematik değişiklikler bu evrede belirgin olmayabilir.**
Parkinson Hastalarında Temporomandibular Eklem Disfonksiyonunun Derin Servikal Kas Enduransı, Gövde Pozisyon Hissi ve Yutma Bozukluğu Üzerindeki Etkisi	-Parkinson hastalarında TMED (temporomandibular eklem disfonksiyonu) varlığının 1. Derin servikal kas enduransı 2. Gövde pozisyon hissi 3. Yutma bozukluğu üzerindeki etkisini araştırmak.	- Gözlemsel ve kesitsel çalışma - 80 Parkinson hastası (40 TMED'li, 40 TMED'siz) - Ankara Etlik Şehir Hastanesi'nde yürütülmüş	- TMED'li Parkinson hastalarında servikal kas enduransı daha düşüktü - Gövde pozisyon hissi bozulmuştu - Yutma performansı daha düşüktü - Gruplar arası istatistiksel anlamlı fark bulundu
Parkinson Hastalarında Ultrasonografik ve Endoskopik Yutma Değerlendirilmesi, Dizabilite ile İlişkisinin İncelenmesi	- Disfaji semptomu olan ve olmayan Parkinson hastaları ile sağlıklı bireylerde: 1. Ultrasonografik yutma değerlendirmesi yapmak 2. FEYÇ (fiberoptik endoskopik yutma	- Kesitsel, gözlemsel çalışma - Katılımcılar: 15 disfajik Parkinson hastası, 16 nondisfajik Parkinson hastası, 30 sağlıklı gönüllü	- Parkinson hastalarının hyoid elevasyonu sağlıklı bireylere göre düşüktü - Disfajik hastalarda yutma süresi daha uzundu - Disfaji ile fonksiyonel durum arasında korelasyon zayıf olsa da disfajik grupta fonksiyonel durum daha kötüydü - Ultrasonografi, klinik değerlendirmelere katkı sağlayabilecek bir yöntem olarak değerlendirildi

	çalışması) ile karşılaştırmak 3. Disfaji ile fonksiyonel durum ve dizabilite arasındaki ilişkiyi incelemek	- Değerlendirme: USG, FEYÇ, klinik testler	
Parkinson Hastalığında Ses ve Yutma Fonksiyonlarının Değerlendirilmesi	İdiyopatik Parkinson hastalarında hastalık evrelerine göre **ses** ve yutma fonksiyonlarında değişiklik olup olmadığını belirlemek Subjektif (VHI-10, EAT-10) ve objektif (MDVP, FEES) ölçütlerle değerlendirme yapmak, ses ve yutma fonksiyonları arasındaki ilişkiyi ortaya koymak, disfajiyi erken tanımak ve terapilere yön vermek	**Kesitsel analitik çalışma** Katılımcılar: 48 Parkinson hastası (Hoehn-Yahr evre 1, 2, 3) Değerlendirme araçları: **Ses:** VHI-10 anketi + MDVP akustik ses analizi **Yutma:** EAT-10 anketi + Fiberoptik Endoskopik Yutma Çalışması (FEES) Analiz: SPSS v25 ile ANOVA, Kruskal-Wallis, Wilcoxon, Spearman, Ki-Kare	FEES ile %82,6 hastada yutma sonrası rezidü saptandı. Yutma güçlüğü, evreye bağlı olmadan Parkinson hastalarında yaygındı. VTI (Evre 1), SHIM ve NHR (Evre 3) değerlerinde FEES sonrası anlamlı artış gözlendi. VHI-10 ve EAT-10 skorlarında evrelere göre fark bulunmadı ancak Evre 2'de orta düzeyde anlamlı ilişki bulundu. Objektif değerlendirmeler, subjektif şikâyet bildirmeyen bireylerde bile disfajiyi ortaya koyabildi.
Parkinson Hastalarında Yutma Kaygısının Anksiyete ve Depresyonla Olan İlişkisi	Parkinson hastalarında yutma kaygısını değerlendirmek	Çok merkezli kesitsel çalışma Katılımcılar: 115 Parkinson hastası	Ortalama YKÖ puanı: 7.26 (kaygının varlığını gösteriyor). Yutma kaygısı, anksiyete (HAÖ) ve depresyon (BDÖ) ile anlamlı ilişkili bulundu. Kadınlarda yutma kaygısı puanı daha yüksekti.

	Bu kaygının anksiyete ve depresyon ile ilişkisini araştırmak	Ölçümler: Yutma Kaygısı Ölçeği (YKÖ), Beck Depresyon Ölçeği (BDÖ), Hamilton Anksiyete Ölçeği (HAÖ), Yüz yüze anket yöntemi ile veri toplandı.	Yutma kaygısı ile yaş ve hastalık süresi arasında ilişki saptanmadı. Depresyonu olanlarda yutma kaygısı daha yüksekti.
Parkinson Hastalarında Kinezyolojik Bant Uygulamasının Yutma Fonksiyonu Üzerine Olan Etkinliğinin İncelenmesi	-Parkinson hastalarında yutma fonksiyonunun değerlendirilmesi - Kinezyolojik bant uygulamasının bu fonksiyon üzerindeki etkisinin araştırılması - Fiberoptik Endoskopik Yutma Çalışması (FEYÇ) ve ultrasonografi ile yutma performansının karşılaştırmalı incelenmesi	- Kesitsel, tek merkezli klinik araştırma - Katılımcılar: 31 Parkinson hastası (15 disfajik, 16 nondisfajik) ve 30 sağlıklı gönüllü - Değerlendirme yöntemleri: USG (ultrasonografi), klinik yutma değerlendirmesi, FEYÇ (Fiberoptik Endoskopik Yutma Çalışması) - Çalışma süresi: Mayıs - Aralık 2023	- Kinezyolojik bant uygulamasının yutma kasları (özellikle submental kaslar) üzerinde olumlu etkiler sağladığı gözlendi. Disfaji semptomu olan Parkinson hastalarında yutma fonksiyonları bant uygulaması sonrası iyileşme gösterdi. USG ile yapılan değerlendirmeler FEYÇ bulgularını destekledi. Kinezyolojik bant uygulaması Parkinson hastalarında yutma rehabilitasyonuna katkı sağlayabilecek potansiyel bir yöntem olarak değerlendirildi
Münih disfaji testi – parkinson hastalığı anketi'nin Türkçe versiyonunun güvenilirliği ve geçerliliği	MDT-PD ölçeğinin Türkçeye çevirisini yapmak. Türkçe'ye uyarlanan T-MDT-PD ölçeğinin güvenilirliğini (iç tutarlılık ve test-tekrar test) ve geçerliliğini	**Katılımcı Sayısı:** 60 İPH tanılı birey (Ortalama yaş: 64.45 ± 10.15 yıl). **Uygulanan Ölçekler:** T-MDT-PD, T-EAT-10, ve T-SWAL-QOL.	T-MDT-PD anketi, Parkinson'da disfaji semptomunu değerlendirmede güvenilir ve dilsel, psikometrik, aynılık olarak geçerli bir ölçektir. Tanısal geçerliliği yetersiz bulunmuştur. Parkinson hastalığındaki disfajinin tespitine katkı sağlayacağı düşünülmektedir.

	(dilsel, psikometrik ve tanısal geçerlilik) test etmek. Bu sayede, Parkinson hastalarında erken dönemde disfaji tespitini kolaylaştırmak ve uzmanların müdahalesini desteklemek.	**Objektif Değerlendirme:** 51 katılımcıya Videofloroskopi Yutma Çalışması (VFYÇ) yapılmış, IDDSI 0, 3, ve 7 kıvamları denenmiştir.	

SONUÇ

PH disfaji, yalnızca motor semptomlarla sınırlı kalmayıp, hastalık sürecinde zayıflayan bilişsel işlevler tarafından da olumsuz yönde etkilenen kompleks bir klinik tablodur. Yapılan sistematik tarama, Türkiye'de PH'de disfaji değerlendirmesinde bilişsel işlevler ile motor bozulmaların bütüncül bir yaklaşımla birlikte araştırıldığı çalışmalara rastlanmadığını ortaya koymuştur. Çalışmanın bulguları, PH araştırmalarının daha çok motor bozulmaya odaklandığını, bilişsel işlevler ile duygusal ve psikolojik faktörlerin etkilerinin ele alındığı kapsamlı ve bütüncül araştırmaların ise yetersiz kaldığını göstermektedir.

Disiplinler arası dağılım incelendiğinde, PH ile ilgili çalışmaların Nöroloji ve Fizyoterapi ve Rehabilitasyon alanlarında yoğunlaştığı; özellikle bilişsel bozukluğun tanı ve mekanizmasıyla olan ilişkisini gösteren güncel çalışmaların büyük bir kısmının (%56) Nöroloji alanından geldiği dikkat çekmektedir. Buna karşın, PH'de disfaji araştırmalarında DKT alanında yapılan yalnızca üç lisansüstü teze ulaşılması, bu alanda araştırma sayısının artırılması gerektiğini ve PH'de disfaji yönetiminde multidisipliner yaklaşım eksikliğini açıkça ortaya koymaktadır.

"Parkinson ve yutma" ile ilgili incelenen çalışmalarda, rehabilitasyon müdahaleleri veya bilişsel süreçlerin yutma üzerindeki etkisi gibi müdahaleye yönelik konular yerine, ağırlıklı olarak değerlendirme yöntemlerine odaklanıldığı görülmüştür. Bu durum, parkinsonda yutma çalışmalarında kanıta dayalı rehabilitasyon müdahalelerine yönelik çalışmaların artırılması gerekliliğine dikkat çekmektedir.

Sonuç olarak, disfajiyi sadece motor belirtilerin değil, aynı zamanda bilişsel işlevlerin bozulmasının da etkilemesi nedeniyle, sadece motor semptomlara odaklanmak PH'nin disfaji üzerindeki etkilerini tam olarak değerlendirmede yetersiz kalmaktadır. Bu nedenle, disfaji değerlendirmesinde bütüncül bir yaklaşım benimsenmesi, motor ve bilişsel işlevleri birlikte ele alarak psikososyal etmenleri göz önünde bulunduran çalışmaların artırılması gerekmektedir. PH'de güvenli yutma ve buna bağlı yaşam kalitesi gibi alanlarda bütüncül yaklaşımların planlanmasına, gelecekte yapılacak araştırmaların ışık tutması beklenmektedir.

KAYNAKÇA

1. Aksu, S. (2021). *Hafif kognitif bozukluk tanılı parkinson hastalarında transkraniyal elektriksel uyarımın bilişsel fonksiyonların üzerine etkisi* [Doktora Tezi, İstanbul Üniversitesi]. YÖK Ulusal Tez Merkezi. (Tez No. 674424)

2. Alkoy, S. (2024). *Parkinson hastalarında yutma performansı ile baş boyun artrokinematik özelliklerinin ilişkisi* [Yüksek Lisans Tezi, Hacettepe Üniversitesi]. YÖK Ulusal Tez Merkezi. (Tez No. 5862340)

3. Baki, N. (2024). *Kognitif bozukluğu olmayan parkinson hastalarında erken tanı amaçlı klinik karar destek sistemi geliştirilmesi* [Doktora Tezi, Karadeniz Teknik Üniversitesi]. YÖK Ulusal Tez Merkezi. (Tez No. 872508)

4. Bingöl, D. (2022). *Parkinson hastalarındaki yutma bozukluğunun yaşam kalitesine olan etkisinin belirlenmesi* [Yüksek Lisans Tezi, İstanbul Medipol Üniversitesi]. YÖK Ulusal Tez Merkezi. (Tez No. 1757513)

5. Çelebi, F. (2022). *Münih disfaji testi – parkinson hastalığı anketi'nin Türkçe versiyonunun güvenilirliği ve geçerliliği* [Yüksek Lisans Tezi, Anadolu Üniversitesi]. YÖK Ulusal Tez Merkezi. (Tez No. 2731104)

6. Çetin, B. (2024). *Parkinson hastalarında sanal gerçeklik temelli oyunların üst ekstremite ve gövde fonksiyonları ve kognitif durum üzerine etkisinin incelenmesi* [Doktora Tezi, Hacettepe Üniversitesi]. YÖK Ulusal Tez Merkezi. (Tez No. 845870)

7. Chaudhuri, K. R., Healy, D. G., & Schapira, A. H. (2006). Non-motor symptoms of Parkinson's disease: Diagnosis and management. *The Lancet Neurology*, *5*(3), 235–245. https://doi.org/10.1016/S1474-4422(06)70373-8

8. Cilli, E. (2023). *Parkinson hastalığında hafif kognitif bozukluk tanısına serum biyobelirteçlerinin katkısının değerlendirilmesi* [Tıpta Uzmanlık Tezi, Sağlık Bilimleri Üniversitesi]. YÖK Ulusal Tez Merkezi. (Tez No. 806176)

9. Coşkun, R. (2020). *Parkinson hastalığında ses ve yutma fonksiyonlarının değerlendirilmesi* [Yüksek Lisans Tezi, Ege Üniversitesi]. YÖK Ulusal Tez Merkezi. (Tez No. 7646407)

10. Daniels, S. K., Corey, D. M., & Anderson, J. A. (2011). Relationship of oral phase dysfunction to cognitive function in individuals with Parkinson’s disease. *Dysphagia*, *26*(3), 280–289. https://doi.org/10.1007/s00455-010-9306-0

11. Erten, K. (2025). *Tremor dominant olan ve olmayan Parkinson hastalarının cerebrum ve cerebellum hacimlerinin ölçülmesi ve hafif kognitif bozukluk ile ilişkisinin değerlendirilmesi* [Doktora Tezi, Karadeniz Teknik Üniversitesi]. YÖK Ulusal Tez Merkezi. (Tez No. 939493)

12. Esgin, Ö. (2023). *Yaşlı parkinson hastalarında mınd diyetine uyum, diyet antioksidan yükünün kognitif fonksiyon ve bazı biyokimyasal parametreler ile ilişkisi* [Doktora Tezi, Ankara Üniversitesi]. YÖK Ulusal Tez Merkezi. (Tez No. 828919)

13. Fernández, H. H., & Lapane, K. L. (2002). Predictors of mortality among nursing home residents with a diagnosis of Parkinson’s disease. *Medical Science Monitor*, *8*(4), CR241–CR246.

14. Güner, H. (2024). *Parkinson hastalarında ultrasonografik ve endoskopik yutma değerlendirilmesi, dizabilite ile ilişkisinin incelenmesi* [Tıpta Uzmanlık Tezi, İstanbul Medipol Üniversitesi]. YÖK Ulusal Tez Merkezi. (Tez No. 4852750)

15. Haj Ebrahimi, F. (2020). *Parkinson hastalığı'nda sanal gerçeklik uygulamasının motor ve kognitif semptomlar üzerine etkilerinin klinik ve rest-fmrı ile değerlendirilmesi* [Doktora Tezi, İstanbul Medipol Üniversitesi]. YÖK Ulusal Tez Merkezi. (Tez No. 629028)

16. Kalia, L. V., & Lang, A. E. (2015). Parkinson’s disease. *The Lancet*, *386*(9996), 896–912. https://doi.org/10.1016/S0140-6736(14)61393-3

17. Kurbeh, B. (2022). *Metaproteomic analysis of saliva samples from parkinson's disease patients with cognitive impairments* [Yüksek Lisans Tezi, İstanbul Medipol Üniversitesi]. YÖK Ulusal Tez Merkezi. (Tez No. 756702)

18. Kurt Türkoğlu, A. (2023). *Parkinson hastalarında kuvvet ve stabilite antrenman programının postüral kontrol ve kognitif fonksiyonları üzerine etkisi* [Doktora Tezi, Balıkesir Üniversitesi]. YÖK Ulusal Tez Merkezi. (Tez No. 775669)

19. Körlü, S. E. (2025). *Parkinson hastalığında 24 saatlik kan basıncı değişikliklerinin kognitif durum ve fonksiyonel manyetik rezonans görüntüleme'ye etkisi* [Tıpta Uzmanlık Tezi, Ondokuz Mayıs Üniversitesi]. YÖK Ulusal Tez Merkezi. (Tez No. 941202)

20. Macit, R. (2018). *Parkinson hastalarında yutma kaygısının anksiyete ve depresyonla olan ilişkisi* [Tıpta Uzmanlık Tezi, Sağlık Bilimleri Üniversitesi]. YÖK Ulusal Tez Merkezi. (Tez No. 9507984)

21. Otlu, M. (2024). *Parkinson hastalarında temporomandibular eklem disfonksiyonunun derin servikal kas enduransı, gövde pozisyon hissi ve yutma bozukluğu üzerinde etkisi* [Yüksek Lisans Tezi, Kırıkkale Üniversitesi]. YÖK Ulusal Tez Merkezi. (Tez No. 3883448)

22. Öngör Sönmez, Ö. (2024). *Bipolar bozukluğuna sahip ve kognitif bozukluğu olmayan parkinson hastalığına sahip 55 yaş üstü bireylerin sağlıklı kişilerle P300-olaya ilişkin potansiyel yöntemiyle karşılaştırılması* [Yüksek Lisans Tezi, Dokuz Eylül Üniversitesi]. YÖK Ulusal Tez Merkezi. (Tez No. 876777)

23. Özdemir, S. (2020). *Parkinson hastalığında klinik evre ve kognitif yıkım için retinal sinir lifi kalınlığı bir biyobelirteç olabilir mi?* [Tıpta Uzmanlık Tezi, Zonguldak Bülent Ecevit Üniversitesi]. YÖK Ulusal Tez Merkezi. (Tez No. 653638)

24. Savran, F. N. (2025). *Parkinson hastalarında kognitif fonksiyonların ve yaşam kalitesinin lateralizasyon öngörüsüyle değerlendirilmesi* [Yüksek Lisans Tezi, Manisa Celal Bayar Üniversitesi]. YÖK Ulusal Tez Merkezi. (Tez No. 976455)

25. Seçkinoğulları, B. (2024). *İdiyopatik parkinson hastalarında duyu-algı-motor eğitimin kognitif fonksiyonlar, denge ve yürüyüşe etkisinin incelenmesi* [Doktora Tezi, Hacettepe Üniversitesi]. YÖK Ulusal Tez Merkezi. (Tez No. 919120)

26. Şahin, F. M. (2024). *Derin beyin stimulasyonu uygulanan parkinson hastalarında ritmik işitsel uyarının kognitif ve motor yetenekler ile müzik algısı üzerine etkisi* [Doktora Tezi, Ondokuz Mayıs Üniversitesi]. YÖK Ulusal Tez Merkezi. (Tez No. 912796)

27. Tanrıverdi, Z. (2008). *Amyotrofik lateral skleroz ve parkinson hastalarında orofaringiyal yutma üzerine viskozite etkisinin bardaktan su içme ve diğer elektrofizyolojik yöntemlerle incelenmesi* [Tıpta Uzmanlık Tezi, Ege Üniversitesi]. YÖK Ulusal Tez Merkezi. (Tez No. 10175739)

28. Yakut, S. (2024). *Parkinson ve alzheimer hafif kognitif bozukluğu olan hastaların kognitif profillerinin karşılaştırılması* [Yüksek Lisans Tezi, İstanbul Medipol Üniversitesi]. YÖK Ulusal Tez Merkezi. (Tez No. 865375)

29. Yaşasın, E. (2022). *Parkinson hastalarında psikoz benzeri yaşantılar: Affektif profil, kognitif profil ve tedavi seçimi* [Tıpta Uzmanlık Tezi, Sağlık Bilimleri Üniversitesi]. YÖK Ulusal Tez Merkezi. (Tez No. 759830)

30. Yıldırım, E. (2021). *Parkinson hastalığı demans, alzheimer hastalığı demans ve lewy cisimcikli demans'ta kognitif fonksiyonların olaya-ilişkin EEG beyin osilasyonları ile incelenmesi* [Doktora Tezi, İstanbul Medipol Üniversitesi]. YÖK Ulusal Tez Merkezi. (Tez No. 710629)

31. Yılmaz Necati, E. (2019). *Parkinson hastalarında kinezyolojik bant uygulamasının yutma fonksiyonu üzerine olan etkinliğinin incelenmesi* [Doktora Tezi, Hacettepe Üniversitesi]. YÖK Ulusal Tez Merkezi. (Tez No. 8605339)

A COMPARATIVE STUDY ON ANTIOXIDANT POTENTIAL OF *Suillus collinitus* COLLECTED FROM TWO DIFFERENT LOCATIONS

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ABSTRACT

In this study, the antioxidant activities of extracts obtained from *Suillus colinitus* mushroom samples collected from two different locations using methanol at different concentrations were compared. The aim was to evaluate the effect of both ecological differences and solvent ratios on extraction yield and antioxidant activity. The mushroom samples (Sc-AU and Sc-NOHU) were collected, dried, ground into powder, and extracted using different methanol-water mixture ratios (10, 30, 50, 70, 100%). The total phenolic compound contents of the obtained extracts were determined using the Folin–Ciocalteu's phenol reagent method, while their antioxidant activities were determined using the DPPH free radical scavenging method. Accordingly, the highest phenolic compound content was determined to be 78.61±2.41 mg GAE/g DW in the Sc-AU sample extracted with 70% MeOH, while the lowest value was detected in the extract obtained from the Sc-NOHU sample with 10% MeOH at 47.21±0.66 mg GAE/g DW. In terms of DPPH free radical scavenging activity, the highest activity was measured in the Sc-AU sample extracted with 70% MeOH at 366.34±9.58 mg TE/g DW, while the lowest value was observed in the extract obtained from the Sc-NOHU sample with 30% MeOH at 243.23±1.53 mg TE/g DW. The results showed that the solvent ratio had a significant effect on the biological activities of the extracts. In both *S. collinitus* samples collected from the two locations, extracts obtained with 70% MeOH yielded the highest values for the parameters investigated. However, the Sc-AU sample was found to have a higher phenolic compound content and higher DPPH radical scavenging activity values compared to the Sc-NOHU sample. This study demonstrates that the biological activities of *Suillus collinitus* vary depending on both environmental factors and the type of solvent used. The findings indicate that *S. collinitus* has the potential to be evaluated in various biotechnological fields as a source of functional foods and natural bioactive compounds.

Keywords: *Suillus collinitus*, Ultrasound Assisted Extraction, Solvent Type, Antioxidant Activity

INTRODUCTION

Fungi are important organisms in terms of biological diversity and ecosystem functions, and have long been the focus of scientific research due to their nutritional and medicinal potential. Recent studies have revealed that macrofungi are particularly rich in phenolic compounds, flavonoids, ascorbic acid derivatives, tocopherols, and bioactive polysaccharides, and that these compounds exhibit potent antioxidant properties. The association of oxidative stress with many chronic diseases has further increased the importance of mushroom-derived natural antioxidants in functional food and pharmaceutical applications (Mwangi et al., 2022).

The genus Suillus belongs to the order Boletales and the family Suillaceae. This genus, which has a wide distribution worldwide, is of interest both for its ecological functions and because some of its species are edible. It consists mainly of fungi that form obligate ectomycorrhizal relationships with Pinus species (Tao et al., 2024). Additionally, ectomycorrhizal fungi can increase the drought tolerance of neighboring plants, particularly in Pinus forest areas. Recent studies have shown that species such as *Suillus luteus*, *S. granulatus*, and *S. collinitus* possess a significant antioxidant capacity, and this activity is largely related to phenolic content. However, data on the biological potential of the genus is still limited, and the need for species-based studies is emphasized (Aytar et al., 2020; Judžentienė and Šarlauskas, 2025).

Phenolic compounds are among the key determinants of antioxidant activity in mushrooms and exert their effects through mechanisms such as scavenging free radicals, metal chelation, and inhibiting oxidative chain reactions. *In vitro* studies conducted on Suillus species have revealed that antioxidant activities measured by methods such as DPPH, ABTS, and FRAP showed a positive correlation with total phenolic content. Furthermore, some Suillus extracts have been reported to exhibit antimicrobial, anti-inflammatory, and cytotoxic properties, indicating that this genus has a multifaceted potential in terms of biological activity (Soyuçok et al., 2022; Yao et al., 2022).

The extraction method, solvent type, temperature, and duration used to determine the antioxidant and biological activities of mushrooms play a decisive role in the results. Methanol, ethanol, water, and their mixtures are among the most commonly used extraction solvents; it has been reported that methanol and aqueous methanol extracts, in particular, yield more effective results in terms of phenolic compounds. Therefore, the application of standardized and comparable extraction protocols is crucial for accurately determining the biological activities of Suillus species (Nguyen et al., 2012; Sudha et al., 2016; Ünal et al., 2025).

In this study, it was aimed to compare the antioxidant potential of *Suillus collinitus* (Fr) Kuntze collected from two different locations in Türkiye. The fungal specimens were extracted with methanol at various concentrations (10%-Pure) by ultrasound ultrasound-assisted extraction method to determine the total content of phenolic compounds and free radical scavenging activities. The effect of environmental factors of growing areas and the solvent concentrations on the total content of phenolic compounds and antioxidant activity was investigated.

METHODOLOGY

Material

The fruiting bodies of the fungal samples were collected from Ankara University campus area under Pinus nigra J.F. Arnold (Pinaceae) in 2018 and from Niğde Ömer Halisdemir University campus area under Pinus sp. in 2023 (Fig 1). Identification of the samples were performed by Prof. Ilgaz AKATA according to the current literature (Breitenbach and Kranzlin, 2000; Cannon and Kirk, 2007). The samples were dried by a commercial vegetable dryer at low temperature (<40°C) and pulverized. The voucher samples were deposited in Ankara University Fungarium.

Fig 1. *Suillus collinitus* samples, collected from two different locations. (A) Sample from Ankara University campus area (B) Sample from Niğde Ömer Halisdemir University campus area.

Extract Preparation

One g of the powdered sample was mixed with 20 mL methanol:water (v:v) solvent at various concentrations namely Pure MeOH (10:0), 70 MeOH (7:3), 50 MeOH (5:5), 30 MeOH (3:7), and 10 MeOH (1:9). The mixture was homogenized at 8000 rpm for 2 min at ambient temperature using a homogenizer (HG-15D, Daihan Scientific, China). Then the homogenate was incubated at 30°C in an ultrasonic bath (Sonorex, Bandelin, Germany) for 30 min and overnight at ambient temperature in the dark. Following the incubation the mixture was centrifuged at 4000 rpm for 20 min and the supernatant was filtered through Whatman No. 1 filter papers. The obtained extracts were used for further analysis.

Determination of Total Phenolic Compounds

The total content of phenolic compounds was determined using Folin-Ciocaltesu's phenol reagent method (Singleton and Rossi, 1965). Briefly; 100 µL extract was added to 1 mL Folin-Ciocalteu's phenol reagent and incubated at ambient temperature for 5 min in the dark. Then, 1 mL 7.5% $NaCO_3$ solution was added and mixed thoroughly by a vortex. Following the incubation for 90 min at ambient temperature in the dark the absorbance of the bluish color formed in the test tube was measured at 765 nm using a spectrophotometer (MultiSkan GO, Thermo, USA). The results were presented as mean ± standard deviation in mg GAE/g DW.

Antioxidant Activity

The antioxidant activity of the *S. collinitus* extracts was determined by 2,2-diphenyl-1-picrylhydrazyl (DPPH) scavenging assay originally reported by Blois (1958), with some minor modifications (Silva et al., 2024). Briefly, 100 µL extract was added to 2.9 mL 0.1 mM DPPH methanol solution, mixed thoroughly and incubated at ambient temperature in the dark for 15 min. Following the incubation the absorbance of the test tube was measured by a spectrophotometer at 517 nm. The scavenging activity of the extract was calculated using the formula $\%SA = [(Abs_0 - Abs_{Sample})/Abs_0] \times 100$, where Abs0 is the absorbance of DPPH solution, Abs_{Sample} is the absorbance of DPPH solution mixed with *S. collinitus* extracts or methanol as control at 517 nm. A standard curve was prepared with various concentrations of Trolox and the results were presented as mean ± standard deviation in mg TE/g DW.

Statistical Analysis

The means between groups were compared using Duncan's multiple range test and one-way analysis of variance (ANOVA) at a significance level of $p<0.05$. Data evaluation was conducted using IBM Statistical Package for the Social Sciences (SPSS) software (Version 24.0, SPSS Inc., Chicago, IL, USA).

RESULTS and DISCUSSION

In this study, mushroom samples belonging to the Suillus genus were collected from the Ankara University campus area and the Niğde Ömer Halisdemir University campus area. Identification of the samples was performed due to the morphological characteristics such as size, shape, and color of the cap, stem, and spores. Based on the current literature data, both mushroom samples were identified by Prof. Ilgaz AKATA as *Suillus collinitus* (Fr)Kuntze.

This study investigated the effect of sampling location and solvent concentration on the total content of phenolic compounds (TPC) by Folin-Ciocalteu's phenol reagent assay and the antioxidant potential by free radical (DPPH) scavenging activity of *Suillus collinitus* species. The results showed that both *S. collinitus* samples collected from Ankara University and Niğde Ömer Halisdemir University campus areas (Sc-AU and Sc-NOHU, respectively) contained high amounts of phenolic compounds (Fig 2).

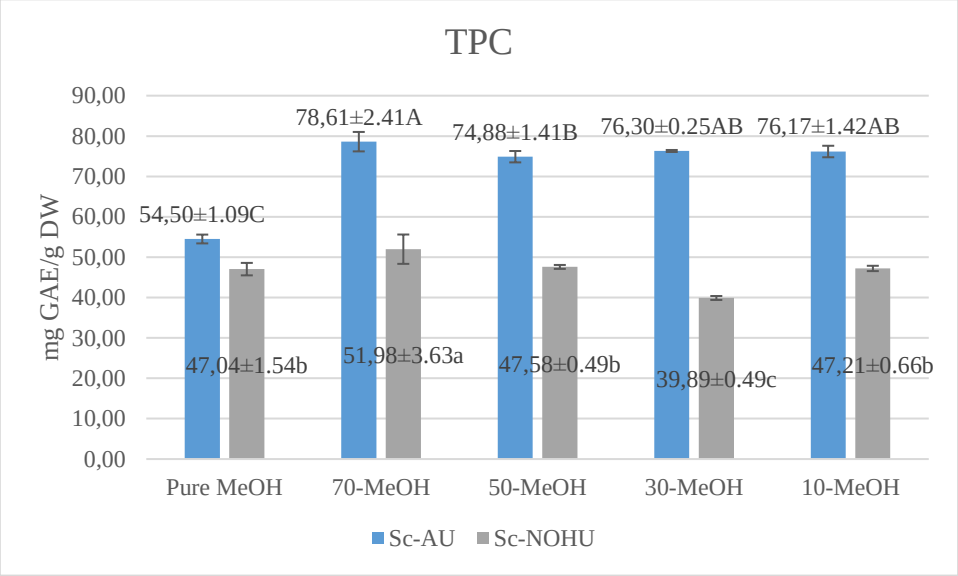

Fig 2. Total content of phenolic compounds extracted by methanol at various concentrations from *S. collinitus* collected from different locations. (The capital letters and lower case letters indicate the significant difference among the test groups at $p<0.05$)

In Fig. 2 the effect of solvent concentration on TPC was illustrated. The highest TPC value was determined in the Sc-AU sample extracted by 70% methanol with 78.61±2.41 mg GAE/g DW, while the lowest value was observed at the Pure-MeOH sample with 54.50±1.09 mg GAE/g DW for the Sc-AU sample. On the other hand, the Sc-NOHU sample was found to have less TPC than the Sc-AU sample, with the highest value of 51.98±3.63 mg GAE/g DW. The figure indicated that the highest

values for TPC in both samples were achieved at 70% MeOH concentration, which were significantly different compared to the other solvent concentrations at $p<0.05$. The significant difference among the groups in terms of solvent concentration suggested that the extraction process of phenolic compounds from *S. collinitus* samples was better achieved when the extraction solvent included water with methanol.

The antioxidant potential of *S. collinitus* samples was determined by DPPH radical scavenging activity and the results are presented in Fig 3.

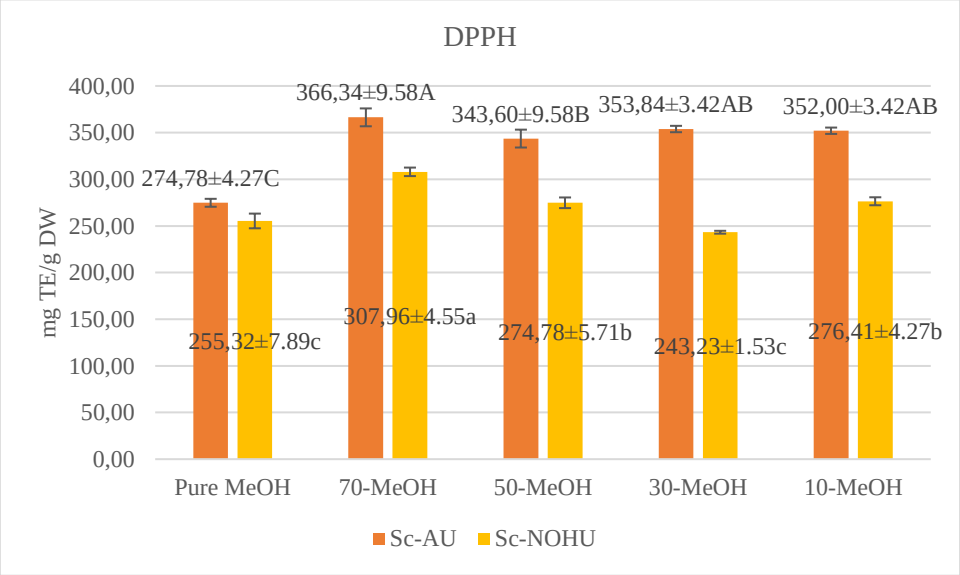

Fig 3. DPPH radical scavenging activity of *S. collinitus* samples collected from two different locations and extracted by methanol at various concentrations. (The capital letters and lower case letters indicate the significant difference among the test groups at $p<0.05$)

The effect of solvent concentration on DPPH radical scavenging activity was illustrated in Fig 3. The highest DPPH scavenging value was determined in the Sc-AU sample extracted by 70% methanol with 366.34±9.58 mg TE/g DW, while the lowest value was observed at the Pure-MeOH sample with 274.78±4.27 mg TE/g DW for the Sc-AU sample. However, the Sc-NOHU sample was found to exhibit less DPPH scavenging activity than the Sc-AU sample, with the highest value of 307.96±4.55 mg TE/g DW. The figure indicated that the highest values for DPPH scavenging activity in both samples were achieved at 70% MeOH concentration, which were significantly different compared to the other solvent concentrations at $p<0.05$.

The effect of solvent type and concentration (water, ethanol, and 1:1 water:ethanol) on TPC, antioxidant activity, and some biological activities of three different mushroom species (*Pleurotus ıstreatus*, *Ganoderma lucidum*, and *Agaricus brasiliensis*) was investigated by Torres-Martinez et al. (2021), in which the researchers found significant differences among the solvent types for the investigated parameters.

In another study investigating the effect of solvent type on total phenolic content, total flavonoid content and antioxidant activity was conducted with *Boletus edulis* and *Cantharellus cibarius* (Fogarasi et al., 2021). It was reported that aqueous extracts of both samples exhibited higher antioxidant activity with higher phenolic contents, while total flavonoids were extracted better with diethyl ether ($p<0.05$). The

authors also concluded that the obtained results were not only dependent on the solvent type but also dependent on some external factors such as sample preparation, extraction method, time, temperature, storage conditions…etc.

The results of both TPC content and DPPH scavenging activity also indicated that Sc-AU sample was superior to Sc-NOHU sample supporting the idea that environmental conditions of the sampling areas significantly ($p<0.05$) affect the content and activity of the bioactive compounds, even for the same species.

REFERENCES

Aytar, E. C., Akata, İ., & Açık, L. (2020). Antioxidant, antimicrobial and anti-proliferative activity of *Suillus luteus* (L.) Roussel extracts. Journal Of Faculty Of Pharmacy of Ankara University, 44(3), 373-387. https://doi.org/10.33483/jfpau.707014

Blois, M. S. (1958). Antioxidant determinations by the use of a stable free radical. *Nature*, *181*(4617), 1199-1200.

Breitenbach, J., & Kränzlin, F. (2000). Fungi of Switzerland: 5 Agarics. Fungi of Switzerland: 5 Agarics.

Cannon, P. F., & Kirk, P. M. (Eds.). (2007). Fungal families of the world. Cabi.

Fogarasi, M., Socaciu, M. I., Sălăgean, C. D., Ranga, F., Fărcaș, A. C., Socaci, S. A., ... & Semeniuc, C. A. (2021). Comparison of different extraction solvents for characterization of antioxidant potential and polyphenolic composition in *Boletus edulis* and *Cantharellus cibarius* mushrooms from Romania. *Molecules*, *26*(24), 7508. https://doi.org/10.3390/molecules26247508

Judžentienė, A., & Šarlauskas, J. (2025). Comparative research of antioxidant, antimicrobial, antiprotozoal and cytotoxic activities of edible *Suillus* sp. fruiting body extracts. Foods, 14(7), 1130. https://doi.org/10.3390/foods14071130

Mwangi, R. W., Macharia, J. M., Wagara, I. N., & Bence, R. L. (2022). The antioxidant potential of different edible and medicinal mushrooms. Biomedicine & Pharmacotherapy, 147, 112621. https://doi.org/10.1016/j.biopha.2022.112621

Nguyen, T. H., Nagasaka, R., & Ohshima, T. (2012). Effects of extraction solvents, cooking procedures and storage conditions on the contents of ergothioneine and phenolic compounds and antioxidative capacity of the cultivated mushroom *Flammulina velutipes*. International Journal of Food Science & Technology, 47(6), 1193-1205. https://doi.org/10.1111/j.1365-2621.2012.02959.x

Silva, F., Veiga, F., Cardoso, C., Dias, F., Cerqueira, F., Medeiros, R., & Paiva-Santos, A. C. (2024). A rapid and simplified DPPH assay for analysis of antioxidant interactions in binary combinations. *Microchemical Journal*, *202*, 110801. https://doi.org/10.1016/j.microc.2024.110801

Singleton, V. L., & Rossi, J. A. (1965). Colorimetry of total phenolics with phosphomolybdic-phosphotungstic acid reagents. *American journal of Enology and Viticulture*, *16*(3), 144-158.

Soyuçok, A., Doğantürk, M., Yavuz, O., Küçükiğci, C. B., & Kıyak, A. (2022). Suillus granulatus' tan elde edilen etanolik ekstraktın antioksidan ve antimikrobiyal aktivitelerinin belirlenmesi. MAE Vet Fak Derg, 7(1), 7-12. http://doi.org/10.5344/ajev.1965.16.3.144

Sudha, G., Janardhanan, A., Moorthy, A., Chinnasamy, M., Gunasekaran, S., Thimmaraju, A., & Gopalan, J. (2016). Comparative study on the antioxidant activity of methanolic and aqueous extracts

from the fruiting bodies of an edible mushroom *Pleurotus djamor*. Food science and biotechnology, 25(2), 371-377. http://doi.org/10.1007/s10068-016-0052-4

Tao, J.; Wang, X.; Long, Y.; Gao, Z.; Zhang, G.; Guo, Z.; Wang, G.; Xu, G.; Wang, Y.; Liu, H. Determining gene order patterns in the *Suillus* and *Boletale*s through comparative analysis of their mitogenomes. Int. J. Mol. Sci. 2024, 25, 9597. https://doi.org/10.3390/ijms25179597

Torres-Martínez, B. D. M., Vargas-Sánchez, R. D., Ibarra-Arias, F. J., Ibarra-Torres, E. V., Torrescano-Urrutia, G. R., & Sánchez-Escalante, A. (2021). Effect of extraction solvent on chemical composition, physicochemical and biological properties of edible mushrooms extracts. *TIP. Revista especializada en ciencias químico-biológicas*, *24*.

Ünal, O., Gürgen, A., Krupodorova, T., Sevindik, M., Kabaktepe, Ş., & Akata, I. (2025). Optimization of *Phellinus hartigii* extracts: Biological activities, and phenolic content analysis. BMC Complementary Medicine and Therapies, 25(1), 113. https://doi.org/10.1186/s12906-025-04851-9

Yao, L.; Lv, J.-H.; Li, J.-P.; An, X.-Y.; Cheng, G.-H.; Li, C.-T.; Li, Y. Chemical constituents from mushroom *Suillus luteus* (Agaricomycetes) and their bioactivities. Int. J. Med. Mushrooms 2022, 24, 63–71. http://doi.org/10.1615/IntJMedMushrooms.2022045041

INVESTIGATION OF THE APHIDICIDAL ACTIVITY OF PLANT EXTRACTS

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ABSTRACT

Aphids are small insects that can infest many herbaceous and woody plants, feeding on phloem sap. In addition to causing direct feeding damage to the host plant, they also cause serious economic losses in agricultural production by playing a role in the transmission of many plant viruses. Synthetic pesticides have been used effectively for many years to control aphids. However, as a result of the intensive and unconscious use of these chemicals, resistance development, environmental pollution, adverse effects on non-target organisms and risks to human health have become increasingly apparent. This has increased interest in alternative, environmentally friendly, and sustainable control methods.

This study evaluated the aphicidal activity of extracts obtained from various plants on aphids based on current literature data. Studies have reported that extracts from many plants, including thyme, garlic, bay laurel, eucalyptus, mint, rosemary, and clove, have high mortality rates on important aphid species such as Myzus persicae, Aphis gossypii, and Brevicoryne brassicae. It is emphasized that aphicidal activity varies depending on the plant species, solvent, extraction methods, application method, and concentration. Furthermore, secondary metabolites such as phenolic compounds, terpenoids, alkaloids, and essential oils are reported to play a key role in aphicidal activity.

In conclusion, plant-derived extracts appear to have the potential to provide a reliable, sustainable and low-toxicity alternative that preserves the ecological balance in the fight against aphids. However, further research is needed to elucidate their mechanisms of action in detail, develop standard formulations, and clearly determine their effectiveness under field conditions.

Keywords: Aphid, Aphidicidal activity, Plant extracts, Biopesticides, Natural insecticides

INTRODUCTION

Aphids (Hemiptera: Aphidoidea) are serious pests that can form dense colonies on many herbaceous and woody plants, as well as ornamental plants, primarily agricultural crops, worldwide. They damage their hosts directly by feeding on the phloem sap and indirectly by acting as transporters of various plant viruses. Furthermore, feeding on the phloem sap, which is rich in carbohydrates and poor in amino acids, results in the production of honeydew. This honeydew can suppress the plant's photosynthetic capacity, negatively impacting the host's development and promoting fungal growth (Olcabey Ergin et al. 2024). Thanks to their cyclical parthenogenesis and telescopic generation characteristics, aphids can quickly reach very large numbers, expand their distribution areas, and thus easily become classified as pests (Hales et al. 2013). In Türkiye, where aphids are represented by approximately 680 species, chemical pesticide applications are widely used in pest control (Olcabey Ergin 2025). However, due to the disadvantages of chemical agents such as causing environmental pollution, harming non-target organisms, and developing resistance, eco-friendly biological control methods have rapidly increased in importance (Botto, 1999). One of the alternative strategies to chemical insecticides is the use of plant-derived extracts, which are generally more selective, biodegradable, and have little or no harmful effects

on non-target organisms. Plant-based products are increasingly used in pest control (Bharti and Chandel 2017; Czerniewicz et al. 2016).

Plant-derived biopesticides are obtained from numerous plant species that possess bioactive components capable of controlling many insect pests belonging to approximately 60 families, providing protection against plant diseases, and being commercially available. Most plant-derived substances are very low to moderately toxic to the environment and can decompose much faster than chemical pesticides. Using plant extracts in various applications (such as feeding inhibitors, repellents, and fumigants) can lead to high mortality rates in insect pests (Ahmed, 2022).

The use of plant extracts in aphid control

Synthetic insecticides have been used effectively to control aphids for many years. However, the intensive and indiscriminate use of these chemicals has led to increasingly significant developments in resistance, environmental pollution, negative effects on non-target organisms, and risks to human health. This situation has increased interest in alternative, environmentally friendly, and sustainable control methods. Biodegradable plant extracts have many advantages compared to chemical pesticides. Research supports this: for example, the insecticidal effect of *Juglans regia* L. extracts against different types of pests has been reported in some studies (Zhai et al. 2006; Chrzanowski et al. 2012). In addition, active compounds obtained from *Mentha piperita* L. showed a repellent effect against *Brevicoryne brassicae* L. (Mekuaninte et al. 2011) and were toxic against *Tetranychus cinnabarinus* Boisd. (Ren et al. 2012). Various data exist regarding the insecticidal properties of *Hypericum perforatum* L. (Al-mazra'awi & Ateyyat, 2009) and *Sambucus nigra* L. (Ciepielewska et al. 2005; Ertürk & Uslu 2007) extracts. Li et al. (2022) investigated a novel botanical insecticide, *Eleocharis dulcis* peel extract, in terms of its active compounds against different aphid species and identified nine different active compounds. They also stated that *E. dulcis* peel extract has high insecticidal activity against *Sitobion avenae*, *Aphis gossypii*, *Megoura crassicauda*, and *Acyrthosiphon pisum*.

Akbar et al. (2016), in a study evaluating the efficacy of different plant extracts (aak (*Calotropis procera*), gul-e-daudi (*Chrysanthemum indicum*), garlic (*Allium sativum*), and knair (*Thevetia peruviana*)) on the aphid *Lipaphis erysimi* infesting canola plants, found that aak extract was the most effective, significantly reducing the aphid population (54.91%), followed by gul-e-daudi (49.55%). Garlic and knair showed the lowest insecticidal activity, recording reductions of 39.41% and 28.07%, respectively. Although garlic and knair were found to be the least effective, they had a significantly greater insecticidal effect compared to the control group.

Various toxic substances naturally produced by plants, such as terpenoids, cucurbitacin, glycosides, and flavonoids, have a positive effect on aphid control. The amount of toxic substances produced can vary in different parts of the plant. Therefore, a detailed examination of the chemical composition of different parts of the plant to be used before application will increase the success of the control. Asiry (2015) investigated the effects of five different concentrations of aqueous extracts obtained from different parts of the *Citrullus colocynthis* apple plant (root, stem, leaf, and fruit) on the *Rhopalosiphum padi* (L.) aphid species under laboratory conditions. The results showed that the aqueous extracts obtained from different parts of *C. colocynthis* differed significantly in reducing the number of *R. padi*. The stem caused a higher mortality rate in *R. padi* compared to other parts. This study is the first to demonstrate that *C. colocynthis* stems have a higher toxic effect in aphid control, suggesting that this part of the *C. colocynthis* plant may contain important chemical compounds that could be used as an alternative and sustainable method to synthetic insecticides for aphid control (Asiry, 2015).

When preparing plant extracts, organic solvents such as ethanol, methanol, and acetone, as well as inorganic solvents such as water and sulfuric acid, can be used (Asiry, 2015; Moawad and Al-Barty 2011). Even the solvent used can have a different lethal effect on aphids. For example, the methanol extract prepared from *Cannabis sativa* leaves has a greater lethal effect on the wheat aphid *Rhopalosiphum maidis* and *Sitobion avenae* (Mondal et al. 2025), and the alcohol extracts of *Ruta chalepensis* (the whole plant) and *A. lanata* (leaves) show better repellent and lethal effects against the pomegranate aphid *Aphis punicae* compared to their water extracts. Moawad and Al-Barty (2011) evaluated ethanol and water extracts of five medicinal and ornamental plant species—*Aerva lanata*, *Ruta chalepensis*, *Fagonia arabica*, *Malva parviflora*, and *Calotropis procera*—on *Aphis punicae* under laboratory conditions. In extracts prepared using the entire plant at the same concentration, the ethanol extract of *R. chalepensis* showed a high repellent effect (75%) and mortality rate (79.5%). The repellent effect of the other plant extracts varied between 36-60%, and the mortality rate between 50-55%. In their study, Yousuf et al. (2023) investigated the lethal activity of the medicinal plants *Artemisia absinthium*, *Euphorbia helioscopia*, *Iris germanica*, *Mentha longifolia*, and *Viola odorata* against *Macrosiphum rosae*. Aqueous extracts were prepared from the plants at three different concentrations, and their lethal effects were evaluated in vitro. The toxicity order of the plant extracts was recorded as *Mentha*, *Viola*, *Artemisia*, *Iris*, and *Euphorbia*. It was concluded that all the plant extracts used could be developed as biological pesticides against *Macrosiphum rosae* without major concerns about environmental conditions. It is thought that the lethal efficacy of the plant extracts prepared using organic and inorganic solvents will vary, and that temperature will also cause differences in this effect. The lethal activity of hot and cold water extracts of some plants against *Aphis craccivora* Koch. was tested. Hot water extracts prepared with the plants used were found to be more effective than cold water extracts (Das et al. 2008).

Natural phenolic acid mixtures obtained from plants have been determined to have repellent-deterrent and lethal effects on aphids. Phenolic acid mixtures obtained from *Hypericum perforatum* (L.), *Juglans regia* (L.), *Mentha piperita* (L.), and *Sambucus nigra* (L.) plants were tested on the aphid species *Myzus persicae* (Sulz.) and *Rhopalosiphum padi* (L.); the findings showed that the phenolic mixtures negatively affected the development of both aphid species (Czerniewicz et al. 2016). The use of synthetic insecticides in organic systems is officially banned, which makes it difficult to control common species, especially *Aphis gossypii*. Bharti and Chandel (2017) tested the effectiveness of 10 different plant extracts in the control of *Aphis gossypii*. In a study conducted in okra fields, the mortality rates of aphid nymphs and adults were monitored using three different doses of each plant extract. The effectiveness of the extracts varied between 40.37% and 75.77%, and these findings demonstrated that plant extracts can be effectively used in the control of *Aphis gossypii*.

The use of essential oils in aphid control

Aphids, which use a wide variety of plants as hosts, including herbaceous and woody plants as well as ornamental plants, especially those of agricultural importance, are considered a significant pest of many crops. Control of this pest relies primarily on synthetic insecticides; however, the negative effects of these insecticides on the environment and human health are encouraging researchers to seek innovative, alternative solutions. In this scenario, essential oils can play a significant role in the development of environmentally friendly insecticides.

Essential volatile oils are a mixture of various compounds effective against insect pests. Many studies have shown that their components, produced through complex mechanisms, are a potent source of biological pesticides. Albouchi et al. (2018) characterized the chemical composition (GC-MS) of the essential oil of *Melaleuca styphelioides* leaves grown in Tunisia and evaluated its lethal activity against

the aphid species *Aphis gossypi*, *Aphis spiraecola*, and *Myzus persicae*. The *M. styphelioides* essential oil, whose chemical composition consists of caryophyllene oxide, spatulenol, isoaromatendrene epoxide, ledol, and α-pinene, was shown to have good fumigant and contact toxicity against the three citrus aphid species tested.

Papadimitriou et al. (2019) investigated the potential of *Mentha pulegium* essential oils, representing pulegon (EO1) and piperiton (EO2) chemotypes, in controlling aphid species *Aphis gossypii*, *Aphis spiraecola*, and *Tetranychus urticae*. In applications using spray technique under greenhouse conditions, mortality rates varied between 40-80% compared to the control group. Ahmed (2022) evaluated the insecticidal activity of essential oil obtained from tea tree leaves by steam distillation method on cotton aphid (*Aphis gossypii*) under laboratory and greenhouse conditions; it showed that tea tree essential oil affected the aphid population and increased the mortality rate of A. *gossypii*.

In the study by Kirişik et al. (2024), three herbal essential oils obtained from thyme (*Thymus vulgaris* L.), orange (*Citrus sinensis* L.), and bay leaf (*Laurus nobilis* L.) were evaluated individually, in binary or ternary combinations, for fumigant and contact toxicity against adult *Aphis gossypii*. The study revealed that all tested essential oils, both individually and in all binary and ternary combinations, showed fumigant and contact toxicity depending on the concentration. However, in fumigant toxicity tests, the mortality rates of adult *A. gossypii* increased proportionally with increasing concentration and exposure time. Overall, it was noted that binary and ternary combinations of the oils were more toxic than oils used alone and that their combined use in the control of *A. gossypii* could yield promising results. However, testing these laboratory studies under field conditions would make the results more meaningful and valuable.

Hakimi and his team (2024) analyzed essential oils obtained from Algerian medicinal plants by GC-MS and determined that the main components of each essential oil were α-pinene, β-pinene, 1,8-cineol, linalool, linalyl acetate, fenchone, pulegon, and camphor. They also tested the insecticidal activity of essential oils obtained from *Juniperus phoenicea*, *Rosmarinus officinalis*, *Lavandula stoechas*, *Mentha pulegium*, and *Pinus sylvestris* against *Aphis gossypii* Glover and found that the toxicity of the essential oils against *Aphis gossypii* varied depending on the concentration used, the duration of exposure, and the chemical composition of the oil. The highest toxicity was observed in *J. phoenicea*, *M. pulegium*, and *L. stoechas*.

CONCLUSION AND DISCUSSION

In aphid control, the harm caused by chemical applications to soil, air, water, humans, and other non-target organisms cannot be ignored. Therefore, the importance of new, clean, and sustainable practices that have been and will be developed is steadily increasing. The fact that plant-derived products such as phenolic compounds, terpenoids, alkaloids, and essential oils are easily biodegradable and cause little to no harm increases their potential for use in pest control. However, examining the chemical composition of plants in terms of various compounds and their potential effects on the natural enemies of pests through more detailed and long-term studies is crucial for sustainability. Furthermore, all these findings – elucidating the chemical composition of plant extracts and essential oils and testing them on aphids – are promising for future research, as they have the potential for commercial market launch.

Studies have shown that plant extracts and essential oils have significant potential in aphid control. However, most of these studies are conducted under laboratory conditions. Biotic and abiotic factors

in the study area can alter the repellent or toxic effects of plant extracts, essential oils, and other compounds on aphids. Therefore, conducting studies under field conditions is crucial.

REFERENCES

Ahmed, Q. (2022). Evaluation of tea tree extract formulation for the control of the cotton aphid, *Aphis gossypii* (Homoptera: Aphididae) on *Capsicum annuum* in the glasshouse. *Journal of Biopesticides*, 15(1), 31-38.

Akbar, W., Asif, M. U., Muhammad, R., & Muhammad, T. (2016). Bio-efficacy of different plant extracts against mustard aphid (*Lipaphis erysimi*) on canola. *Pak. J. Entomol*, 31(2), 189-196.

Albouchi, F., Ghazouani, N., Souissi, R., Abderrabba, M., & Boukhris-Bouhachem, S. (2018). Aphidicidal activities of Melaleuca styphelioides Sm. essential oils on three citrus aphids: Aphis gossypii Glover; Aphis spiraecola Patch and Myzus persicae (Sulzer). *South African Journal of Botany*, 117, 149-154.

Al-mazra'awi, M. S., & Ateyyat, M. (2009). Insecticidal and repellent activities of medicinal plant extracts against the sweet potato whitefly, Bemisia tabaci (Hom.: Aleyrodidae) and its parasitoid Eretmocerus mundus (Hym.: Aphelinidae). Journal of Pest Science, 82(2), 149-154.

Asiry, K. A. (2015). Aphidicidal activity of different aqueous extracts of bitter apple Citrullus colocynthis (L.) against the bird cherry-oat aphid, *Rhopalosiphum padi* (L.)(Homoptera: Aphididae) under laboratory conditions. *JAPS: Journal of Animal & Plant Sciences*, 25(2).

Bharti, A., & Chandel, B. S. (2017). Aphidicidal compatibility of certain ecofriendly asteraceous biorational extractives against okra aphid, *Aphis gossypii* Glover (Hemiptera: Aphididae) under field conditions. *International Journal of Fauna and Biological Studies*, 4(3): 125-132.

Botto, E. (1999). Control biologico de plagas horticolas en ambientes protegidos. Rev. Soc. Ent. Arg., 58: 58-64.

Chrzanowski, G., Leszczynski, B., Czerniewicz, P., Sytykiewicz, H., Matok, H., Krzyzanowski, R. and Sempruch, C. (2012). Effect of phenolic acids from blackcurrant, sourcherry and walnut on grain aphid (Sitobion avenae F.) development. *Crop Protection*, 35, 71-77.

Ciepielewska, D., Kordan, B., & Nietupski, M. (2005). Effect of plant extracts on some stored product insect pests. *Polish Journal of Natural Sciences*, 18 (1), 7-14.

Czerniewicz, P., Chrzanowski, G., Sytykiewicz, H., Sprawka, I., & Leszczynski, B. (2016). Aphidicidal and deterrent activity of phenolic acid extracts from some herbal plants towards *Myzus persicae* Sulz. and *Rhopalosiphum padi* L. Fresenius Environ. Bull, 25, 5714-5721.

Das, B. C., Sarker, P. K., & Rahman, M. M. (2008). Aphidicidal activity of some indigenous plant extracts against bean aphid *Aphis craccivora* Koch (Homoptera: Aphididae). *Journal of Pest Science*, 81(3), 153-159.

Ertürk, Ö., & Uslu, U. (2007). Antifeedant, growth and toxic effects of some plant extracts on Leptinotarsa decemlineata (Say.)(Coleoptera, Chrysomelidae). Fresenius Environ. Bull, 16(6), 602-608.

Hakimi, S., Araj, S. E., Ateyyat, M. A., Bounechada, M., Demirtas, I., & Gul, F. (2024). Analysis of Essential Oils Extracted from Algerian Medicinal Plants and Their Aphicidal Effect Against the Melon Aphid *Aphis Gossypii* Glover (Homoptera: Aphididae). *Jordan Journal of Agricultural Sciences*, 20(3), 158-172.

Hales, D. F., Tomiuk, J., Wöhrmann, K., & Sunnucks, P. (2013). Evolutionary and genetic aspects of aphid biology: a review. EJE, 94(1), 1-55.

Kirişik, M., Çinar, O., & Erler, F. (2024). Comparative fumigant and contact toxicities of single, binary and tertiary combinations of three plant essential oils against *Aphis gossypii* Glover (Hemiptera: Aphididae). *Journal of Plant Diseases and Protection*, 131(2), 413-421.

Li, J., Wang, M., Zhao, Y., Yu, H., Zhang, X., Feng, Y., ... & Ma, S. (2022). Potent insecticidal activity of Eleocharis dulcis peel extract and its main components against aphids.(on preprint)

Mekuaninte, B., Yematawa, A., Alemseged, T. & Nagappan, R. (2011). Efficacy of *Melia azadarach* and *Mentha piperita* plant extracts against cabbage aphid, *Brevicoryne brassicae* (Homoptera: Aphididae). *World Applied Sciences Journal*, 12, 2150-2154.

Moawad, S. S., & Al-Barty, A. M. (2011). Evaluation of some medicinal and ornamental plant extracts toward pomegranate aphid, Aphis punicae (Passerini) under laboratory conditions. *African Journal of Agricultural Research*, 6(10), 2425-2429.

Mondal, P. C., Salim, R., Kaushik, P., Pankaj, Timmanna, H., Shakil, N. A., & Rana, V. S. (2025). Phytochemical, Nematicidal, and Aphidicidal Studies of the Leaves of *Cannabis sativa* L. *ACS Agricultural Science & Technology*, 5(11), 2132-2143.

Olcabey Ergin, G., Bozkurt, Y., Başer, G., Canpolat, E. Y., Görür, G., & Öztürk, A. (2024). Effect of Honeydew Secreted by Aphis gossypii Glover (Hemiptera: Aphididae) on Fungal Growth. Turkish Journal of Agriculture-Food Science and Technology, 12(s4), 2817-2822.

Olcabey Ergin, G. (2025). Determined aphid species from Ardahan Province with three new records for Türkiye aphid (Hemiptera: Aphidoidea) fauna. Artvin Çoruh Üniversitesi Orman Fakültesi Dergisi, 26(1).

Papadimitriou, D. M., Petrakis, E. A., Arvaniti, K. A., Kimbaris, A. C., Polissiou, M. G., & Perdikis, D. C. (2019). Comparative bioactivity of essential oils from two *Mentha pulegium* (Lamiaceae) chemotypes against *Aphis gossypii*, *Aphis spiraecola*, *Tetranychus urticae* and the generalist predator *Nesidiocoris tenuis*. *Phytoparasitica*, 47(5), 683-692.

Ren, J., Shi, G., Ma, L., Liu, Y. & Wang, Y. (2012). Effects of *Mentha piperita* extracts on activities of several enzymes of *Tetranychus cinnabarinus*. In: Zhu, E. and Sambath, S. (Eds.) Information Technology and Agricultural Engineering. Springer-Verlag Berlin Heidelberg, Germany, pp. 577-588.

Yousuf, I., Buhroo, A. A., & Nisa, G. (2023). Lethal effects of therapeutic plant extracts against rose aphid, *Macrosiphum rosae* (L.)(Hemiptera: Aphididae). *Munis Entomology & Zoology*, 18(1), 542-551.

Zhai, Z.M., Zhang, F.Y., Wei, H.H. and Wang, W. (2006) A study on the bioactivity of secondary metabolites from walnut green hull. *Journal of Northwest Forestry University*, 21, 122-125.

KLİNİK UYGULAMA ve ARAŞTIRMADA SANAL GERÇEKLİK: HEMŞİRELİK BAKIŞ AÇISI

VIRTUAL REALITY in CLINICAL PRACTICE and RESEARCH: A NURSING PERSPECTIVE

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ÖZ

Sanal gerçeklik, kullanıcıların kendilerini gerçekten o dünyadaymış gibi hissettirecek şekilde sanal bir ortamı keşfetmelerine ve onunla etkileşime girmelerine olanak tanıyan bilgisayar tarafından oluşturulmuş bir simülasyon olarak tanımlanabilir. Sanal gerçeklik, endüstrileri ve pazarları tamamen değiştirme ve katılımcılar arasındaki etkileşimi değiştirebilme potansiyeline sahip, gelişmekte olan güncel bir teknolojidir. Sanal gerçeklik, bakış açısını ve gerçekliği değiştirerek hemşirelerin hasta koşullarını daha iyi belirlemelerine ve daha iyi bakım uygulamalarına yardımcı olabilir. Sanal gerçeklik, bireylerin hayatlarından daha olumlu düşünceler ve duygular deneyimleyebilecekleri hoş ortamlara "kaçmalarına" izin vererek hastalığın bazı olumsuz yönlerini hafifletme potansiyeline sahiptir. Yukarıda sunulan bilgiler doğrultusunda; sağlık sektörü ve hemşirelik mesleği için sanal gerçeklik kavramının gelecekte önemli bir yere sahip olacağı aşikardır. Literatür incelendiğinde klinik uygulama ve araştırmada sanal gerçeklik: hemşirelik bakış açısına yönelik çalışmaların sınırlılığı göze çarpmaktadır. Bu nedenle sunulan derlemenin amacı sanal gerçekliği gözden geçirmek ve hemşirelikteki yerini irdelemektir. Google Scholar, PubMed, Cochrane, Web of Science ve YÖK Tez veri tabanlarında “sanal gerçeklik”, “sağlık hizmetlerinde sanal gerçeklik”, “hemşirelikte sanal gerçeklik”, “virtual reality”, “virtual reality in healthcare”, “virtual reality in nursing” ve “hemşirelik” anahtar kelimeleri ile literatür taraması yapılmıştır. Bu derlemenin klinik uygulama ve araştırmada sanal gerçeklik: hemşirelik bakış açısı başlığını tüm yönleriyle ele alması, kapsamı ve alt boyutlarının detaylı olarak incelenmesi açısından planlanan araştırmalara yol gösterici olması beklenmektedir.

Anahtar kelimeler: Hemşirelik, sanal gerçeklik, sağlık hizmetlerinde sanal gerçeklik, hemşirelikte sanal gerçeklik

ABSTRACT

Virtual reality can be defined as a computer-generated simulation that allows users to explore and interact with a virtual environment in a way that makes them feel as if they were actually in that world. Virtual reality is an emerging technology that has the potential to completely disrupt industries and markets and change the interaction between participants. By altering perspective and reality, virtual reality can help nurses better assess patient conditions and provide better care. Virtual reality has the potential to alleviate some of the negative aspects of illness by allowing individuals to "escape" their lives to pleasant environments where they can experience more positive thoughts and emotions. Based

on the information presented above, it is clear that virtual reality will play a significant role in the healthcare sector and the nursing profession in the future. A review of the literature reveals a limited number of studies focusing on virtual reality in clinical practice and research from a nursing perspective. Therefore, the purpose of this review is to review virtual reality and examine its place in nursing. A literature search was conducted using the keywords "virtual reality," "virtual reality in healthcare," "virtual reality in nursing," "virtual reality," "virtual reality in healthcare," "virtual reality in nursing," and "nursing" in Google Scholar, PubMed, Cochrane, Web of Science, and the Council of Higher Education (YÖK) thesis databases. This review is expected to cover the topic of virtual reality in clinical practice and research: a nursing perspective in all its aspects and to guide planned research in terms of examining its scope and sub-dimensions in detail.

Keywords: Nursing, virtual reality, virtual reality in healthcare, virtual reality in nursing

GİRİŞ

Hemşirelik, insan sağlığı ve refahının ayrılmaz bir parçası olarak sahip olduğu ideal değerlere dayanan bir bilgi disiplini ve uygulama mesleğidir. Yirmi birinci yüzyılda robot teknolojisi ve yapay zekanın gelişmesi hemşirelik uygulamalarını etkilemektedir. (Locsin ve Ito, 2018). Hemşirelikte, sanal gerçeklik teknolojisi öncelikle simülasyon tabanlı beceri eğitimi ve uzaktan eğitim gibi hemşirelik eğitiminde kullanılmıştır (Son ve ark. 2022).

Sanal Gerçeklik TDK ye göre “Yapay zekâ kullanılarak 360 derece görüş imkânı sağlayan sanal bir küre içerisinde gerçek ortamların taklitlerinin verilmesiyle oluşturulan, gerçek olmayan ortamların gerçekmiş gibi deneyimlenebildiği, karmaşık sorunları çözme, bilgi aktarımı, eğlence vb. amaçlarla kullanılan üç boyutlu ortam” olarak tanımlanmaktır (https://sozluk.gov.tr/ erişim tarihi:26.12.2024). Sanal gerçeklik, kullanıcıların kendilerini gerçekten o dünyadaymış gibi hissettirecek şekilde sanal bir ortamı keşfetmelerine ve onunla etkileşime girmelerine olanak tanıyan bilgisayar tarafından oluşturulmuş bir simülasyon olarak tanımlanabilir (Leggiero 2020). Günümüzde sanal gerçeklik, kullanıcıların 'sanal dünyaya' geçiş yapmalarını sağlayan, gelişmiş bir teknolojik sistem olarak açıklanmaktadır. Kullanıcılar, kafaya takılan bir ekran (HMD), ses / müzik ve gürültü azaltma özellikli kulaklıklar, joystick veya sanal ortamın manipülasyonu / sanal gerçeklik navigasyonu için başka bir cihaz da dahil olmak üzere teknolojilerin bir kombinasyonu ile tamamen etkileyici bir sanal gerçeklik deneyimi yaşamaktadırlar (Tuna ve Öskan 2022).

Sanal gerçeklik, endüstrileri ve pazarları tamamen değiştirme ve katılımcılar arasındaki etkileşimi değiştirebilme potansiyeline sahip, gelişmekte olan güncel bir teknolojidir (Kulkov ve ark. 2021). Sanal gerçeklik, bakış açısını ve gerçekliği değiştirerek hemşirelerin hasta koşullarını daha iyi belirlemelerine ve daha iyi bakım uygulamalarına yardımcı olabilir (Plotzky ve ark. 2021). Bireylerin hayatlarından daha olumlu düşünceler ve duygular deneyimleyebilecekleri hoş ortamlara "kaçmalarına" izin vererek hastalığın bazı olumsuz yönlerini hafifletme potansiyeline sahiptir (Leggiero 2020). Son yıllarda VR uygulamalarının geliştirildiği ve psikiyatri ve davranışsal tıbbın birçok alanına, özellikle anksiyete bozukluklarının, travma sonrası stres bozukluğunun (TSSB) ve ağrı yönetiminin tedavisi için entegre edildiği görülmüştür (Vincent ve ark. 2021).

KAVRAMSAL ÇERÇEVE

SANAL GERÇEKLİK KAVRAMI

Sanal Gerçeklik, "bilgisayarda oluşturulmuş görüntü ve seslerden oluşan ve o dünyayı deneyimleyen bir bireyin eylemlerinden etkilenen yapay bir dünya" olarak tanımlanmaktadır. (Son ve ark. 2022). Sanal gerçeklik, dijitalleştirilmiş bir dünyada gerçekçi ortamları yeniden yaratan ve insanların bu yeni ortamla aktif olarak etkileşime girmeleri için fırsat sağlayan bir bilgisayar teknolojisi biçimidir (Kılıç ve ark. 2021). Sanal Gerçeklik etkileşimli üç boyutlu görselleştirme sağlama yeteneğine sahip bir bilgisayar,

animasyonlarla etkileşim için bir kontrol cihazı, bir konum izleyici ve görsel çıktıyı iletmek için başa takılan bir ekran (HMD) içeren belirli bir teknolojik sistemi ifade eder (İoannou ve ark. 2020).

Sanal gerçeklik teknolojisinin tarihsel süreci 1962 yılında Mortan Heilig tarafından ilk çoklu duyu simülatörü olan Sensorama tasarlanmasıyla başlamıştır (Cantekin 2023). Ivan Sutherland 1965 yılında farklı duyusal özellikleri ve etkileşimli grafikleri içeren yapay bir dünya tasarlamasının yanı sıra "sanal gerçeklik" terimini ilk kez "gerçekçi hissedilen sanal dünya" olarak 1965 yılında kullanmıştır (Hoşgör 2022). 1968 yılında Ivan Sutherland tarafından kafaya takılarak kullanıcılara sanal ortam sağalayan HMD (Head Mounted Display) ilk kez geliştirilmiştir. Geliştirilen yapay simülatörler ve HMD çalışmaları geliştikçe sanal gerçeklik askeri amaçlı çalışmalarda kullanılmaya başlanmıştır. Thomas Furnes tarafından ilk askeri amaçlı uçuş simülatörü 1982 yılında tasarlanmıştır. İlk ticari sanal gerçeklik donanımları VPL araştırma şirketi tarafından üretilerek 1988 yılında piyasaya sürülmüştür. 1990'lı yıllardan itibaren sanal gerçeklik uygulamaları popüler olmaya başlamış ve sürekli gelişmeye devam ederek günümüze kadar ulaşmıştır (Öztürk ve Sondaş 2020).

Sanal gerçeklik, kullanıcının birden fazla duyusunu harekete geçirerek kullanıcının gerçekçi 3B sanal ortamlarla etkileşime girmesini sağlar (Son ve ark. 2022). Sanal gerçeklik (VR), bir bireyin görsel bir görüntüye karşılık gelen uyaranları duymasını ve hissetmesini sağlayarak, sanal ortamla ve sanal ortamın bu eylemlere verdiği yanıtlar ile gerçek zamanlı olarak etkileşime girebilir (İoannou ve ark. 2020). VR teknolojisi, mobil yüksek performanslı bilgi işlemin yaygınlaşması ve çeşitli yazılım programlarının bulunması nedeniyle daha sürükleyici, uygun fiyatlı ve taşınabilir hale gelmiştir (Son ve ark. 2022, Ioannou ve ark. 2020). Kullanım kolaylığının artması ve uygun fiyatları sayesinde, VR başlıkları son zamanlarda teknoloji meraklıları için niş bir araç olmaktan ana akım bir tüketici ürününe dönüşmüştür (Siani ve ark.). Eğlence, eğitim, iş ve sağlık gibi farklı amaçlar için çok çeşitli VR uygulamaları geliştirilmiştir (Siani ve ark. 2021, Son ve ark. 2022).

Sanal Gerçeklik Türleri

Tam Anlamıyla Sürükleyici: Kullanıcılar genellikle kulaklıklı bir başlık ve bir ekran takarlar ve sanki gerçekten içindeymiş gibi sanal ortamla etkileşime girerler.

Yarı-Sürükleyici: Kullanıcılar kısmen sanal bir ortamla etkileşime girer (örneğin, kontrollerin gerçek olduğu, ancak pencerelerin sanal görüntüler gösterdiği bir uçuş simülatörü).

Sürükleyici Olmayan: Kullanıcı sanal dünyaya ayrı bir monitör (örneğin bir bilgisayar) aracılığıyla bağlanır, ancak yine de gerçek dünyayı deneyimleyebilir (Lambert ve ark. 2020).

SAĞLIK HİZMETLERİNDE SANAL GERÇEKLİK

Sanal gerçekliğin özellikleri sağlık alanında dikkat çekmiştir ve özellikle bu teknoloji tıp mesleklerindeki öğrenciler ve personel için eğitim ve öğretimde aktif olarak kullanılmıştır. Tıp eğitiminde VR genellikle cerrahi ve fiziksel muayene becerileri eğitimi, anatomik bilgi edinimi ve nörodejeneratif hastalıkları olan hastalara karşı empati kurma amacıyla kullanılmıştır (Barteit ve ark. 2021). VR'nin tıp eğitiminde nispeten uzun bir geçmişi olmasına rağmen hemşirelikte ancak yakın zamanda evrimleşmiştir (Plotzky ve ark. 2021). VR'nin hemşirelikte nispeten kısa bir geçmişi olmasına rağmen, VR esas olarak hemşirelik öğrencilerinin ve hemşirelerin pratik beceriler ve teorik bilgi edinimini optimize etmek için hemşirelik eğitimi amaçlarıyla kullanılmıştır. Ayrıca intravenöz enjeksiyonun hazırlanması, yara bakımı tedavi prosedürü idrar kateterizasyonu uygulaması, temel yaşam desteği eğitimi ve sanal demanslı hastalarla iletişim uygulaması yer almaktadır (Plotzky ve ark. 2021, Son ve ark. 2022). Son COVID-19 salgını nedeniyle temassız öğrenmeye olan yüksek taleple birlikte, VR'nin sağlık eğitimine uygulanması artmıştır. (Son ve ark. 2022).

Sanal gerçeklik (VR) tabanlı teknolojiler, karmaşık tıbbi içeriklerin öğretilmesini ve öğrenilmesini teşvik edebilecek sürükleyici deneyimlere izin verdikleri için tıp eğitimi için yeni öğretim ve eğitim yollarını açmasının (Barteit ve ark. 2021). yanı sıra aynı zamanda terapötik amaçlar içinde kullanılmaktadır (Son ve ark. 2022). VR'yi terapötik bir müdahale olarak kullanan geçmiş klinik araştırmalar, yetişkin ve pediatrik popülasyonlarda stresli tıbbi prosedürler sırasında dikkat

dağıtma, yanık pansuman değişiklikleri sırasında iyileştirilmiş ağrı kontrolü, anksiyete ve depresif semptomların azalması dahil olmak üzere ümit verici sonuçlar bildirmiştir (Leggiero ve ark. 2020).

HEMŞİRELİK BAKIMINDA SANAL GERÇEKLİK KULLANIM AMAÇLARI

Dikkat Dağıtma

Dikkat dağıtma bir davranış yönlendirme tekniği olarak, Amerikan Pediatrik Diş Hekimliği Akademisi (AAPD) tarafından "hastanın dikkatini, hoş olmayan bir işlem olarak algılanabilecek şeyden başka yöne çekme tekniği" olarak tanımlanmaktadır (AAPD 2015). Kullanıcının dikkati gerçek dünyadaki görsel, işitsel ve dokunsal uyaranlardan uzaklaştırılıp sanal dünyaya, sanal ortamın çok duyulu (yani görme, duyma, dokunma) yapısıyla çekilir (Lambert ve ark. 2020). "Kullanıcının bilgisayar tarafından oluşturulan ortamla dinamik olarak etkileşime girmesini sağlayan bir insan-bilgisayar arayüzü" olarak tanımlanan sanal gerçeklik (VR) dikkat dağıtma, hasta davranış yönetimine yardımcı olmayı amaçlayan tıbbi alanda yeni bir yöntemdir. Özellikle genç hastalarda olumsuz bir tutuma neden olabilecek dış uyaranları engelleyen sürükleyici bir sanal deneyim avantajı sunar (Felemban ve ark. 2021). Geleneksel dikkat dağıtma veya maruz bırakma gibi çeşitli metodolojiler, tıbbi prosedür korkusunun tedavisinde kullanılmıştır ve film izlemek gibi bu yöntemlerin ağrı, kaygı ve korku sonuçları üzerindeki etkileri sınırlı olabilir. Buna karşılık, en erken seanstan itibaren VR kullanımı, muhtemelen duygusal, bilişsel ve dikkat süreçleri yoluyla daha sürükleyici bir dikkat dağıtma sağlayabilir (Kılıç ve ark. 2021). VR müdahalelerinin, kullanıcının dikkatini ağrılı işlemden uzaklaştırarak ağrı algısını değiştirerek analjezik etkiler gösterdiği, ayrıca kişinin gelen ağrı sinyallerini yorumlama biçimini değiştirdiği ve sonuç olarak ağrıyla ilişkili beyin aktivitesinin miktarını azalttığı düşünülmektedir (Lambert ve ark. 2020). Spigel ve ark. (2019). tarafından yapılan bir hastanede ortopedi ve dahiliye servislerinde yatmakta olan ağrı skoru en az 10 üzerinde 3 olan 120 yetişkin ile yapılan randomize kontrollü bir çalışmada VR kullanan hastaların televizyon programı izleyenlere oranla 48-72 saat sonra ağrıda azalmalar olduğu sonucuna ulaşılmıştır. Chen ve ark., (2020) tarafından yapılan bir çalışmada acil servis kliniğine başvuran okul çağı çocuklarının intravenöz uygulamaları sırasındaki durumları incelenerek çocukların ağrı ve korku düzeylerinin azaltılmasında sanal gerçeklik uygulamalarının etkili olduğu sonucuna ulaşılmıştır. Piskorz ve ark (2020). Tarafından yapılan bir çalışmada, kan örneklemesi sırasında VR oyunları oynayarak veya izleyerek dikkati dağılan 36 çocuğun, VR deneyimi yaşamayan 21 çocuğa kıyasla önemli ölçüde daha düşük ağrı ve stres bildirdiği saptanmıştır.

Rahatlama ve Farkındalık

Sanal gerçeklik (VR), stres yönetimi için büyüleyici bir çözüm olarak ortaya çıkmış olup, modern yaşamın taleplerinden uzaklaşmak ve rahatlamak için benzersiz bir yol sunmaktadır (Meshkat ve ark. 2024). VR, stres ve psikolojik semptomlara sahip bireyler için etkili ve uygulanabilir bir rahatlama aracı olabilir (Son ve ark. 2022). VR kullanıcıları görsel olarak çarpıcı ve duygusal olarak ilgi çekici ortamlara daldırarak, stres seviyelerini etkili bir şekilde düşürebilen ve rahatlamayı teşvik edebilen duyusal bir kaçış sağlar (Meshkat ve ark. 2024). Gullo ve ark. (2023). tarafından yapılan randomize kontrollü bir bir çalışmada endovasküler müdahale sırasında VR işlem öncesi kaygıyı önemli ölçüde azaltarak hastanın sıkıntısının yönetimini iyileştirme potansiyeline sahip olduğu bildirilmiştir.

Dikkatli farkındalık , *"zihni yargılamadan ve ana bağlanmadan bilinçli olarak şimdiki ana odaklama eylemi"* olarak tanımlanmıştır (Failla ve ark. 2022). Sanal gerçeklik (VR), farkındalığı uygulamak için sürükleyici bir ortam sağlayarak ve kullanıcının dikkatini özel bir sanal ortamda şimdiki ana yönlendirmesini destekler (Seabrook ve ark. 2020). VR, kişinin dikkatini kabul edici ve yargısız bir tavırla şimdiki ana odaklayarak farkındalığı artırma potansiyeline sahiptir (Son ve ark. 2022). Yıldırım ve Grady (2020) tarafından 45 sağlıklı yetişkinle yapılan bir çalışmada hem VR uygulamaları hem de ses tabanlı uygulamaların daha yüksek düzeyde farkındalığa sebep olduğu bildirilmiştir. Rahatlamayı ve farkındalığı artırmak için VR kullanımını inceleyen çalışmalar genellikle sağlıklı popülasyonları içermiştir ancak VR kullanarak farkındalık seviyelerini artırmak, çeşitli fiziksel ve zihinsel rahatsızlıkları olan hastalar için faydalı olabilir (Son ve ark. 2022).

Bilişsel Başa Çıkma

Sanal gerçeklik ve yapay zeka gibi teknoloji tabanlı müdahalelerdeki son gelişmeler, zihinsel engelli hastalara ağrı ve kaygıyı etkili bir şekilde azaltarak ağrıyla başa çıkma becerileri geliştirmeleri için umut verici sonuçlar sağlamak amacıyla hızla artmaktadır (Tallawy ve ark. 2023). VR tabanlı terapinin potansiyeli, travma sonrası stres bozukluğu (TSSB) ve depresif bozukluk gibi psikiyatrik bozuklukları olan bireylerde bilişsel başa çıkma becerilerini geliştirmenin bir yolu olarak dikkat çekiyor (Peskin ve ark. 2019). Sanal gerçeklik, bireyleri dikkatlice kontrol edilen bir ortamda travmatik tetikleyicilerine güvenli bir şekilde maruz bırakarak, zaman içinde sağlıklı bilişsel başa çıkma becerileri geliştirmelerini sağlamak için psikoterapiye yararlı bir yardımcı olabileceği öne sürülmektedir (Son ve ark. 2022).

Rehabilitasyon

Rehabilitasyon alanında, yardımcı teknolojilerin (örneğin, robotik, koşu bantları, tekerlekli sandalye, giyilebilir sensörler) ve VR' nin kullanılması giderek artmaktadır. VR teknolojileri, bulaşıcı olmayan hastalıkların bireyler, aileler ve toplum üzerindeki olumsuz etkisini en aza indirmek için yenilikçi bir rehabilitasyon yaklaşımıdır (Moreno ve ark. 2019). VR ve bilişsel rehabilitasyon, duyusal katılım (artırılmış görsel ve işitsel geri bildirim) yoluyla hastaların dikkat, bellek, dil, yönetici işlevler, mekansal biliş ve algısal yetenekler gibi belirli alanlarda rehabilitasyonunu kolaylaştıran terapötik sistemlerdir ve rehabilitasyon seanslarının kalitesini güçlendirir, motivasyonu ve katılımı artırır (Formica ve ark. 2023). VR, yaşlılarda ve felç ve Parkinson hastalığı olan bireylerde günlük yaşam aktivitelerini gerçekleştirme yeteneğini artırmak için, bilişsel gerileme riski yüksek bireylerde, bir hafıza kliniğine ilk kez başvuran yaşlı yetişkinlerde kaygıyı azaltmak için ve NCD'li (nörobilişsel bozukluklar) bireylerde hafıza rehabilitasyonu için başarıyla kullanılmıştır (Moreno ve ark. 2019). Mekbib ve ark. (2021) tarafından yapılan çalışmada VR tabanlı bir rehabilitasyon sistemi geliştirdiler ve felç geçiren 23 yeni hastada terapötik potansiyelini doğruladılar. Sistem, sürükleyici bir sanal ortamda üst ekstremite eğitimi sağladı ve geleneksel mesleki terapi ile birleştirildiğinde üst ekstremite motor fonksiyonunun iyileştirilmesinde etkili olduğu saptanmıştır.

HEMŞİRELİKTE UYGULAMA VE ARAŞTIRMA İÇİN GELECEKTEKİ ETKİLER

Dijitalleşen dünyanın gerisinde kalmamak amacıyla sağlık işletmelerinin bu teknolojiye yatırım yapmaları, altyapılarını uygun hale getirmeleri ve sağlık hizmeti sunucularına gerekli eğitimler vererek bilgi ve farkındalık düzeylerini artırmaları büyük bir önem arz etmektedir (Hoşgör 2022). Hemşirelik profesyonelleri, sağlık hizmetlerinde teknolojinin benimsenmesinin ilk günlerinden itibaren, değişimin ön saflarında yer almaktadır. Hemşireliğin teknolojiye uyumunda rol üstelenen öncü hemşireler, klinik birimlerde iş akışını desteklemek üzere hemşirelik bilimini bilgisayar ve bilgi bilimiyle birleştirerek, dijital yenilikleri benimseme konusunda çalıştıkları organizasyonlara değer katmışlardır (Şendir ve ark. 2019). Hemşireler, uzun yıllardır hastalardaki fiziksel ve psikolojik semptomların yönetimini sağlamak için çeşitli farklı stratejiler kullanmışlardır. Hastanın tüm ihtiyaçlarını karşılamak için, klinisyenler yalnızca hastalığın biyolojik etkisini değil aynı zamanda psikososyal etkisini de dikkate almalıdır (Ioannou ve ark. 2020). VR teknolojileri, öğrenmeyi ve klinik muhakemeyi kolaylaştırmak için hemşirelik eğitiminde kullanılmıştır (Mendez ve ark. 2020). VR'nin uygulaması eğitim veya öğretim amaçlarıyla sınırlı değildir, aynı zamanda giderek daha fazla terapötik amaçlar için de kullanılmaktadır (Son ve ark. 2022).

VR teknolojisi giderek daha uygun fiyatlı, sürükleyici, esnek ve taşınabilir hale gelmiş ve yatılı tıbbi ortam da dahil olmak üzere daha geniş bir yelpazede ortamda kullanımına olanak sağlamıştır (Ioannou ve ark. 2020). Sanal gerçeklik, klinik kullanım için henüz başlangıç aşamasında olan gelişen bir teknolojidir. (Smith ve ark. 2020). Kliniklerde VR'nin eğlenceli unsurları, özellikle oyun teknolojisine daha fazla ilgi duyma eğiliminde olan pediatrik hastalar olmak üzere hastanede yatan hastalarda ağrıyı hafifletmede ve psikolojik refahı teşvik etmede etkili olabilir (Tennant 2020). VR, kemoterapi gibi yoğun tedaviler gören hastaların sıkıntılarını hafifletmek için destekleyici bir ortam olabilir (Wilson ve ark. 2021).

Gelişmekte olan bir teknolojinin benimsenmesi ancak bu alana ilgi duyan hemşirelerle mümkündür (Şendir ve ark. 2019). Sanal gerçekliğin sağlık hizmetlerinde sağlayabileceği fırsatları optimize etmek için, hemşirelerin öncelikle teknolojiye aşina olmaları gerekir, böylece hastalara ve hasta yakınlarına VR tabanlı programları tanıtabilir ve eğitebilirler. Hemşirelerin VR dahil olmak üzere dijital sağlık teknolojilerini kullanma konusunda yetkin olmalarını destekleyen bir ortam yaratmak önemlidir (Buchanan ve ark. 2021).

Terapötik VR'nin kullanımı genişledikçe, farmakoterapiler için belirlenmiş standartlara benzer şekilde, VR uygulamalarının geliştirilmesi ve değerlendirilmesinde bilimsel titizliği sağlamak için yönergelerin oluşturulması esastır (Birckhead ve ark. 2019). Bakım ortamlarında VR kullanımına ilişkin araştırmalar pratik olmalı, yalnızca müdahalelerin etkili olup olmadığını değil, aynı zamanda hemşirelerin uygulamalarında kullanmalarının mümkün olup olmadığını ve denekler için tatmin edici olup olmadığını da incelemelidir (Son ve ark. 2022). Klinik uygulamada VR teknolojisinden yararlanmak için maliyet etkinliğini, etkililiği ve güvenliği değerlendirilmelidir çünkü VR, yazılım geliştirme ve ekipman gerektiren yüksek maliyetli bir teknolojidir (Garret ve ark. 2018). Hemşirelerin, eğilimler ve beklentiler dahil olmak üzere sağlık hizmetlerinde VR kullanımı hakkında güncel bilgilerle donatılması ve ilgili alanlardaki uzmanlarla etkileşim kurması gerekir. Bu tür teknolojilerin kullanımı, mevcut sağlık hizmeti sunumunu destekleyecek şekilde optimize edilmelidir (Son ve ark. 2022). Araştırma açısından, farklı yaş grupları ve klinik popülasyonlarda ruh hali, bilişsel işlev ve fiziksel ve psikolojik semptomlar üzerindeki VR müdahalelerinin etkilerini titizlikle değerlendirmek için daha büyük ölçekli, uzun vadeli çalışmalara ihtiyaç vardır (Ansado ve ark. 2021, Smith ve ark. 2020).

YAPILAN ULUSAL VE ULUSLARARASI ÇALIŞMALAR

Klinik uygulama ve araştırmada sanal gerçekliğe ilişkin yapılan ulusal çalışmalar incelendiğinde; Yildiz ve Demiray (2022) tarafından yapılan randomize kontrollü bir çalışmada sanal gerçeklik teknolojisinin intravenöz kateter uygulama ve sıvı verme becerilerinin geliştirilmesinde bir öğretim yöntemi olarak etkili olduğu bildirilmiş ve hemşirelik eğitiminde kullanımının artırılması önerilmiştir. Keskin ve ark. (2021) tarafından yapılan bir çalışmada pediatrik hastalarda sanal gerçeklik uygulamalarının ağrıyı gidermede etkili olduğu sonucuna ulaşılmıştır. Başak ve ark. (2020) tarafından yapılan randomize kontrollü deneysel bir çalışmada genç yetişkinlerde periferik intravenöz kateterizasyon uygulaması sırasında sanal gerçeklik gözlükleri kullanılarak su altı işitsel 3D video izletilmesinin ve dikkat dağıtıcı resimler içeren kartların kullanılarak işlem sırasındaki ağrıyı azalttığı sonucuna ulaşılmıştır. Özkan ve Polat (2020) tarafından yapılan bir çalışmada çocuklarda damar yolu açılması esnasında dikkati başka yöne çekme amacıyla sanal gerçeklik gözlüğü kullanılarak çocukların seçtiği bir video izletilmesi ile kaleydoskop kullanımını incelenen çalışmada, her iki yöntemin de ağrıyı azalttığı ancak sanal gerçeklik gözlüğünün ağrı algısını azaltmada kaleydoskopa göre daha etkili olduğu bildirilmiştir.

Klinik uygulama ve araştırmada sanal gerçekliğe ilişkin yapılan uluslararası çalışmalar incelendiğinde; Zhang ve arkadaşlarının (2022) izolasyon servislerindeki hemşirelik personelinin hizmet öncesi eğitiminde sanal gerçekliğin rolünü araştırmak için yaptığı bir çalışmada, kliniğe yeni başlayan hemşirelerin servise adaptasyonları sanal gerçeklik teknolojisi kullanılarak sağlanarak hemşirelerin büyük bir çoğunluğunun endişe düzeylerinde azalma olduğu, hemşirelik girişimlerini daha kısa sürede ve eksiksiz bir biçimde tamamladıkları ve malzeme tüketiminde azalma olduğu bildirilmiştir. Liu ve ark. (2023) tarafından yapılan Hemşirelik eğitiminde sanal gerçekliğin etkinliği isimli bir meta-analiz çalışmasında sanal gerçeklik teknolojisinin hemşirelik öğrencilerinin teorik bilgilerini, pratik becerilerini, ve memnuniyet düzeylerini geleneksel veya alternatif öğretim metodolojilerine kıyasla önemli ölçüde artırdığı sonucuna ulaşılmıştır. Chiu ve ark. (2023) tarafından yapılan bir çalışmada VR tabanlı bir müdahalenin elektif cerrahi geçiren yetişkin hastalarda ameliyat öncesi kaygıyı azaltmanın uygulanabilir ve etkili bir yolu olduğu sonucuna ulaşılmıştır. Whong ve Choi (2023) tarafından yapılan randomize kontrollü bir çalışmada venipunktur uygulanan pediatrik hastalar için bir sürükleyici sanal gerçeklik uygulamasında prosedürel bilgi ve dikkat dağıtmanın entegre edilmesi, sürükleyici sanal gerçeklik grubunda kontrol grubuna kıyasla ağrı ve kaygıyı önemli ölçüde iyileştirdiği bildirilmiştir. Chen ve ark. (2020) tarafından yapılan randomize kontrollü bir çalışmada sanal gerçeklik müdahalesi, okul çağındaki çocuklarda acil serviste intravenöz işlem sırasında oluşan ağrı ve korkuyu etkili bir şekilde azaltabileceği bildirilmiştir.

SONUÇ

Sağlık alanında sanal gerçeklik teknolojileri kullanılmasının sağlık hizmeti alıcılarına zaman ve maliyeti azaltmada etkili bir yöntemdir. Sanal gerçeklik yöntemi, hemşirelerin bilgi ve becerilerini geliştirmeleri için kullanışlı bir yöntemdir. Kullanıcının daha az risk ve korku ile uygulamayı gerçekleştirmesi, maliyet açısından giderek uygun fiyatlı olması ve yüksek kullanım oranları ile sanal gerçeklik teknolojisi hemşirelik eğitimini destekleyici simülasyon teknikleri arasında hızla yerini almaktadır. Literatür incelendiğinde sanal gerçeklik hemşirelik bakımında; ağrı yönetiminde, zor tıbbi prosedürlerden ve tedavilerden dikkati dağıtmada, rahatlama ve farkındalıkta, bilişsel davranışçı terapide ve rehabilitasyonda kullanılmaktadır. Ülkemizde kullanımının yaygınlaştırılması ve konuyla ilgili deneysel araştırmalara daha fazla ağırlık verilmesi önerilebilir.

KAYNAKLAR

American Academy of Pediatric Dentistry. (2015). Guideline on behavior guidance for the pediatric dental patient. *Reference Manual of Pediatric Dentistry, 36*(6), 180–190.

Ammatuna, G., & Changcoco, R. (2017). Which trends will most affect talent developers in the healthcare industry: Who is doing the training and how it's delivered is changing. *TD Magazine, 71*(4), 60.

Ansado, J., Chasen, C., Bouchard, S., & Northoff, G. (2021). How brain imaging provides predictive biomarkers for therapeutic success in the context of virtual reality cognitive training. *Neuroscience & Biobehavioral Reviews, 120*, 583–594.

Atıf Tuna, A., & Öskan, D. (2022). Hemşirelik bölümü öğrencilerinin öğrenmesinde yeni bir gerçeklik: Sanal gerçeklik. *Uluslararası Eğitim Bilimleri Dergisi, 9*(32), 320–331.

Barteit, S., Lanfermann, L., Bärnighausen, T., Neuhann, F., & Beiersmann, C. (2021). Augmented, mixed, and virtual reality-based head-mounted devices for medical education: Systematic review. *JMIR Serious Games, 9*(3).

Başak, T., Duman, S., & Demirtaş, A. (2020). Distraction-based relief of pain associated with peripheral intravenous catheterisation in adults: A randomised controlled trial. *Journal of Clinical Nursing, 29*(5–6), 770–777.

Birckhead, B., Khalil, C., Liu, X., Conovitz, S., Rizzo, A., Danovitch, I., Bullock, K., & Spiegel, B. (2019). Recommendations for methodology of virtual reality clinical trials in health care by an international working group: Iterative study. *JMIR Mental Health, 6*(1).

Buchanan, C., Howitt, M. L., Wilson, R., Booth, R. G., Risling, T., & Bamford, M. (2021). Predicted influences of artificial intelligence on nursing education: Scoping review. *JMIR Nursing, 4*(1).

Cantekin, A. (2023). Sanal gerçeklik kavramı: Sinemada yarattığı yenilikçi dönüşümler. *Eurasian Journal of Media Communication and Culture Studies, 1*(1), 4–15.

Chen, Y. J., Cheng, S. F., Lee, P. C., Lai, C. H., Hou, I. C., & Chen, C. W. (2020). Distraction using virtual reality for children during intravenous injections in an emergency department: A randomised trial. *Journal of Clinical Nursing, 29*(3–4), 503–510.

Chiu, P. L., Li, H., Yap, K. Y., Lam, K. C., Yip, P. R., & Wong, C. L. (2023). Virtual reality–based intervention to reduce preoperative anxiety in adults undergoing elective surgery: A randomized clinical trial. *JAMA Network Open, 6*(10).

El-Tallawy, S. N., Ahmed, R. S., & Nagiub, M. S. (2023). Pain management in the most vulnerable intellectual disability: A review. *Pain Therapy, 12*(4), 939–961.

Failla, C., Marino, F., Bernardelli, L., Gaggioli, A., Doria, G., Chilà, P., Minutoli, R., Mangano, R., Torrisi, R., Tartarisco, G., Bruschetta, R., Arcuri, F., Cerasa, A., & Pioggia, G. (2022). Mediating mindfulness-based interventions with virtual reality in non-clinical populations: The state-of-the-art. *Healthcare, 10*(7).

Felemban, O. M., Alshamrani, R. M., Aljeddawi, D. H., & Bagher, S. M. (2021). Effect of virtual reality distraction on pain and anxiety during infiltration anesthesia in pediatric patients: A randomized clinical trial. *BMC Oral Health, 21*(1).

Formica, C., Bonanno, L., Latella, D., Ferrera, M. C., Maresca, G., Logiudice, A. L., Sorbera, C., Brigandì, A., Di Lorenzo, G., & Marino, S. (2023). The effect of computer-assisted rehabilitation environment (CAREN) in cognitive impairment and coping strategies in Parkinson's disease: A preliminary study. *Scientific Reports, 13*(1).

Garrett, B., Taverner, T., Gromala, D., Tao, G., Cordingley, E., & Sun, C. (2018). Virtual reality clinical research: Promises and challenges. *JMIR Serious Games, 6*(4).

Gullo, G., Rotzinger, D. C., Colin, A., Frossard, P., Gudmundsson, L., Jouannic, A. M., & Qanadli, S. D. (2023). Virtually augmented self-hypnosis in peripheral vascular intervention: A randomized controlled trial. *Cardiovascular and Interventional Radiology, 46*(6), 786–793.

Hoşgör, H. (2022). Sağlık alanında sanal gerçekliğin kullanımı: Türkiye ve dünyadan örnekler. *Fenerbahçe University Journal of Health Sciences, 2*(3), 647–660.

https://sozluk.gov.tr/ erişim tarihi:26.12.2024

Ioannou, A., Papastavrou, E., Avraamides, M. N., & Charalambous, A. (2020). Virtual reality and symptoms management of anxiety, depression, fatigue, and pain: A systematic review. *SAGE Open Nursing, 6*, 1–13.

Keskin, E., Buldur, E., & Bal Yılmaz, H. (2021). Pediatrik hastalarda ağrı yönetiminde sanal gerçeklik uygulamalarının etkinliği: Sistematik derleme. *Güncel Hemşirelik Araştırmaları Dergisi, 1*(3), 96–106.

Kulkov, I., Berggren, B., Hellström, M., & Wikström, K. (2021). Designing business models for virtual and augmented reality companies in the medical industry. *Journal of Engineering and Technology*, 1–15.

Lambert, V., Boylan, P., Boran, L., Hicks, P., Kirubakaran, R., Devane, D., & Matthews, A. (2020). Virtual reality distraction for acute pain in children. *Cochrane Database of Systematic Reviews, 10*(10), 1–101.

Leggiero, N. M., Armstrong, T. S., Gilbert, M. R., & King, A. L. (2022). Use of virtual reality for symptom management in solid-tumor patients with implications for primary brain tumor research: A systematic review. *Neuro-Oncology Practice, 7*(5), 477–489.

Liu, K., Zhang, W., Li, W., Wang, T., & Zheng, Y. (2023). Effectiveness of virtual reality in nursing education: A systematic review and meta-analysis. *BMC Medical Education, 23*(1).

Locsin, R. C., & Ito, H. (2018). Can humanoid nurse robots replace human nurses? *Journal of Nursing, 5*, 1–6.

Mekbib, D. B., Debeli, D. K., Zhang, L., Fang, S., Shao, Y., Yang, W., Han, J., Jiang, H., Zhu, J., Zhao, Z., Cheng, R., Ye, X., Zhang, J., & Xu, D. (2021). A novel fully immersive virtual reality environment for upper extremity rehabilitation in patients with stroke. *Annals of the New York Academy of Sciences, 1493*(1), 75–89.

Mendez, K. J. W., Piasecki, R. J., Hudson, K., Renda, S., Mollenkopf, N., Nettles, B. S., & Han, H. R. (2020). Virtual and augmented reality: Implications for the future of nursing education. *Nurse Education Today, 93*, 1–3.

Meshkat, S., Edalatkhah, M., Di Luciano, C., Martin, J., Kaur, G., Hee Lee, G., Park, H., Torres, A., Mazalek, A., Kapralos, B., Dubrowski, A., & Bhat, V. (2024). Virtual reality and stress management: A systematic review. *Cureus, 16*(7).

Moreno, A., Wall, K. J., Thangavelu, K., Craven, L., Ward, E., & Dissanayaka, N. N. (2019). Virtual reality and cognition in individuals with neurocognitive disorders: A systematic review. *Alzheimer's & Dementia: Translational Research & Clinical Interventions, 5*, 834–850.

Nakhoul, G. N., Taliercio, J. J., Bassil, E. H., Arrigain, S., Schold, J. D., Wardrop, R., & Mehdi, A. (2024). Virtual Nephron: Evaluation of a novel virtual reality educational tool. *Kidney International Reports*.

Özkan, T. K., & Polat, F. (2020). The effect of virtual reality and kaleidoscope on pain and anxiety levels during venipuncture in children. *Journal of PeriAnesthesia Nursing, 35*(2), 206–211.

Öztürk, E. O., & Sondaş, A. (2020). Sanal sağlık: Sağlıkta sanal gerçekliğe genel bakış. *Kocaeli Üniversitesi Fen Bilimleri Dergisi, 3*(2), 164–169.

Peskin, M., Wyka, K., Cukor, J., Olden, M., Altemus, M., Lee, F. S., & Difede, J. (2019). The relationship between posttraumatic and depressive symptoms during virtual reality exposure therapy with a cognitive enhancer. *Journal of Anxiety Disorders, 61*, 82–88.

Piskorz, J. E., Czub, M., Šulžickaja, B., & Kiliś-Pstrusińska, K. (2020). Mobile virtual reality distraction reduces needle pain and stress in children. *Cyberpsychology, 14*(1), 1–12.

Plotzky, C., Lindwedel, U., Sorber, M., Loessl, B., König, P., Kunze, C., Kugler, C., & Meng, M. (2021). Virtual reality simulations in nurse education: A systematic mapping review. *Nurse Education Today, 101*, 1–11.

Seabrook, E., Kelly, R., Foley, F., Theiler, S., Thomas, N., Wadley, G., & Nedeljkovic, M. (2020). Understanding how virtual reality can support mindfulness practice: Mixed methods study. *Journal of Medical Internet Research, 22*(3).

Siani, A., & Marley, S. A. (2021). Impact of the recreational use of virtual reality on physical and mental wellbeing during the COVID-19 lockdown. *Health Technology, 11*(2), 425–435.

Smith, V., Warty, R. R., Sursas, J. A., Payne, O., Nair, A., Krishnan, S., Da Silva Costa, F., Wallace, E. M., & Vollenhoven, B. (2020). The effectiveness of virtual reality in managing acute pain and anxiety for medical inpatients: Systematic review. *Journal of Medical Internet Research, 22*(11).

Son, H., Ross, A., Mendoza-Tirado, E., & Lee, L. J. (2022). Virtual reality in clinical practice and research: Novel applications for nursing. *JMIR Nursing, 5*(1), 1–7.

Spiegel, B., Fuller, G., Lopez, M., Dupuy, T., Noah, B., Howard, A., Albert, M., Tashjian, V., Lam, R., Ahn, J., Dailey, F., Rosen, B. T., Vrahas, M., Little, M., Garlich, J., Dzubur, E., IsHak, W., & Danovitch, I. (2019). Virtual reality for management of pain in hospitalized patients: A randomized comparative effectiveness trial. *PLoS One, 14*(8).

Şendir, M., Şimşekoğlu, N., Kaya, A., & Sümer, K. (2019). Geleceğin teknolojisinde hemşirelik. *Sağlık Bilimleri Üniversitesi Hemşirelik Dergisi, 1*(3), 209–214.

Tennant, M., Youssef, G. J., McGillivray, J., Clark, T., McMillan, L., & McCarthy, M. C. (2020). Exploring the use of immersive virtual reality to enhance psychological well-being in pediatric oncology: A pilot randomized controlled trial. *European Journal of Oncology Nursing, 48*.

Vincent, C., Eberts, M., Naik, T., Gulick, V., & O'Hayer, C. V. (2021). Provider experiences of virtual reality in clinical treatment. *PLoS One*, *16*(10).

Wilson, K., & Scorsone, G. (2021). The use of virtual reality technologies to reduce anxiety and improve experience in chemotherapy patients during treatment. *Frontiers in Virtual Reality*, *2*.

Wong, C. L., & Choi, K. C. (2023). Effects of an immersive virtual reality intervention on pain and anxiety among pediatric patients undergoing venipuncture: A randomized clinical trial. *JAMA Network Open*, *6*(2).

Yildirim, C., & Grady, T. (2020). The efficacy of a virtual reality-based mindfulness intervention. In *2020 IEEE International Conference on Artificial Intelligence and Virtual Reality (AIVR)* (pp. 158–165).

Yildiz, H., & Demiray, A. (2022). Virtual reality in nursing education 3D intravenous catheterization e-learning: A randomized controlled trial. *Contemporary Nurse*, *58*(2–3), 125–137.

Zhang, W., Luo, M., Liu, Y., Cai, S., Yang, Q., Huang, Y., & Yu, X. (2022). A pilot study to investigate the role of virtual reality in the preservice training of nursing staff in isolation wards. *Computers, Informatics, Nursing*, *40*(5), 307–316.

YOĞUN BAKIM ÜNİTELERİ VE HEMŞİRELİK BAKIMINDA YAPAY ZEKA KULLANIMI

USE OF ARTIFICIAL INTELLIGENCE IN INTENSIVE CARE UNITS AND NURSING CARE

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ÖZ

Yapay Zeka (YZ), karar alma, desen tanıma ve doğal dil işleme (NLP) gibi genellikle insan zekası gerektiren görevleri gerçekleştirebilen bilgisayar sistemlerini ifade eder. YZ'nin sağlık hizmetlerine entegrasyonu ve uygulanması hızla genişlemekte ve hasta bakımında devrim yaratmaktadır. ABD'de YZ'nin sağlık hizmetlerine etkisinin 2021'de 6,9 milyardan 2027'ye kadar 67,4 milyara çıkacağı tahmin edilmektedir. Yapay zekanın gelecekteki yoğun bakım ünitelerinde çeşitli sağlık görevlerini yerine getirmede önemli bir rol oynayacağını tahmin edilmektedir. YZ teknolojileri geliştikçe yoğun bakım hemşirelik uygulamalarına entegrasyonu daha da sorunsuz hale gelecek, kritik bakımı daha da dönüştürecek ve hemşirelerin daha iyi hasta sonuçları sunmasını sağlayacaktır. Özellikle hemşirelikte YZ'nin anlaşılması ve uygulanmasına yönelik bir ihtiyaç vardır. Yukarıda sunulan bilgiler doğrultusunda; yoğun bakım ünitesi ve hemşirelik bakımında yapay zeka uygulamalarının kullanımının gelecekte önemli bir yere sahip olacağı aşikardır. Literatür incelendiğinde yoğun bakımlarda hemşirelik bakımında yapay zeka kullanımına yönelik çalışmaların sınırlılığı göze çarpmaktadır. Bu nedenle sunulan derlemenin amacı yapay zeka uygulamalarını gözden geçirmek, yoğun bakım ünitelerindeki kullanımını ve hemşirelik bakımındaki yerini irdelemektir. Google Scholar, PubMed, Cochrane, Web of Science ve YÖK Tez veri tabanlarında “yapay zeka”, “yapay zeka robotları”, “hemşirelik bakımı”, “hemşirelik bakımında yapay zeka”, “yoğun bakım ünitesinde yapay zeka”, “artificial intelligence”, “artificial intelligence robots”, “nursing care”, “artificial intelligence in nursing care”, “artificial intelligence in the intensive care unit” anahtar kelimeleri ile literatür taraması yapılmıştır. Bu derlemenin yoğun bakımlarda hemşirelik bakımında yapay zeka kullanımı başlığını tüm yönleriyle ele alması, kapsamı ve alt boyutlarının detaylı olarak incelenmesi açısından, planlanan araştırmalara yol gösterici olması beklenmektedir.

Anahtar kelimeler: Yapay zeka, yapay zeka robotları, hemşirelik bakımında yapay zeka, yoğun bakım ünitesinde yapay zeka

ABSTRACT

Artificial Intelligence (AI) refers to computer systems that can perform tasks that typically require human intelligence, such as decision-making, pattern recognition, and natural language processing (NLP). The integration and application of AI in healthcare is rapidly expanding and revolutionizing patient care. In the US, the impact of AI on healthcare is estimated to grow from 6.9 billion in 2021 to 67.4 billion by 2027. It is anticipated that AI will play a significant role in performing various healthcare tasks in future intensive care units. As AI technologies develop, their integration into intensive care nursing practices will become even more seamless, further transforming critical care and enabling nurses

to deliver better patient outcomes. There is a particular need for understanding and applying AI in nursing. Based on the information presented above, it is clear that the use of AI applications in intensive care units and nursing care will play a significant role in the future. A review of the literature reveals the limited number of studies on the use of AI in intensive care nursing care. Therefore, the purpose of this review is to review artificial intelligence applications, examine their use in intensive care units, and their place in nursing care. A literature search was conducted using the keywords "artificial intelligence," "artificial intelligence robots," "nursing care," "artificial intelligence in nursing care," "artificial intelligence in the intensive care unit," "artificial intelligence," "artificial intelligence robots," "nursing care," "artificial intelligence in nursing care," and "artificial intelligence in the intensive care unit" in Google Scholar, PubMed, Cochrane, Web of Science, and YÖK Thesis databases. This review is expected to address all aspects of the use of artificial intelligence in nursing care in intensive care units and to guide future research by examining its scope and sub-dimensions in detail.

Keywords: Artificial intelligence, artificial intelligence robots, artificial intelligence in nursing care, artificial intelligence in the intensive care unit

GİRİŞ

Yapay zeka (YZ), çeşitli alanlarda yenilikçi çözümler sunarak sağlık hizmetlerinde hızla dönüştürücü bir güç olarak ortaya çıkmıştır (Bellini ve ark. 2022). Sağlık hizmetlerinde yapay zeka (YZ) hızla büyümekte ve hemşirelik bakımının kalitesini artırma potansiyeli vardır (Pailaha 2023). Hastaların kritik derecede hasta olduğu ve sürekli izleme ve hızlı müdahaleler gerektirdiği yoğun bakım ünitelerinde (YBÜ), hemşirelik bakımını yeni zirvelere taşımak için değerli ve oldukça etkili bir araçtır (Gutierrez 2020). Yoğun bakım hemşireliğinde YZ, özellikle yüksek hacimli, karmaşık ve zamana duyarlı verilerle karakterize edilen ortamlarda, özel bir umut vaat etmektedir (Saqib ve ark. 2023).

Yoğun bakım üniteleri, yüksek keskinlikte karar alma ve verimli kaynak tahsisi gerektiren karmaşık ortamlardır (Hassan ve El- Ashry 2024). Yoğun bakım üniteleri (YBÜ) bütüncül bakım yaklaşımının ön planda olduğu özellikli kliniklerdir (Çınar ve Eti Aslan 2017). Yoğun bakım ünitesindeki klinisyenler ve hemşireler, çoklu organ sistemlerini içeren karmaşık, yaşamı tehdit eden durumlara sahip hastalara kapsamlı bakım sağlamaktan sorumludur. Bu süreç sürekli izleme, değerlendirme, önceliklendirme, tanı, tedavi kararları ve bakım koordinasyonu gerektirir. (Levin ve ark. 2024).

Bakım, ahlaki bir zorunluluk, bir duygulanım, bir insan özelliği, şefkat gösterme, destekleme, kişilerarası etkileşim ve terapötik müdahale gibi tüm olumlu girişimler olarak tanımlanmakta ve bireyin kendisi ve çevresindeki bireyler arasında gelişen bir süreçtir. Bakım hasta bireyin iyileşmesinin temelidir ve aynı zamanda hemşirelik mesleğinin merkezi ve özüdür (Toru 2020).

Hemşirelik, mesleki gelişim, karşı karşıya kalacağı her duruma etkili çözüm yolu bulma ve hasta güvenliği gibi konularda teknolojinin kendisine katkı sağlayacağı bilinciyle değişimi, yeniliği ve teknolojik gelişmeleri öğrenmeye zaman ayıran meslek gruplarından biridir (Carroll, 2018). Teknolojik gelişmeler, hemşireliği birçok yönden ilerletmekte, hasta güvenliğini artırmakta ve hemşirelerin hastayı daha yakından tanımasına olanak sağlamaktadır. Yıllar geçtikçe hemşirelik bakımı, teknolojinin akışı ile değişmektedir. (Akgerman 2022). Yapay zeka, verimliliği artırarak, hasta bakımını iyileştirerek ve tıbbi uygulamanın çeşitli yönlerini ilerletmek suretiyle sağlık hizmetlerinde devrim yaratma konusunda önemli bir potansiyele sahiptir (Mohanasundari ve ark. 2023). YZ'nin sağlık hizmetlerine entegrasyonu ve uygulanması hızla genişlemekte ve hasta bakımında devrim yaratmaktadır. (Al Kuwaiti ve ark. 2023). ABD'de YZ'nin sağlık hizmetlerine etkisinin 2021'de 6,9 milyardan 2027'ye kadar 67,4 milyara çıkacağı tahmin edilmektedir. (Fernandes ve ark. 2023).

KAVRAMSAL ÇERÇEVE

Yapay Zeka Kavramı

Yapay zeka (YZ), üst düzey uzman grubu (YZ HLEG) tarafından "belirli bir hedefe ulaşmak için önceden tanımlanmış parametrelere göre en iyi eylemi/eylemleri belirleyerek fiziksel veya dijital dünyada hareket eden insanlar tarafından tasarlanmış bir sistem" olarak tanımlanmıştır (Porcellato ve ark. 2025). Türk Dil Kurumu (TDK)'na göre ise "yapay zeka" kavramı: "Bir bilgisayarın, bilgisayar kontrolündeki bir robotun veya programlanabilir bir aygıtın insana benzer biçimde algılama, öğrenme, fikir yürütme, karar verme, sorun çözme, iletişim kurma vb. işlevleri sergileyebilme yeteneği" olarak tanımlanmıştır (TDK 2025). Yapay Zeka (YZ) terimi ilk "artificial intelligence" olarak John McCarthy tarafından 1956 yılında Dartmouth'da düzenlenen bir konferansta "zeki makineler yapma bilimi ve mühendisliği" olarak ortaya atılmıştır (Ahuja 2019). Yapay zeka (YZ), makineler, özellikle bilgisayar sistemleri tarafından insan zekasının simülasyonudur (Alowais ve ark. 2023). Yapay Zeka (YZ), karar alma, desen tanıma ve doğal dil işleme (NLP) gibi genellikle insan zekası gerektiren görevleri gerçekleştirebilen bilgisayar sistemlerini ifade eder (Park ve ark. 2025). YZ'nin işlevleri arasında makine öğrenimi (ML), doğal dil işleme (NLP), davranışsal desen tanıma, arama motoru yetenekleri, görüntü ve ses analizi, çevresel algı, veri tabanları, bilgi sınıflandırması ve yapay sinir ağları bulunur (Martinez-Ortigosa ve ark. 2023). Yapay zeka teknolojisi makine öğrenimini, yapay sinir ağlarını, derin öğrenmeyi, uzman sistemleri, doğal dil işlemeyi, ve büyük dil modellerini kapsamaktadır.

Makine Öğrenimi (Machine Learning):

Yapay zeka, "akıllı" yollarla kullanılacak öğrenme modelleri oluşturarak veri analitiği gerçekleştirmek için makine öğrenimi algoritmalarını kullanır (Abonamah ve ark. 2021).Makine öğrenimi, insan zekasıyla ilişkilendirilen deneyimsel "öğrenmeyi" sergilerken, hesaplama algoritmalarının kullanımıyla öğrenme ve analizlerini geliştirme kapasitesine sahiptir (Bini ve Stefano 2018). Algoritmalar bir veri parçasını doğru bir şekilde sınıflandırmak veya sağlanan diğer verileri inceleyerek doğru tahminlerde bulunmak için kullanılır (Shah ve ark. 2023). Bu algoritmalar, makineyi otonom öneriler veya kararlar vermesi için eğitmek amacıyla desenleri tanımak ve etkili bir şekilde "öğrenmek" için büyük veri giriş ve çıkış kümeleri kullanır (Helm ve ark. 2020). Yeterli tekrarlama ve algoritmanın değiştirilmesinden sonra, makine bir girdi alabilir ve bir çıktıyı tahmin edebilir hale gelir (Bini ve Stefano 2018). Çıktılar daha sonra algoritmanın doğruluğunu değerlendirmek için bilinen bir dizi sonuçla karşılaştırılır ve daha sonra daha fazla sonucu tahmin etme yeteneğini mükemmelleştirmek için yinelemeli olarak ayarlanır (Haeberle ve ark. 2019). Gözetimli makine öğrenimi ve Gözetimsiz makine öğrenimi olarak ikiye ayrılır.

Gözetimli Makine Öğrenimi:

Gözetimli makine öğrenmesi tıp alanında en yaygın olanıdır. Gözetimli öğrenmede, etiketli veri kümeleri, bir algoritmayı verileri doğru şekilde sınıflandırmak üzere eğitmek için kullanılır (Rajkomar ve ark. 2019). Bir algoritmayı eğitmek için, etiketli veriler bağımsız ve bağımlı değişkenler arasındaki herhangi bir ilişkiyi çıkarmak için kullanılır. Bağımsız değişkenlerin ilgili ağırlıkları, bağımlı değişkeni tahmin etmede en az hataya sahip en iyi uyuma ulaşana kadar algoritma içinde ayarlanır. Bu işlemden türetilen eğitilmiş model daha sonra algoritmanın genelleştirilebilirliğini değerlendirmek için ek veri kümeleri üzerinde doğrulanır. Algoritma performansı, duyarlılık, doğruluk ve bir alıcı işletim karakteristiği eğrisinin eğrisi altında kalan alan dahil olmak üzere çeşitli yollarla değerlendirilebilir (Shah ve ark. 2023). Gözetimli makine öğreniminin yaygın olarak kullanılan bir örneği, bir hastanın demografisini ve sigara içme geçmişini akciğer kanseri gibi belirli bir sonuçla ilişkilendirmek için bir modeli eğitmektir (Sidey-Gibbons JAM ve Sidey-Gibbons CJ 2019).

Gözetimsiz Makine Öğrenimi:

Gözetimli öğrenmenin aksine, gözetimsiz öğrenme önceden tanımlanmış bir çıktı içermez (Sidey-Gibbons JAM ve Sidey-Gibbons CJ 2019). Gözetimsiz makine öğrenimi, etiketlenmemiş verilerde daha önce tespit edilmemiş kalıpları ve kümeleri bulmak için kullanılır (Chen ve ark. 2021). Gözetimsiz makine öğrenimi, etiketlenmemiş verileri içerdiği için daha az manuel müdahale gerektirdiğinden bir veri keşif aracı olarak hizmet edebilir. Bu teknikler daha önce keşfedilmemiş kalıplar üretebilse de,

gruplamalar klinisyen içgörüsü olmadan klinik olarak anlamlı olmayabilir. Veri keşfine ek olarak, gözetimsiz makine öğrenimi sınıflandırma görevleri için de kullanılabilir (Shah ve ark. 2023).

Gözetimsiz makine öğreniminin örnekleri arasında kümeleme analizi yer alır; burada veriler benzerliklere, farklılıklara ve ilişkilere göre gruplandırılır. Boyutsallık azaltma, üretim öncesi aşamada büyük veri kümelerinde kullanılabilir ve veri kümesinin bütünlüğünü korurken değişken sayısını azaltır ve analiz için daha yönetilebilir hale getirir (Shah ve ark. 2023). Yapılan bir çalışma akut solunum sıkıntısı sendromunun benzer fenotiplerin hedefli tedavilere (örneğin Pozitif Son Ekspirasyon Basıncı (PEEP), sıvı yüklenmesi, statinler) farklı yanıtlar verdiğini göstermiştir (Calfee ve ark. 2018). Araştırmacılar gözetimsiz makine öğrenimini sepsis ve ölümcül astımı olan hasta çocuklarda fenotipleri belirlemek için kullanmışlardır (Kolli ve ark. 2021).

Yapay Sinir Ağı:

Yapay sinir ağı (YSA), Yapay zeka algoritmalarını yürütmek için kavramsal bir çerçevedir. İnsan beyninin bir taklididir ve nöronlar arasında ağırlıklı iletişim kanallarının bulunduğu, birbirine bağlı bir nöron ağıdır. Bir nöron, komşu nöronlardan gelen birden fazla uyarana tepki verebilir ve tüm ağ, ortamdan gelen farklı girdilere göre durumunu değiştirebilir. Yapay sinir ağı (YSA), tıpkı insan beyninin farklı çevresel değişikliklere tepki vermesi gibi, çevresel uyaranlara verdiği yanıtlar olarak çıktılar üretebilir (Rong ve ark. 2020). Günümüzde, bazı mühendisler 100 katmana kadar derinlikte YSA ağları oluşturmakta, dolayısıyla bu algoritmalar için "derin" öğrenme adı buradan gelmektedir (Bini ve Stefano 2018).

Derin Öğrenme:

Derin öğrenme, bir makinenin kalıpları gözlemlemesini ve bilgileri sınıflandırmasını sağlayan, herhangi bir insan müdahalesine ihtiyaç duymadan daha gelişmiş ve karmaşık bir şekilde "düşünmesini" sağlayan makine öğrenmesinin bir alt kümesidir (Abonamah ve ark. 2021). Birden çok işleme katmanından oluşan hesaplama modellerinin, birden çok soyutlama düzeyi sayesinde verilerin temsillerini öğrenmesine olanak tanır (Çilhoroz ve Işık 2021). "Derin sinir ağları", nihai çıktıyı ayırmak ve yönetmek için hiyerarşik katmanlardan yararlanan karmaşık bir model türüdür. Ağın her biri girdinin farklı özelliklerine yanıt veren bir dizi "gizli katmana" ilerleyen bir girdi katmanıyla başlar. Bu katmanlar, "daha derinlere" gittikçe anlayışın artmasını sağlayarak, açıkça programlanmış talimatlar olmadan modellerin geliştirilmesine izin verir. Makine belirli bir kavramı birden fazla katmanda inceledikçe, mevcut algoritma daha sonra yeni veriler mevcut oldukça kendini art arda iyileştirebilir. İnsan beyninin işleyiş biçimine benzer şekilde, makine birden fazla hiyerarşik veri düzeyinde "dendritik" bağlantılardan "nöronal" bağlantılar kurabilir. Bu ağlar böylece "derin öğrenme" olarak bilinen yeni bir yapay zeka biçiminin ortaya çıkmasına neden olmuştur (Shah ve ark. 2023, Helm ve ark. 2020, Haeberle ve ark. 2019).

Uzman Sistemler (Expert Systems):

Bakım sağlayıcılara rutin işlerinde yardımcı olmak için akıl yürütme tekniklerini tespit etme ve uzman bilgisi yeteneğine sahip sistemler olarak tanımlanmaktadır (Çilhoroz ve Işık 2021).

Doğal Dil İşleme (Natural Language Processing):

Doğal dil işleme (NLP), bilgisayarların insan dilini anlamak ve üretmek üzere eğitildiği geniş yapay zeka alanıdır (Alowais ve ark. 2023, Pruneski ve ark. 2023).). Serbest metni anlamak ve üretmek için makine öğrenimi (ML) ve derin öğrenme (DL) tekniklerini birleştirebilen bir yapay zeka (YZ) uygulamasıdır (Pruneski ve ark. 2023). Metin madenciliği, duygu analizi, konuşma tanıma ve makine çevirisi gibi çeşitli teknikleri içerir (Alowais ve ark. 2023). Bilgisayar bilimi ve dilbilimin kesişimi olarak kavramsal olarak tanımlanabilecek doğal dil işleme, yapılandırılmamış metin veya insan tabanlı dili (bilgiyi temsil edebileceğimiz herhangi bir metin tabanlı yol) analiz etmek için hesaplamalı yöntemlerin uygulanmasını içermesinin yanı sıra bu teknoloji günlük yaşamımızda mevcuttur ve Alexa, Siri ve Google Assistan'ın günlük işlerimizde bize yardımcı olmasını sağlar. Akademide ise gelişmiş NLP tabanlı uygulamalar genellikle bilgi alma, bilgi çıkarma ve kohort/tanımlama gibi bir dizi görevi gerçekleştirmek için kullanılmaktadır. (Pruneski ve ark. 2023).

Büyük Dil Modelleri (LLM):

Yeni metin tabanlı içeriği anlamak, özetlemek, tahmin etmek ve oluşturmak için çok büyük veri kümelerini ve derin öğrenme tekniklerini kullanan bir tür YZ algoritmasıdır (Suleimanov ve ark.2020). Metin tabanlı içerik üretmek için tasarlanmıştır ve metin üretimi, çeviri, içerik özeti, yeniden yazma, sınıflandırma, kategorizasyon ve duygu analizi dahil olmak üzere çeşitli NLP görevleri için geniş uygulanabilirliğe sahiptir (Alowais ve ark. 2023, Davenport ve Kalakota 2019).

YZ'nin popülaritesindeki artış, makine öğrenimi, derin öğrenme ve doğal dil işleme alanındaki kayda değer gelişmelere bağlanabilmesinin sonucu olarak finans, üretim, eğlence ve en önemlisi sağlık hizmetleri gibi çeşitli alanlarda dönüştürücü bir güç haline gelmektedir (Rony ve ark. 2024,Rong ve ark. 2020).

HEMŞİRELİK BAKIMINDA YAPAY ZEKA KULLANILMASI

Bakım, insanlığın varoluşu ile ortaya çıkan, çeşitli şekillerde tanımlanmış olmasına karşın, tek bir tanımı olmayan ancak fenomenolojik, ilişkisel, etik ve öznel yönleri olan çok boyutlu bir olgudur (Gül 2019). Bakım uygulamaları bireyin duygu, düşünce ve ihtiyaçlarına yönelik, bireye içten şefkat ve sevgi verilerek, destek sağlanarak yapılan uygulamalardır (Toru 2020). Türk Dil Kurumu (TDK)'na göre ise "bakım" kavramı; "bakma işi, bir şeyin iyi gelişmesi/iyi bir durumda kalması için verilen emek, bir kişinin beslenme, giyinme vb. ihtiyaçlarını üstlenme ve sağlama işi olarak" tanımlanmıştır (TDK 2025).

Hemşirelik ve bakım, birbiriyle ayrılmaz bir bütündür. Bakım kavramı hemşirelik mesleğinin temelinde, yer almaktadır (Karaca ve Durna 2018). Hemşireler, sağlığı geliştirme ve korumaya odaklanan tedavi, bakım ve rehabilitasyon süreçlerinde yer alan sağlık profesyonelleridir (Doğan Merih ve Akdoğan 2021). Hemşirelik, birey, aile ve toplumun sağlığı ile ilgilenen ve basmakalıp algılanma biçiminden sıyrılarak teknolojik, sosyo-kültürel ve bilimsel değişimlerle kendini sürekli yenileyen, uygulamalı profesyonel meslek disiplinidir (Ulubay ve ark. 2022). Sağlık alanındaki yenilikleri değişimleri, gelişmeleri takip etmekte ve uyum sağlamaktadırlar (Doğan Merih ve Akdoğan 2021). Hasta bakımının sunulmasında hemşireler, önemli bir rol oynamaktadırlar ve yüksek kaliteli, kanıta dayalı uygulamalara olan talebin artmasının sonucu olarak hemşirelik işgücü en son teknolojik gelişmelerle güncel kalmaktadırlar. (Seibert ve ark. 2021, Martinez Ortigosa ve ark. 2023). Hemşirelik uygulamalarının da sağlık sektörünün tüm alanlarında olduğu gibi karmaşık duruma gelmesi, hastaların beklentilerindeki artış, hızla gelişmekte olan bilgi ve teknolojiye uyum sağlama gereksinimi, küresel rekabet ve sağlık bakım hizmetleri maliyetlerindeki artış hemşirelik mesleğinde teknolojik gelişmeleri zorunlu kılmaktadırlar. (Doğan Merih ve Akdoğan 2021, Ulubay ve ark. 2022). Teknoloji, hemşireliği birçok yönden ilerletmekte, hasta güvenliğini artırmakta ve hemşirelerin hastayı daha yakından tanımasına olanak sağlamaktadır (Akgerman ve ark. 2022).

Hemşireliğin yapay zeka teknolojisiyle bütünleşmesi sadece bir olasılık değil, kaçınılmaz bir gelecektir (Pepito ve Locsin 2019). YZ teknolojilerinin entegrasyonundan hasta bakımının ön saflarında yer alan hemşireler önemli ölçüde faydalanabilir (Rony ve ark. 2024, O'Connor ve ark. 2023). Günümüzde bazı hastanelerdeki yoğun bakım hemşireleri, hasta takibini ve hemşirelik bakım planları geliştirmek, idari görevleri ele almak ve klinik karar almayı iyileştirmek için YZ'yi kullanmaktadırlar (Alderden ve Johnny 2023, Escobar ve ark. 2020). Gelecekte YZ, erken tespit ve teşhis için gerçek zamanlı içgörüler sağlayacak, sağlık hizmeti kaynaklarının verimli bir şekilde tahsisini kolaylaştıracak ve dokümantasyon dahil olmak üzere rutin hemşirelik görevlerini düzene sokacak ve otomatikleştirecektir (Rajpurkar ve ark. 2022).

YZ destekli sistemler, müdahaleler için kanıta dayalı öneriler sunarak, ilaç dozlarını optimize ederek veya gerçek zamanlı hasta verilerine dayalı tedavi planlarında ayarlamalar önererek hemşirelere destek olabilir (Datta ve Singh 2021). . Yapay zekadan yararlanarak hemşireler, iş akışlarını optimize ederken ve hasta güvenliğini artırırken zamanında, doğru ve kişiselleştirilmiş bakım sağlamak için daha iyi donanımlı hale gelirler(Van de Sande ve ark. 2021). Gerçek zamanlı veri analizinden tahmini içgörülere ve özelleştirilmiş bakım planlarına kadar, YZ hemşirelerin kritik derecede hasta hastaları yönetme biçimini yeniden şekillendirir ve sağlık hizmetlerinin en zorlu alanlarından birinde sonuçları iyileştirir (Khani ve ark. 2024, Lovejoy ve ark. 2019). Yapay zeka yoğun bakım hemşirelik bakımını önemli

ölçüde etkilemektedir (Khani ve ark. 2024). Kaynak tahsisinin yaşam ile ölüm arasındaki farkı yaratabileceği yoğun bakım ünitelerinde, yapay zekanın hasta ihtiyaçlarını tahmin etme yeteneği, doğru kaynakların doğru zamanda mevcut olmasını sağlayarak (Khani ve ark. 2024). hemşirelik ekiplerinin yüksek talep durumlarında bile optimum bakım seviyelerini korumasına yardımcı olur (Ortiz-Barrios ve ark. 2023).

Yapay zekanın yoğun bakım hemşirelik bakımına entegrasyonu, sağlık ekipleri arasındaki iletişimi ve iş birliğini iyileştirme potansiyeline de sahiptir. Yapay zeka sistemleri, hemşireler, doktorlar ve diğer uzmanlar arasında hasta verilerinin ve klinik içgörülerin paylaşılmasını kolaylaştırarak, hastanın bakımına dahil olan herkesin en güncel bilgilere erişmesini sağlayarak koordinasyonu iyileştirir ve tedavide yanlış iletişimi veya gecikmeleri önlemeye yardımcı olur ve sonuç olarak daha iyi hasta sonuçlarına yol açar (Yoon ve ark. 2022). Yoğun bakım hemşireleri, zararı tanıyıp azaltırken sağlık hizmeti YZ'sinin faydalarını en üst düzeye çıkarmak için bilgilerini kullanırlar (Alderden ve Johnny 2023).

Yapay zekanın yoğun bakımda hemşirelik bakımını iyileştirme potansiyeli çok büyük olsa da, yapay zekanın insan hemşirelerin yerini almadığını belirtmek önemlidir. YZ hemşirelik profesyonellerinin becerilerini ve uzmanlıklarını tamamlayan güçlü bir araçtır (Khani ve ark. 2024). Yapay zeka algoritmaları yararlı bilgiler sağlayabilmesine rağmen, hemşirelerin karar alma süreçlerini ikame etmektense her zaman destekleyen araçlar olarak görülmelidir. (Alderden ve Johnny 2023). Yapay zeka, hemşirelerin daha verimli çalışmasını ve daha iyi bilgilendirilmiş kararlar almasını sağlar, ancak en iyi hasta sonuçları için insan yargısı ve bakımı esastır (Chiu ve Yen ark. 2023, Yoon ve ark. 2022).

Yapay zeka sistemleri veri analizi, karar alma ve iş akışı optimizasyonuna yardımcı olabilir, ancak hemşirelerin şefkatli bakımı, empati ve eleştirel düşünme becerileri yeri doldurulamaz olmaya devam etmektedir (Khani ve ark. 2024). YZ, yoğun bakım hemşirelik iş akışını ve bakım kalitesini artırabilse de YZ bir araçtır ve tüm araçlar gibi hem fayda hem de zarar potansiyeline sahiptir (Alderden ve Johnny 2023). YZ'nın hem sağlık hizmetlerine hem de hemşirelik eğitimine entegrasyonuyla ilişkili zorlukların anlaşılması gerekir. YZ kullanımında saçma veya yanlış üretilen çıktılar (halüsinasyonlar olarak bilinir), önyargı ve veri güvenliği gibi etik endişelerin dikkate alınması gerekir (Montejo ve ark. 2024).

YOĞUN BAKIM ÜNİTELERİNDE YAPAY ZEKA KULLANIMI

Yoğun bakım ünitesi, kritik derecede hasta olan hastaların tedavisine adanmış özel bir alandır (Li ve ark. 2024).Yoğun bakım ünitesi ortamı, hızlı değerlendirme ve tedavi kararları modeli gerektiren karmaşık, yaşamı tehdit eden koşullara sahip kritik derecede hastaların bulunduğu ortamlardır (Levin ve ark. 2024). Kritik derecede hasta olan hastaların izlenmesi için oldukça spesifik ve karmaşık bir alandır. Daha yoğun, zamanında ve koordineli müdahaleler gerektirir ve 24 saat kesintisiz bakım sağlar. Yüksek hasta keskinliği ve karmaşık bakım ihtiyaçları ve yoğun bakım ünitesinin benzersiz talepleri, yapay zekayı yoğun bakım ünitesi teknolojilerine entegre etmek için ideal bir ortam haline getirir (Khani ve ark. 2024).

Yoğun bakım üniteleri, rutin olarak önemli miktarda veri toplayarak makine öğrenimi ve YZ teknolojileri kullanımı için ideal bir ortam sağlar (Li ve ark. 2024). Yapay zeka yoğun bakım ünitesindeki karar alma süreçlerini geliştirir (Khani ve ark. 2024). Yapay Zeka (AI), görevleri otomatikleştirerek, gerçek zamanlı veri analizi sağlayarak ve klinik karar almayı destekleyerek yoğun bakımı devrim niteliğinde değiştirme potansiyeline sahiptir (Sun ve ark. 2024). Yoğun bakım ünitesinde hasta bakımı dokümantasyonu, ilaç yönetimi ve izleme verileri esastır ancak zaman alıcı olmasına rağmen yapay zeka destekli sistemler bu dokümantasyon sürecinin çoğunu otomatikleştirebilir, ilgili verileri yakalayabilir ve hemşirelerden minimum girdiyle raporlar oluşturabilir (Khani ve ark. 2024). Yapay zeka robotlarının yoğun bakım ünitelerine girişi henüz başlangıç aşamasında olmasına rağmen özerklikleri, eğitim kolaylığı ve güçlü uyarlanabilirlikleri performanslarını artırır ve sağlık çalışanlarına önemli ölçüde yardım sağlar. COVID-19 salgını, yorulmayan veya enfekte olmayan yapay zeka robotlarına olan talebi artırmasının sonucu olarak yoğun bakım ünitesi tıbbi personelinin yorgunluğunu azaltabilir, tıbbi hataları azaltabilir ve hasta güvenliğini iyileştirebilir (Li ve ark. 2024). Yoğun bakım hastaları genellikle kalp hızı, kan basıncı, oksijen satürasyonu ve solunum kalıpları gibi hayati belirtileri

izleyen çeşitli cihazlarla izlenir. Yapay zeka algoritmaları bu verileri anında analiz ederek kalıpları belirleyebilir ve potansiyel komplikasyonları kritik hale gelmeden önce tahmin edebilir (Khani ve ark. 2024). Liu ve ark. (2020) tarafından yapılan bir çalışmada sepsisli hastalarda risk yörüngelerini tahmin etmek için bir yapay zeka algoritması geliştirildi ve algoritmanın performansının laktat gibi laboratuvar değerlerinin daha erken ve daha sık ölçülmesiyle sepsisin daha erken saptanabileceği sonucuna ulaşılmıştır. Yapay zeka robotlarının gelecekteki yoğun bakım ünitelerinde çeşitli sağlık görevlerini yerine getirmede önemli bir rol oynayacağını tahmin edilmektedir (Kosa ve ark. 2023). Yapay zeka hemşirelik iş akışlarını kolaylaştırmaya, idari görevlerin yükünü azaltmaya ve hemşirelerin doğrudan hasta bakımına daha fazla odaklanmasını sağlamaya yardımcı olabilir (Khani ve ark. 2024). YZ'nın hasta durumlarının tanımlanmasını, önlenmesini ve yönetimini iyileştirme potansiyeli gösterdiği ve böylece hasta bakımını ve hemşirelik uygulamasını geliştirdiği görülmüştür (Porcellato ve ark. 2025). Yapay zekanın gelecekteki yoğun bakım ünitelerinde çeşitli sağlık görevlerini yerine getirmede önemli bir rol oynayacağını tahmin edilmektedir (Kosa ve ark. 2023). YZ teknolojileri geliştikçe yoğun bakım hemşirelik uygulamalarına entegrasyonu daha da sorunsuz hale gelecek, kritik bakımı daha da dönüştürecek ve hemşirelerin daha iyi hasta sonuçları sunmasını sağlayacaktır (Khani ve ark. 2024). Özellikle hemşirelikte YZ'nin anlaşılması ve uygulanmasına yönelik bir ihtiyaç vardır. Swan (2021).

YOĞUN BAKIM ÜNİTELERİ VE HEMŞİRELİK BAKIMINDA YAPAY ZEKA KULLANIMINA İLİŞKİN ULUSAL VE ULUSLARARASI ÇALIŞMALAR

Yoğun bakım üniteleri ve hemşirelik bakımında yapay zeka kullanımına ilişkin ulusal literatür incelendiğinde; Kuleyin ve Çiçek Korkmaz (2025) tarafından yapılan bir derleme çalışmasında yapay zeka destekli robot hemşirelerin, tedavi ve bakım hizmetlerinin sunulmasında, hastaların izlenmesinde hemşirelere destek sağlayan önemli araçlar olduğu, pandemi gibi kriz durumlarında, hemşirelerin iş yükünü azaltmak, enfeksiyon riskini düşürmek ve bakım kalitesini artırmak adına anlamlı katkılar sunduğu ve etik, hukuki ve kültürel kaygılar göz önünde bulundurulduğunda, insan merkezli bakımın yerini almak yerine süreci tamamlayıcı bir bileşen olarak değerlendirilmesi gerektiği sonucuna ulaşılmıştır. Kandemir ve Azizoğlu (2024) tarafından yapılan kesitsel tanımlayıcı bir çalışmada hemşirelerin yapay zekaya yönelik genel tutumlarının olumlu olduğu ve sağlık hizmetlerinde yapay zekanın hemşirelik bakım ve uygulamalarında önemli bir rol oynadığı sonucuna ulaşılmıştır. Özdemir ve ark. (2024) tarafından yapılan bir çalışmada bir yapay zeka destekli bir robot hemşire geliştirilmiş ve robotun, hastalara zaman kaybetmeden müdahale ettiği, rutin sağlık kontrol ve bakımlarının eksiksiz ve sürekli yapılmasını ilaçların hastalara zamanında dağıtılmasına yardımcı olduğu, ekipmanların üzerinde olması ile acil durumlarda hastaya anında ve doğru müdahale tedavinin yapılmasını sağladığı, hemşirelerin görevlerinin hafifleterek eksiksiz ve doğru sağlık hizmeti vermeye destek olduğu sonucuna ulaşılmıştır.

Yoğun bakım üniteleri ve hemşirelik bakımında yapay zeka kullanımına ilişkin uluslararası literatür incelendiğinde; Raghunath ve ark. (2021) tarafından yapılan bir çalışmada derin öğrenmenin, daha önce AF öyküsü olmayan hastalarda 12 derivasyonlu EKG'den yeni başlayan AF'yi tahmin edebildiği ve AF ile ilişkili inme riski taşıyan hastaların belirlenmesine yardımcı olduğu sonucuna ulaşılmıştır. Yang ve ark. (2024) tarafından yapılan bir çalışmada YBÜ'de Kritik hastalarda sürekli renal replasman tedavisinin (CRRT) alan hastalarda 48 saat içinde devre pıhtılaşmasını tahmin etmek için bir tahmin modeli geliştirmiş modelin önemli klinik fayda sağladığı, sağlık hizmeti sağlayıcılarının, devre pıhtılaşma riski yüksek olan hastaları derhal belirlemek için bu modelden yararlanabileceği sonucuna ulaşılmıştır. Alanazi ve ark. (2023) tarafından yapılan bir çalışmada yoğun bakım ünitesi hastalarında sepsis'in erken tahmini için makine öğrenimi yaklaşımının kullanılmasının hastalarda sepsisi geleneksel yöntemlerden daha iyi tahmin ettiği sonucuna ulaşılmıştır. Liu ve ark. (2023) tarafından yapılan bir çalışmada YZ'nin hastaları izlemek ve tedavileri gerçek zamanlı olarak ayarlamak için verileri entegre etmedeki etkinliğini vurgulanmış ve ciddi komplikasyonlarda azalma ile sonuçlandığı sonucuna ulaşılmıştır. Rodriguez ve arkadaşlarına (2023) tarafından yapılan bir çalışmada, YZ rehberliğinde sıvı hacim replasmanı pulmoner ödem insidansını azalttığı ve hastanede kalış süresini

kısalttığı sonucuna ulaşılmıştır. Schuurmans ve ark. (2025) tarafından yapılan randomize klinik bir çalışmada Elektif kalp cerrahisi hastalarında kardiyak cerrahi sırasında ve yoğun bakım ünitesinde standart bakıma ek olarak tanı rehberliği ile birlikte hipotansiyon için makine öğrenimi türevi bir erken uyarı aracı olan Hipotansiyon Tahmin İndeksi (HPI)'nin kullanılması, hipotansiyon şiddetini standart bakıma göre anlamlı derecede azalttığı sonucuna ulaşılmıştır.

SONUÇ

Yapay zekanın sağlık hizmetlerine entegrasyonu, hasta bakımı ve sonuçlarını devrim niteliğinde değiştirmek için muazzam bir potansiyele sahiptir (Alowais ve ark. 2023). Yapay zeka, yoğun bakım ünitesinde hemşirelik bakımını iyileştirmek için değerli ve etkili çözümler sunar. YZ, hemşirelerin gerçek zamanlı izleme ve öngörücü analizlerden kişiselleştirilmiş bakım ve iş akışı optimizasyonuna kadar kritik ortamlarda yüksek kaliteli bakım sağlama yeteneğini artırmaktadır. Ülkemizde kullanımının yaygınlaştırılması ve konuyla ilgili deneysel araştırmalara daha fazla ağırlık verilmesi önerilebilir.

KAYNAKLAR

1. Bellini, V., Valente, M., Bertorelli, G., Pifferi, B., Craca, M., Mordonini, M., Lombardo, G., Bottani, E., Del Rio, P., & Bignami, E. (2022). Machine learning in perioperative medicine: A systematic review. *Journal of Anesthesia, Analgesia and Critical Care, 2*(1), 2–13.

2. Gutierrez, G. (2020). Artificial intelligence in the intensive care unit. *Critical Care, 24*(1), 1–9.

3. Sun, K., Roy, A., & Tobin, J. M. (2024). Artificial intelligence and machine learning: Definition of terms and current concepts in critical care research. *Journal of Critical Care, 82*.

4. Alowais, S. A., Alghamdi, S. S., Alsuhebany, N., Alqahtani, T., Alshaya, A. I., Almohareb, S. N., Aldairem, A., Alrashed, M., Bin Saleh, K., Badreldin, H. A., Al Yami, M. S., Al Harbi, S., & Albekairy, A. M. (2023). Revolutionizing healthcare: The role of artificial intelligence in clinical practice. *BMC Medical Education, 23*(1), 689.

5. Ahuja, A. S. (2019). The impact of artificial intelligence in medicine on the future role of the physician. *PeerJ*.

6. Seibert, K., Domhoff, D., Bruch, D., et al. (2021). Application scenarios for artificial intelligence in nursing care: Rapid review. *Journal of Medical Internet Research, 23*(11).

7. Escobar, G. J., Liu, V. X., Schuler, A., Lawson, B., Greene, J. D., & Kipnis, P. (2020). Automated identification of adults at risk for in-hospital clinical deterioration. *The New England Journal of Medicine, 383*(20), 1951–1960.

8. Rajpurkar, P., Chen, E., Banerjee, O., & Topol, E. J. (2022). AI in health and medicine. *Nature Medicine, 28*(1), 31–38.

9. Datta, R., & Singh, S. (2021). Artificial intelligence in critical care: It's about time! *Medical Journal Armed Forces India, 77*(3), 266–275.

10. van de Sande, D., van Genderen, M. E., Huiskens, J., Gommers, D., & van Bommel, J. (2021). Moving from bytes to bedside: A systematic review on the use of artificial intelligence in the intensive care unit. *Intensive Care Medicine, 47*(7), 750–760.

11. Lovejoy, C. A., Buch, V., & Maruthappu, M. (2019). Artificial intelligence in the intensive care unit. *Critical Care, 23*(1), 7.

12. Ortiz-Barrios, M., Arias-Fonseca, S., Ishizaka, A., Barbati, M., Avendaño-Collante, B., & Navarro-Jiménez, E. (2023). Artificial intelligence and discrete-event simulation for capacity management of intensive care units during the COVID-19 pandemic: A case study. *Journal of Business Research, 160*.

13. Yoon, J. H., Pinsky, M. R., & Clermont, G. (2022). Artificial intelligence in critical care medicine. *Critical Care, 26*(1), 75.

14. Chiu, F. Y., & Yen, Y. (2023). Imaging biomarkers for clinical applications in neuro-oncology: Current status and future perspectives. *Biomarker Research, 11*(1), 35.

15. Rong, G., Mendez, A., Assi, E. B., Zhao, B., & Sawan, M. (2020). Artificial intelligence in healthcare: Review and prediction case studies. *Engineering, 6*(3), 291–301.

16. Haeberle, H. S., Helm, J. M., Navarro, S. M., Karnuta, J. M., Schaffer, J. L., Callaghan, J. J., Mont, M. A., Kamath, A. F., Krebs, V. E., & Ramkumar, P. N. (2019). Artificial intelligence and machine learning in lower extremity arthroplasty: A review. *Journal of Arthroplasty, 34*(10), 2201–2203.

17. Rajkomar, A., Dean, J., & Kohane, I. (2019). Machine learning in medicine. *The New England Journal of Medicine, 380*, 1347–1358.

18. Sidey-Gibbons, J. A. M., & Sidey-Gibbons, C. J. (2019). Machine learning in medicine: A practical introduction. *BMC Medical Research Methodology, 19*(1), 64.

19. Chen, B., Alrifai, W., Gao, C., Jones, B., Novak, L., Lorenzi, N., France, D., Malin, B., & Chen, Y. (2021). Mining tasks and task characteristics from electronic health record audit logs with unsupervised machine learning. *Journal of the American Medical Informatics Association, 28*(6), 1168–1177.

20. Calfee, C. S., Delucchi, K. L., Sinha, P., Matthay, M. A., Hackett, J., Shankar-Hari, M., McDowell, C., Laffey, J. G., O'Kane, C. M., McAuley, D. F., & Irish Critical Care Trials Group. (2018). Acute respiratory distress syndrome subphenotypes and differential response to simvastatin: Secondary analysis of a randomised controlled trial. *The Lancet Respiratory Medicine, 6*(9), 691–698.

21. Kolli, S., Rodenbough, A., Jones, K., Mason, C., Opolka, C., Grunwell, J., & Fitzpatrick, A. (2021). Latent class analysis of pediatric patients with near-fatal asthma. *Critical Care Medicine, 49*(1), 484.

22. Suleimenov, I. E., Vitulyova, Y. S., Bakirov, A. S., & Gabrielyan, O. A. (2020). Artificial intelligence: What is it? In *Proceedings of the 2020 6th International Conference on Computer Technology and Applications* (pp. 5–22).

23. Davenport, T., & Kalakota, R. (2019). The potential for artificial intelligence in healthcare. *Future Healthcare Journal, 6*(2), 94–98.

24. Liu, R., Greenstein, J. L., Fackler, J. C., Bembea, M. M., Winslow, R. L. (2020). Spectral clustering of risk score trajectories stratifies sepsis patients by clinical outcome and interventions received. *eLife, 9.*

25. Kuleyin, B., & Çiçek Korkmaz, A. (2025). Robot hemşirelerin hemşirelik mesleği üzerine yansımaları. *Sağlık ve Hemşirelik Yönetimi Dergisi, 12*(1), 192–198.

26. Pailaha, A. D. (2023). The impact and issues of artificial intelligence in nursing science and healthcare settings. *SAGE Open Nursing, 9.*

27. Park, Y., Chang, S. J., & Kim, E. (2025). Artificial intelligence in critical care nursing: A scoping review. *Australian Critical Care, 38*(4).

28. Saqib, M., Iftikhar, M., Neha, F., Karishma, F., & Mumtaz, H. (2023). Artificial intelligence in critical illness and its impact on patient care: A comprehensive review. *Frontiers in Medicine, 10.*

29. Raghunath, S., Pfeifer, J. M., Ulloa-Cerna, A. E., Nemani, A., Carbonati, T., Jing, L., … Haggerty, C. M. (2021). Deep neural networks can predict new-onset atrial fibrillation from the 12-lead ECG and help identify those at risk of atrial fibrillation-related stroke. *Circulation, 143*(13), 1287–1298.

30. Yang, E., Wang, Q., Guo, J., Wei, J., Zhang, C., Zhao, W., He, X., Bo, E., Mao, Y., Yang, H. (2024). Development and external validation of a prediction model for the premature circuit clotting of continuous renal replacement therapy in critically ill patients. *Intensive and Critical Care Nursing, 84.*

31. Alanazi, A., Aldakhil, L., Aldhoayan, M., & Aldosari, B. (2023). Machine learning for early prediction of sepsis in intensive care unit (ICU) patients. *Medicina (Kaunas), 59*(7), 1276.

32. Liu, F., Yao, J., Liu, C., & Shou, S. (2023). Construction and validation of machine learning models for sepsis prediction in patients with acute pancreatitis. *BMC Surgery, 23*(1), 267.

33. Rodríguez, A., Gómez, J., Franquet, Á., Trefler, S., Díaz, E., Sole-Violán, J., Zaragoza, R., Papiol, E., Suberviola, B., Vallverdú, M., Jimenez-Herrera, M., Albaya-Moreno, A., Canabal Berlanga, A., Del Valle Ortíz, M., Carlos Ballesteros, J., López Amor, L., Sancho Chinesta, S., de Alba-Aparicio, M., Estella, A., … Bodi, M. (2024). Applicability of an unsupervised cluster model developed on first wave COVID-19 patients in second/third wave critically ill patients. *Medicina Intensiva (English Edition), 48*(6), 326–340.

34. Schuurmans, J., Rellum, S. R., Schenk, J., van der Ster, B. J. P., van der Ven, W. H., Geerts, B. F., Hollmann, M. W., Cherpanath, T. G. V., Lagrand, W. K., Wynandts, P. R., Paulus, F., Driessen, A. H. G., Terwindt, L. E., Eberl, S., Hermanns, H., Veelo, D. P., & Vlaar, A. P. J. (2025). Effect of a machine learning-derived early warning tool with treatment protocol on hypotension during cardiac surgery and ICU stay: The Hypotension Prediction 2 (HYPE-2) randomized clinical trial. *Critical Care Medicine, 53*(2).

35. Alderden, J., Johnny, J., Brooks, K. R., Wilson, A., Yap, T. L., Zhao, Y. L., van der Laan, M., & Kennerly, S. (2024). Explainable artificial intelligence for early prediction of pressure injury risk. *American Journal of Critical Care, 33*(5), 373–381.

36. Hassan, E. A., & El-Ashry, A. M. (2024). Leading with AI in critical care nursing: Challenges, opportunities, and the human factor. *BMC Nursing, 23*(1), 752.

37. Çınar, F., & Eti Aslan, F. (2017). Spiritüalizm ve hemşirelik: Yoğun bakım hastalarında spiritüel bakımın önemi.

38. Levin, C., Suliman, M., Naimi, E., & Saban, M. (2024). Augmenting intensive care unit nursing practice with generative AI: A formative study of diagnostic synergies using simulation-based clinical cases. *Journal of Clinical Nursing.*

39. Khani, A., Sadeghi Velni, E., Hosseini, S. S., Bagherieh, D., Abshat, M., & Masoumi, S. J. (2024). Artificial intelligence: A valuable and effective tool to improve nursing care of patients admitted to the intensive care unit. *Journal of Nursing Reports in Clinical Practice, 3*(4), 415–417.

40. Swan, B. A. (2021). Assessing the knowledge and attitudes of registered nurses about artificial intelligence in nursing and health care. *Nursing Economic$, 39*(3).

41. Martinez-Ortigosa, A., Martinez-Granados, A., Gil-Hernández, E., Rodriguez-Arrastia, M., Ropero-Padilla, C., & Roman, P. (2023). Applications of artificial intelligence in nursing care: A systematic review. *Journal of Nursing Management.*

42. Porcellato, E., Lanera, C., Ocagli, H., & Danielis, M. (2025). Exploring applications of artificial intelligence in critical care nursing: A systematic review. *Nursing Reports, 15*(2), 55.

43. Türk Dil Kurumu. (2025). *Güncel Türkçe Sözlük*. www.sozluk.gov.tr (Erişim tarihi: 10.05.2025)

44. Abonamah, A. A., Tariq, M. U., & Shilbayeh, S. (2021). On the commoditization of artificial intelligence. *Frontiers in Psychology, 12.*

45. Bini, S. A. (2018). Artificial intelligence, machine learning, deep learning, and cognitive computing: What do these terms mean and how will they impact health care? *The Journal of Arthroplasty*, 2358–2361.

46. Shah, N., Arshad, A., Mazer, M. B., Carroll, C. L., Shein, S. L., & Remy, K. E. (2023). The use of machine learning and artificial intelligence within pediatric critical care. *Pediatric Research, 93*(2), 405–412.

47. Helm, J. M., Swiergosz, A. M., Haeberle, H. S., Karnuta, J. M., Schaffer, J. L., Krebs, V. E., Spitzer, A. I., & Ramkumar, P. N. (2020). Machine learning and artificial intelligence: Definitions, applications, and future directions. *Current Reviews in Musculoskeletal Medicine, 13*(1), 69–76.

48. Çilhoroz, Y., & Işık, O. (2021). Yapay zekâ: Sağlık hizmetlerinde uygulamalar. *Ankara Hacı Bayram Veli Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, 23*(2), 573–588.

49. Pruneski, J. A., Pareek, A., Nwachukwu, B. U., Martin, R. K., Kelly, B. T., Karlsson, J., Pearle, A. D., Kiapour, A. M., & Williams, R. J. (2023). Natural language processing: Using artificial intelligence to understand human language in orthopedics. *Knee Surgery, Sports Traumatology, Arthroscopy, 31*(4), 1203–1211.

50. Rony, M. K. K., Kayesh, I., Bala, S. D., Akter, F., & Parvin, M. R. (2024). Gelecekteki hemşirelik bakımında yapay zeka: Hemşirelik profesyonellerinin bakış açılarını keşfetmek – Tanımlayıcı nitel bir çalışma. *Heliyon, 10*(4).

51. Li, Y., Wang, M., Wang, L., Cao, Y, Liu, Y., Zhao, Y., Yuan, R., Yang, M., Lu, S., Sun, Z., Zhou, F., Qian, Z., Kang, H. (2024). Advances in the application of AI robots in critical care: Scoping review. *Journal of Medical Internet Research, 26*.

52. Toru, F. (2020). Hemşirelik uygulamalarının kilit noktası: Bireyselleştirilmiş bakım. *Adnan Menderes Üniversitesi Sağlık Bilimleri Fakültesi Dergisi, 4*(1), 46–59.

53. Carroll, W. (2018). Artificial intelligence, nurses and the quadruple aim. *Online Journal of Nursing Informatics, 22*(2).

54. Akgerman, A., Yavuz, E. D. Ö., Kavaslar, İ., & Güngör, S. (2022). Yapay zeka ve hemşirelik. *Sağlık Bilimlerinde Yapay Zeka Dergisi, 2*(1), 21–27.

55. Özdemir, N., Kızıl, H., & Yılmaz, A. (2024). Yapay zeka destekli robot hemşire. *Beykent Üniversitesi Fen ve Mühendislik Bilimleri Dergisi, 17*(1), 56–69.

56. Al Kuwaiti, A., Nazer, K., Al-Reedy, A., Al-Shehri, S., Al-Muhanna, A., Subbarayalu, A. V., … Al-Muhanna, F. A. (2023). A review of the role of artificial intelligence in healthcare. *Journal of Personalized Medicine, 13*(6), 951.

57. Fernandes, F., Santos, P., Sá, L., & Neves, J. (2023). Contributions of artificial intelligence to decision making in nursing: A scoping review protocol. *Nursing Reports, 13*(1), 67–72.

58. Kosa, G., Morozov, O., Lehmann, A., Pargger, H., Marsch, S., & Hunziker, P. (2023). Robots and intelligent medical devices in the intensive care unit: Vision, state of the art, and economic analysis. *IEEE Transactions on Medical Robotics and Bionics, 5*(1), 2–17.

59. Karaca, A., & Durna, Z. (2018). Hemşirelik bakım kalitesi ve ilişkili faktörler. *Sağlık ve Toplum, 28*(2), 16–23.

60. Merih, Y. D., & Akdoğan, E. (2021). Hemşirelikte yapay zekâ. In *4th International Eurasian Conference on Biological and Chemical Sciences*.

61. Ulubay, S., Ayoğlu, T., & Özcan, E. (2022). Hemşirelik bakım ve uygulamalarında yapay zekâ kullanımının önemi. *Sağlık Bilimlerinde Yapay Zeka Dergisi, 2*(2), 13–17.

62. Pepito, J. A., & Locsin, R. (2019). Can nurses remain relevant in a technologically advanced future? *International Journal of Nursing Sciences, 6*(1), 106–110.

63. O'Connor, S., Yan, Y., Thilo, F. J., Felzmann, H., Dowding, D., & Lee, J. J. (2023). Artificial intelligence in nursing and midwifery: A systematic review. *Journal of Clinical Nursing, 32*(13–14), 2951–2968.

64. Kandemir, F., & Azizoğlu, F. (2024). Hemşirelerin yapay zekâya yönelik genel tutumlarının incelenmesi. *Yoğun Bakım Hemşireliği Dergisi, 28*(2), 113–125.

65. Alderden, J. G., & Johnny, J. D. (2023). Artificial intelligence and the critical care nurse. *Critical Care Nurse, 43*(5), 7–8.

66. Montejo, L., Fenton, A., & Davis, G. (2024). Artificial intelligence (AI) applications in healthcare and considerations for nursing education. *Nurse Education in Practice, 80*.

67. Gül, Ş. (2019). Bakım kavramı ışığında hemşirelik bakımı ve etkileyen faktörler. *ACU Sağlık Bilimleri Dergisi, 10*(2), 129–134.

SPORTIF FIZIKSEL AKTIVITEYE YÖNELIK TUTKUNUN KEYIF ALMA ÜZERINDEKI ETKISI

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Özet

Bu araştırma, sportif fiziksel aktiviteye yönelik tutkunun bireylerin fiziksel aktivitelerden aldıkları keyif üzerindeki etkisini incelemeyi amaçlamaktadır. Araştırma, nicel yöntemlerden ilişkisel tarama deseniyle yürütülmüş olup çalışma grubunu 2025-2026 eğitim-öğretim yılında Balıkesir Üniversitesi Spor Bilimleri Fakültesi'nde öğrenim gören 110'u (53,7) kadın ve 95'i (46,3) erkek toplam 205 öğrenci oluşturmaktadır. Veriler Demografik Bilgi Formu, Sporda Tutku Ölçeği ve Fiziksel Aktivitelerden Keyif Alma Ölçeği kullanılarak toplanmıştır. Analizlerde betimsel istatistikler, bağımsız örneklem T-Testi, tek yönlü ANOVA analizi, Pearson Korelasyon ve Regresyon analizi uygulanmıştır. Analiz sonuçları, sporda tutku ve fiziksel aktivitelerden keyif alma düzeylerinin cinsiyete göre anlamlı bir farklılık göstermediğini ortaya koymuştur. Spor yılı değişkenine göre yapılan analizlerde ise yalnızca sporda tutku düzeylerinin anlamlı biçimde farklılaştığı, dört yıl ve üzeri süredir spor yapan bireylerin tutku düzeylerinin daha yüksek olduğu belirlenmiştir. Buna karşılık, fiziksel aktiviteden keyif alma düzeylerinin spor yılına göre anlamlı biçimde değişmediği saptanmıştır. Korelasyon analizi sonuçları, sporda tutku ile fiziksel aktivitelerden keyif alma arasında pozitif ve anlamlı bir ilişki bulunduğunu göstermiştir. Regresyon analizi bulguları ise sporda tutkunun fiziksel aktivitelerden keyif alma düzeyini anlamlı biçimde yordadığını ve keyif alma üzerindeki toplam varyansın %4,7'sini açıkladığını ortaya koymuştur. Her ne kadar açıklanan varyans oranı sınırlı olsa da elde edilen bulgular, sportif fiziksel aktiviteye yönelik tutkunun bireylerin aktivite sürecinde yaşadıkları haz ve doyumu destekleyen önemli bir psikolojik bileşen olduğunu göstermektedir. Sonuç olarak, sportif fiziksel aktivite deneyiminin niteliğini artırmak amacıyla, bireylerin spora yönelik tutku düzeylerini güçlendirmeye yönelik uygulamaların destekleyici bir yaklaşım olarak değerlendirilebileceği söylenebilir.

Anahtar Kelimeler: Fiziksel Aktiviteden Keyif Alma; Sporda Tutku; Sportif Fiziksel Aktivite; Spor Bilimleri Öğrencileri

THE EFFECT OF PASSİON FOR SPORTS AND PHYSİCAL ACTİVİTY ON ENJOYMENT

Abstract

This study aims to examine the effect of passion for sports and physical activity on the enjoyment individuals derive from physical activities. The research was conducted using a correlational survey design, a quantitative method, and the study group consisted of a total of 205 students, 110 (53.7%) female and 95 (46.3%) male, studying at the Faculty of Sports Sciences at Balıkesir University during the 2025-2026 academic year. Data were collected using a Demographic Information Form, the Passion for Sports Scale, and the Enjoyment of Physical Activities Scale. Descriptive statistics, independent samples t-test, one-way ANOVA analysis, Pearson correlation, and regression analysis were applied in the analyses. The analysis results revealed that the levels of passion for sports and enjoyment of physical activities did not show a significant difference according to gender. In the analyses performed according to the variable of years of sports participation, only the levels of passion for sports were found to differ significantly, with individuals who had been participating in sports for four years or more having higher levels of passion. In contrast, it was found that the levels of enjoyment of physical activities did not change significantly according to the year of participation in sports. The correlation analysis results showed that there was a positive and significant relationship between passion for sports and enjoyment of physical activities. Regression analysis findings revealed that passion for sports significantly predicted the level of enjoyment of physical activities and explained 4.7% of the total variance in enjoyment. Although the explained variance ratio was limited, the findings indicate that passion for sports-related physical activity is an important psychological component that supports the pleasure and satisfaction individuals experience during the activity process. In conclusion, it can be said that practices aimed at strengthening individuals' levels of passion for sports can be considered a supportive approach to enhancing the quality of the sporting physical activity experience.

Anahtar Kelimeler: Enjoyment of Physical Activity; Passion for Sports; Sporting Physical Activity; Sports Science Students

GİRİŞ

Sportif fiziksel aktiviteler, bireylerin gündelik yaşamın stresinden uzaklaşmasını, bedensel canlılık kazanmasını ve psikolojik açıdan yenilenmesini sağlayan güçlü bir deneyim alanıdır (Lapa & Korkmaz, 2017; Van Der Zwan vd., 2015). Rekabetten bağımsız olarak gerçekleştirilen bu aktiviteler, kişinin kendi sınırlarını keşfetmesine, sosyal etkileşim kurmasına ve fiziksel-ruhsal dengeyi desteklemesine katkı sunmaktadır (Cuberos vd., 2018). Son yıllarda spor salonlarına, açık hava parkurlarına ve çeşitli egzersiz programlarına katılımın artması, bireylerin fiziksel aktiviteyi yalnızca sağlık için değil aynı

zamanda keyif ve içsel tatmin aracı olarak gördüklerini göstermektedir (Avşar & Kızılaslan, 2025; Gjestvang vd., 2021). Bu bağlamda sportif fiziksel aktivitelere yönelik geliştirilen tutku, bireylerin etkinlikten aldıkları haz, motivasyon ve sürdürülebilir katılım açısından belirleyici bir unsur haline gelebilir.

Sportif fiziksel aktiviteye yönelik bu tutkunun temelinde, bireylerin fiziksel, psikolojik ve sosyal açıdan kazandıkları olumlu deneyimler yer almaktadır (Curran vd., 2013). Bu süreçte tutkunun, aktivite sırasında yaşanan keyfi güçlendirdiği, bireyin etkinlikten aldığı haz, memnuniyet ve psikolojik canlılığı artırdığı düşünülmektedir. Keyif alma deneyiminin güçlenmesi, bireyin sportif aktivitelere yönelik bağlılığını korumasına ve etkinlik sürecinde daha yoğun bir tatmin yaşamasına katkı sağlamaktadır (Sun vd., 2025; Tianyue & Taresh, 2025). Aktivite sırasında hissedilen bu memnuniyet, bireyin sporla ilişkisini daha sürdürülebilir hale getirirken, sportif katılım motivasyonunu da desteklemektedir (Ardahan & Çalışkan, 2017). Dolayısıyla tutku ve keyif alma birlikte değerlendirildiğinde, sportif fiziksel aktivitelerin yalnızca performans sağlama sürecinden ziyade bireyin duygusal ve psikolojik iyi oluşunu güçlendiren önemli bir deneyim alanı sunduğu söylenebilir.

Son yıllarda sportif fiziksel aktiviteye yönelik tutku ve keyif alma kavramları, spor psikolojisi alanında giderek daha fazla ilgi görmeye başlamıştır (Breslow, 2023; Habib vd., 2022; Karakullukcu vd., 2025; Yücekaya, 2025). Özellikle bireyin bir aktiviteye güçlü bir duygusal bağ ile katılım göstermesinin, etkinlik sırasında yaşadığı haz ve memnuniyeti artırdığına yönelik bulgular araştırmacıların dikkatini çekmektedir (Feil vd., 2025; Liu vd., 2021). Yapılan çalışmalar, sportif tutkunun aktiviteye devam etme isteğini güçlendirdiğini, bunun da keyif alma düzeyini olumlu yönde etkilediğini göstermektedir Bento vd., 2024; Yukhymenko-Lescroart, 2021). Aynı şekilde fiziksel aktivite sürecinde yaşanan keyfin artması, bireyin spora yönelik bağlılığını ve katılım sürekliliğini desteklemektedir (Joung vd., 2024). Bu çerçevede tutku ve keyif alma arasındaki etkileşimin spor psikolojisi perspektifinden incelenmesi önemlidir. Ancak literatürde sportif fiziksel aktiviteye yönelik tutkunun keyif alma üzerindeki etkisini bütüncül olarak ele alan çalışmaya rastlanmamıştır. Mevcut araştırmalar genellikle tutku ve motivasyon, katılım gibi değişkenlere odaklanmaktadır (Breslow, 2023; Habib vd., 2022). Tutkunun doğrudan keyif alma üzerindeki etkisini derinlemesine ele alan çalışmaya rastlanmamıştır. Bu nedenle iki değişkenin birlikte incelenmesi literatürdeki boşluğun giderilmesine katkı sağlayacaktır.

Bu çalışma, sportif fiziksel aktiviteye yönelik tutkunun keyif alma üzerindeki etkisini inceleyerek alan yazına hem teorik hem de uygulamalı açıdan katkı sunmayı amaçlamaktadır. Akademik açıdan bakıldığında, fiziksel aktiviteye duyulan tutkunun keyif alma deneyimini nasıl şekillendirdiğine yönelik çalışmaya rastlanmamıştır. Bu araştırma, tutkunun ile keyif alma üzerindeki etkisini inceleyerek literatürdeki bu boşluğun giderilmesine katkı sağlamayı hedeflemektedir. Uygulama açısından ise elde edilecek bulguların, sportif etkinliklere katılan bireylerin deneyimlerini geliştirme, antrenör ve program planlayıcılarının katılım motivasyonunu artıracak stratejiler oluşturma ve rekreatif spor programlarının daha sürdürülebilir biçimde tasarlanmasına destek olacağı öngörülmektedir. Bu doğrultuda araştırmanın temel hipotezi aşağıdaki şekilde oluşturulmuştur:

H: Sportif fiziksel aktiviteye yönelik tutkunun, bireylerin fiziksel aktivitelerden aldıkları keyif üzerinde anlamlı bir etkisi bulunmaktadır.

Bu hipotez doğrultusunda araştırmanın amacı, sportif fiziksel aktiviteye yönelik tutkunun keyif alma düzeyini nasıl etkilediğini incelemektir.

YÖNTEM

Araştırma Modeli

Bu araştırmada, nicel araştırma yöntemleri arasında yer alan ilişkisel tarama deseni kullanılmıştır. İlişkisel tarama deseni, değişkenler arasındaki ilişkiyi ortaya koymayı hedefleyen bir araştırma yöntemidir (Karasar, 2005). Çalışma kapsamında, sportif fiziksel aktiviteye yönelik tutkunun keyif alma üzerindeki etkisi incelenmiştir.

Araştırma Grubu

Araştırmanın çalışma grubunu, 2025-2026 eğitim-öğretim yılında Balıkesir Üniversitesi Spor Bilimleri Fakültesi'nde öğrenim gören toplam 205 öğrenci oluşturmaktadır. Katılımcıların yaş ortalaması 20,03'tür. Katılımcıların 110'u (%53,7) kadın, 95'i (%46,3) ise erkektir. Spor yapma sürelerine bakıldığında, katılımcıların 33'ü (%16,1) bir yıldan az süredir, 43'ü (%21,0) 2–3 yıldır, 129'u ise (%62,9) dört yıl ve daha uzun süredir fiziksel aktiviteye katılım göstermektedir. Katılımcıların belirlenmesinde, erişilebilirliğin ön planda tutulduğu kolayda örnekleme yöntemi tercih edilmiştir. Bu yöntem, nicel araştırmalarda veri toplama sürecinin hem hızlı hem de ekonomik biçimde yürütülmesine olanak tanıdığı için kullanılmaktadır (Karagöz, 2021). Bryman ve Cramer'a (2002) göre, ölçek temelli çalışmalarda örneklem büyüklüğü, kullanılan ölçek maddelerinin en az beş katı olmalıdır. Bu araştırmada kullanılan ölçekler dikkate alındığında (19×5=95), 205 katılımcıdan oluşan örneklemin yeterli olduğu değerlendirilmiştir. Katılımcıların demografik özelliklerine ilişkin bilgiler Tablo 1'de sunulmuştur.

Tablo 1. Katılımcılara Ait Bilgiler

Değişkenler		**x̄**	**SS**
Yaş		20.03	2.31
		F	**%**
Cinsiyet	Kadın	110	53.7
	Erkek	95	46.3
Spor Yılı	1 Yıldan Az	33	16.1
	2-3 Yıl	43	21.0
	4 Yıl ve Daha Fazla	129	62.9
	Toplam	**205**	**100**

Veri Toplama Araçları

Araştırmada veri toplama aracı olarak; Demografik Bilgi Formu, Özdayı vd. (2021) tarafından Türkçeye uyarlanan Sporda Tutku Ölçeği ile Özkurt vd. (2022) tarafından uyarlanan Fiziksel Aktivitelerden Keyif Alma Ölçeği kullanılmıştır.

Demografik Bilgi Formu

Katılımcıların demografik özelliklerini belirlemek amacıyla, araştırmacı tarafından hazırlanan formda "yaş", "cinsiyet" ve "spor yılı" olmak üzere üç değişkene yer verilmiştir.

Sporda Tutku Ölçeği:

Katılımcıların spora yönelik tutku düzeylerini ölçmek amacıyla, Sigmundsson vd. (2020) tarafından geliştirilen, Türkçeye Özdayı vd. (2021) tarafından uyarlanarak geçerlik ve güvenirlik çalışmaları yapılan "Sporda Tutku Ölçeği" kullanılmıştır. Sekiz maddeden ve tek faktörden oluşan bu ölçekte, 5'li Likert tipi derecelendirme sistemi yer almaktadır: (1) Kesinlikle Katılmıyorum, (2) Katılmıyorum, (3) Kararsızım, (4) Katılıyorum, (5) Kesinlikle Katılıyorum. Ölçekte ters puanlanan herhangi bir madde bulunmamaktadır. Katılımcıların ölçekten alabileceği en düşük puan 8 (hiç tutkulu değil), en yüksek puan ise 45 (son derece tutkulu) olarak belirlenmiştir.

Fiziksel Aktivitelerden Keyif Alma Ölçeği:

Katılımcıların fiziksel aktivitelerden ne düzeyde keyif aldıklarını belirlemek amacıyla, Mullen vd. (2011) tarafından geliştirilen ve Özkurt vd. (2022) tarafından Türkçeye uyarlanan bir ölçek kullanılmıştır. Geçerlik ve güvenirlik analizleri yapılmış olan bu ölçek, tek boyutlu bir yapıya sahip olup toplam sekiz maddeden oluşmaktadır. Ölçek, 7'li Likert tipi derecelendirme sistemi ile yapılandırılmıştır: (1) Kesinlikle Katılmıyorum, (2) Katılmıyorum, (3) Kısmen Katılmıyorum, (4) Kararsızım, (5) Kısmen Katılıyorum, (6) Katılıyorum, (7) Kesinlikle Katılıyorum. Ölçekte ters puanlanan madde bulunmamaktadır. Ölçekten elde edilen puan ortalamasının yüksek olması, bireyin fiziksel aktivitelerden aldığı keyif düzeyinin yüksek olduğunu; düşük puan ortalaması ise keyif düzeyinin düşük olduğunu göstermektedir.Araştırmada kullanılan ölçeklere ait Cronbach"s Alpha iç tutarlılık katsayıları hesaplanmış ve sonuçları Tablo 2'de sunulmuştur.

Tablo 2. Ölçeklerin güvenirlik değerlerine ilişkin sonuçlar

Ölçekler	Ölçeğin Kendisine Ait Değer	Araştırmada Elde Edilen Değerler
Sporda Tutku Ölçeği	.81	.94
Fiziksel Aktivitelerden Keyif Alma Ölçeği	.96	.96

Verilerin Toplanması ve Analizi

Veriler, 2025-2026 eğitim-öğretim yılının güz döneminde, araştırmacılar tarafından çevrim içi form yöntemi aracılığıyla toplanmıştır. Gönüllü olarak araştırmaya katılmayı kabul eden Spor Bilimleri Fakültesi öğrencilerine veri toplama formu sunulmuştur. Elde edilen verilerin analiz süreci, SPSS 27.0 istatistik yazılımı ile yürütülmüştür. Verilerin normal dağılıma uygunluğunu değerlendirmek amacıyla Shapiro-Wilk ve Kolmogorov-Smirnov testleri uygulanmış; ayrıca çarpıklık (skewness) ve basıklık (kurtosis) değerleri göz önünde bulundurulmuştur. Bu değerlerin ±2 aralığında olup olmadığı kontrol edilerek, verilerin normal dağılım gösterip göstermediği belirlenmiştir (Tabachnick ve Fidell, 2013). Yapılan değerlendirmeler sonucunda, verilerin normal dağılım gösterdiği saptanmıştır. Bu doğrultuda,

analiz sürecinde öncelikle demografik değişkenlere ilişkin frekans ve yüzde dağılımları hesaplanmış; ardından betimsel istatistikler, Bağımsız Örneklem t-Testi, Tek Yönlü Varyans Analizi (ANOVA), Pearson Korelasyon Analizi ve Regresyon Analizi uygulanmıştır. Tüm analizler, SPSS 27.0 yazılımı ve Excel veri tabanı desteğiyle tamamlanmıştır.

BULGULAR

Tablo 3. Ölçeklerden Alınan Ortalama Puanın Cinsiyet Değişkenine Göre t-Testi Sonuçları

Ölçekler	Cinsiyet	N	x̄	SS	t	p
Sporda Tutku Ölçeği	Kadın	110	4.03	.83	.031	.975
	Erkek	95	4.02	.96		
Fiziksel Aktivitelerden Keyif Alma Ölçeği	Kadın	110	6.48	.83	.380	.704
	Erkek	95	6.43	.92		
	Toplam	**205**				

*p<.05

Cinsiyet değişkenine göre yapılan bağımsız örneklem t-testi sonuçlarına göre, Sporda Tutku Ölçeği puanları kadın (x̄=4.03) ve erkek katılımcılar (x̄=4.02) arasında anlamlı bir farklılık göstermemektedir (t=.031, p=.975). Benzer şekilde, Fiziksel Aktivitelerden Keyif Alma Ölçeği puanları da kadın (x̄=6.48) ve erkek katılımcılar (x̄=6.43) arasında istatistiksel olarak anlamlı bir farklılık içermemektedir (t=.380, p=.704). Elde edilen bulgular, katılımcıların sporda tutku düzeyleri ile fiziksel aktiviteden aldıkları keyfin cinsiyete göre değişmediğini göstermektedir.

Tablo 4. Ölçeklerden Alınan Ortalama Puanın Spor Yılı Değişkenine Göre One-Way Anova Sonuçları

Ölçekler	Spor yılı	N	x̄	SS	t	p	Anlamlılık
Sporda Tutku Ölçeği	1 Yıldan Az[a]	33	3.79	1.07	3.085	**.048**	**c>a**
	2-3 Yıl[b]	43	3.85	.97			
	4 Yıl ve Daha Fazla[c]	129	4.14	.79			
	Toplam	205	4.02	.89			
Fiziksel Aktivitelerden Keyif Alma Ölçeği	1 Yıldan Az[a]	33	6.68	.59	1.279	.281	
	2-3 Yıl[b]	43	6.41	.86			
	4 Yıl ve Daha Fazla[c]	129	6.41	.93			
	Toplam	205	6.46	.87			
	Toplam	**205**					

*p<.05

Spor yılı değişkenine göre yapılan tek yönlü varyans analizi sonucunda, Sporda Tutku Ölçeği puanlarının gruplar arasında anlamlı düzeyde farklılaştığı belirlenmiştir (p=.048). Ortalama değerler incelendiğinde, spora 4 yıl ve daha fazla süredir katılım gösteren bireylerin tutku düzeylerinin (x̄=4.14), 1 yıldan az (x̄=3.79) spor deneyimine sahip olanlara kıyasla daha yüksek olduğu görülmektedir. Buna karşın, Fiziksel Aktivitelerden Keyif Alma Ölçeği puanları spor yılına göre anlamlı bir farklılık göstermemektedir (p=.281).

Tablo 5. Değişkenler Arası İlişkinin Pearson Momentler Çarpımı Korelasyonu ile İncelenmesi

Değişken		**Sporda Tutku Ölçeği**
Fiziksel Aktivitelerden Keyif Alma Ölçeği	r	.228**
	p	,001

****p<.01**

Pearson korelasyon analizi sonuçları, Sporda Tutku Ölçeği ile Fiziksel Aktivitelerden Keyif Alma Ölçeği arasında pozitif ve anlamlı bir ilişki olduğunu göstermektedir (r=.228, p=.001).

Tablo 6. Sporda Tutkunun Keyif Alma Üzerindeki Etkisine Yönelik Regresyon Analizi Sonuçları

Değişken	**B**	**Std. Hata**	**β**	**t**	**p**
Sabit	5.555	.276	---	20.104	<.001
Sporda Tutku Ölçeği	.224	.067	.228	3.338	.001
			Bağımlı Değişken: Fiziksel Aktüvütelerden Keyif Alma Ölçeği		
				R=.228	R^2_{adj}=.047
				$F_{(1,203)}$ =11.142	p=.001

Regresyon analizi sonuçlarına göre, **Sporda Tutku Ölçeği**, **Fiziksel Aktivitelerden Keyif Alma** düzeyinin anlamlı bir yordayıcısıdır (β=.228, p=.001). Model genel olarak anlamlı bulunmuştur (F(1,203)=11.142, p=.001) ve sporda tutku değişkeni keyif alma puanlarındaki varyansın yaklaşık %4.7'sini açıklamaktadır (R^2adj=.047).

Tartışma ve Sonuç

Bu araştırmada spor bilimleri öğrencilerinin sporda tutku düzeylerinin fiziksel aktivitelerden elde ettikleri keyif üzerindeki etkisi incelenmiş ve ulaşılan bulgular mevcut literatürdeki çalışmalar ışığında yorumlanmıştır.

Araştırmanın ilk önemli sonucu, cinsiyet değişkeninin sporda tutku ve fiziksel aktiviteden keyif alma düzeylerini anlamlı biçimde farklılaştırmadığını ortaya koymuştur. Kadın ve erkek katılımcıların bu değişkenlerde benzer ortalama değerlere sahip olması, cinsiyetin tutku ve keyif düzeylerini belirleyen temel bir unsur olmadığına işaret etmektedir. Bu bulgu literatürdeki pek çok çalışma ile uyumludur. Philippe vd. (2009), tutku düzeylerinin çoğu durumda cinsiyet temelinde anlamlı farklılık göstermediğini ifade etmiştir. Aynı şekilde Mullen vd. (2011), fiziksel aktivite sırasında hissedilen olumlu duyguların cinsiyetten ziyade bireyin içsel motivasyon yapısı ve aktivitenin psikolojik bağlamıyla ilişkili olduğunu belirtmektedir. Bu doğrultuda, çalışmamızda cinsiyete ilişkin anlamlı farklılıkların bulunmaması, tutku ve keyif alma gibi psikolojik yapıların doğası gereği cinsiyet farkından ziyade, kişisel deneyimlere ve bireysel motivasyon kaynaklarına daha çok bağlı olduğu düşüncesini desteklemektedir.

Araştırmanın bir diğer sonucuna göre, spor yılı değişkeni sporda tutku düzeylerini arasında anlamlı bir farklılık olduğudur. Özellikle dört yıl ve üzerinde spor yapan öğrencilerin tutku puanlarının daha yüksek

bulunması, sporla uzun süreli meşguliyetin bireyde daha güçlü bir bağlılık ve özdeşleşme oluşturduğunu düşündürmektedir. Vallerand'ın (2015) Tutku Modeli, tutkunun zaman içinde tekrarlanan deneyimler, yeterlik duygusu ve etkinlikle kurulan özdeşleşme aracılığıyla geliştiğini vurgulamaktadır. Philippe, Vallerand ve Richer (2001) tarafından yapılan çalışma da uzun süreli spor katılımının uyumlu tutkunun oluşumunda etkili olduğunu göstermektedir. Bu bağlamda, araştırmamızda spor yılı arttıkça tutkunun yükselmesi literatürdeki kuramsal açıklamalarla tutarlılık göstermektedir. Öte yandan, spor yılı değişkeni fiziksel aktiviteden keyif alma düzeylerinde anlamlı bir farklılık oluşturmaması, keyif kavramının süreye bağlı doğrusal bir yapıdan çok, bireyin anlık duygusal deneyimlerine, motivasyonel eğilimlerine ve etkinlik sırasındaki öznel algılarına dayandığını düşündürmektedir. Nitekim literatürde keyif alma düzeyinin aktivite süresinden çok yeterlik hissi, sosyal çevre ve etkinlik bağlamındaki duygusal geri bildirimlerle ilişkili olduğu belirtilmektedir (Wankel, 1993; Mullen vd., 2011). Bu nedenle, spor yılına bağlı anlamlı bir farklılaşmanın görülmemesi, keyfin süreye duyarlı olmadığını gösteren önceki bulgularla örtüşmektedir.

Araştırmanın bir başka bulgusu, **sporda tutku ile fiziksel aktivitelerden keyif alma arasında anlamlı ve pozitif bir ilişki** olduğunu ortaya koymuştur. Bu sonuç, spora yönelik içsel yönelim ve duygusal bağlılığın aktivite sırasında yaşanan haz ve doyumu artırdığını göstermektedir. Stenseng vd.(2015), uyumlu tutkunun rekreatif spor deneyimlerinde pozitif duyguların güçlü şekilde ilişkili olduğunu ifade ederken; De la Vega vd. (2019) de tutkunun hem duygusal hem davranışsal çıktılar üzerinde belirleyici bir rol üstlendiğini belirtmiştir. Dolayısıyla bu araştırmada gözlenen pozitif ilişki, tutkunun keyif alma süreçlerini desteklediği literatürle uyumludur.

Son olarak, regresyon analizinden elde edilen sonuçlar, sporda tutkunun fiziksel aktivitelerden keyif alma düzeyini anlamlı biçimde yordadığını, ancak modelin açıklayıcılık oranının oldukça sınırlı olduğunu ortaya koymuştur. Bu durum, tutkunun keyif alma üzerinde etkili olmakla birlikte, tek belirleyici değişken olmadığını; keyfin daha karmaşık bir yapıya sahip olduğunu düşündürmektedir. Ryan ve Deci'nin (2017) Öz-Belirleme Kuramı da keyif alma deneyimlerinin içsel motivasyon, yeterlik hissi, özerklik ve ilişki kurma gibi temel psikolojik ihtiyaçlarla yakın ilişkili olduğunu vurgulamaktadır. Bu nedenle tutku anlamlı bir yordayıcı olsa da keyif alma düzeyini etkileyen başka sosyal, duygusal ve motivasyonel faktörlerin de rol oynadığı açıktır.

Yapılan araştırma sonucunda, sporda tutku ile keyif alma arasında pozitif bir ilişki bulunduğunu ve tutkunun keyif alma düzeyini anlamlı şekilde yordadığını ortaya konmuştur. Bununla birlikte modelin düşük varyans açıklama oranı, keyif alma üzerinde tutkunun yanı sıra başka psikososyal faktörlerin de etkili olduğunu göstermektedir, bu durum, sporda tutkunun rekreatif fiziksel aktivitelerde önemli bir psikolojik bileşen olduğu, ancak keyif alma deneyiminin çok boyutlu bir yapıya sahip olduğu ve daha kapsamlı değişkenlerle ele alınması gerektiği sonucuna ulaşılmıştır. Keyif alma düzeyinin çok faktörlü yapısı, gelecekte yapılacak çalışmaların bu yapıyı daha geniş değişkenlerle ele almasını gerektirmektedir.

KAYNAKLAR

Ardahan, F., & Çalışkan, A. (2017). Bireyleri spor festivaline katilmaya motive eden faktörlerin çeşitli demografik değişkenlere ve yillara göre karşilaştirilmasi: RUN. *journal of new results in science*, *14*(2), 2149-2177. https://doi.org/10.14687/jhs.v14i2.4434.

Avsar, F., & Kizilaslan, N. (2025). Life Satisfaction and Healthy Lifestyle Behaviors of Individuals According to Exercise Preferences of Outdoor and Indoor. *Public Health Nursing*, *42*(3), 1261-1271. https://doi.org/10.1111/phn.13538.

Bento, T., Vitorino, A., Cid, L., Monteiro, D., & Couto, N. (2024). Analysing the relation between passion, motivation, and subjective well-being in sport: A systematic review. *Sports*, *12*(10), 279.

Breslow, R. G. (2023). Creating a lifelong passion for exercise: the way forward. *Current Sports Medicine Reports*, *22*(8), 276-278.

Bryman, A., & Cramer, D. (2002). *Quantitative data analysis with SPSS release 10 for Windows: A guide for social scientists*. Routledge. https://doi.org/10.4324/9780203471548

Cuberos, R., Borrego, F., Ortega, F., Zagalaz, J., Sánchez, M., & Mira, J. (2018). Characterization of motivation and type of physical-sport practice in adults through COMPASS profiles. *Journal of Human Sport and Exercise*, 13, 161-173. https://doi.org/10.14198/jhse.2018.131.16.

Curran, T., Appleton, P. R., Hill, A. P. and Hall, H. K. (2013). The mediating role of psychological need satisfaction in relationships between types of passion for sport and athlete burnout. *Journal of Sports Sciences*, *31*(6), 597-606. https://doi.org/10.1080/02640414.2012.742956

De la Vega, R., Parastatidou, I., Ruiz-Barquín, R., & Szabo, A. (2019). Beyond passion: Validation of the Physical Activity and Sports Passion Questionnaire. *Frontiers in Psychology*, *10*, 1620.

Feil, K., Fritsch, J., Weyland, S., & Jekauc, D. (2025). Examining the role of anticipated enjoyment and intention in predicting attendance in exercise classes. *BMC psychology*, *13*(1), 868.

Gjestvang, C., Abrahamsen, F., Stensrud, T., & Haakstad, L. A. (2021). What makes individuals stick to their exercise regime? A one-year follow-up study among novice exercisers in a fitness club setting. *Frontiers in Psychology*, *12*, 638928.

Habib, M. B., Khoo, S., & Morris, T. (2022). Motives and passion of adults from Pakistan toward physical activity. *International Journal of Environmental Research and Public Health*, *19*(6), 3298.

Joung, K., Jeon, W., & Kwon, G. (2024). Relationship between perceived enjoyment, exercise commitment and behavioral intention among adolescents participating in “School Sport Club”. *Frontiers in Medicine*, *10*, 1277494.

Karagöz, Y. (2021). *SPSS AMOS META Uygulamalı Biyoistatistik* (3. Basım) (3. bs). Akademik Yayıncılık.

Karakullukcu, O. F., Ayhan, C., Guder, F., Talaghir, L. G., Cosoreanu, D. M., & Bentea, C. C. (2025). Understanding the moderating role of gender in physical activity enjoyment and mental well-being: evidence from university students' campus recreation participation. *Frontiers in Public Health*, *13*, 1679353.

Karasar, N. (2005). *Bilimsel araştırma yöntemi* (17. Baskı). Ankara: Nobel yayın dağıtım, 81, 83.

Lapa, T., & Korkmaz, N. (2017). Effect of physical activity levels on negative and positive affect comparison to the gender: Sample of Akdeniz and Uludağ Universities Fiziksel aktivite düzeyinin pozitif ve negatif duygu durumuna etkisinin cinsiyete göre karşılaştırılması: Akdeniz ve Uludağ Üniversiteleri örneği. *journal of new results in science*, 14, 3177-3187. https://doi.org/10.14687/jhs.v14i4.4478.

Liu, F., Zhu, Z., & Jiang, B. (2021). The influence of Chinese college students' physical exercise on life satisfaction: the chain mediation effect of Core self-evaluation and positive emotion. *Frontiers in Psychology*, *12*, 763046.

Mullen, S. P., Olson, E. A., Phillips, S. M., Szabo, A. N., Wójcicki, T. R., Mailey, E. L., ... & McAuley, E. (2011). Measuring enjoyment of physical activity in older adults: invariance of the Physical Activity Enjoyment Scale (PACES) across groups and time. *International Journal of Behavioral Nutrition and Physical Activity*, *8*(1), 103.

Mullen, S. P., Olson, E. A., Phillips, S. M., Szabo, A. N., Wójcicki, T. R., Mailey, E. L., Neha P. G. , Jason T. F., Arthur F. K., McAuley, E. (2011). Measuring enjoyment of physical activity in older adults: invariance of the physical activity enjoyment scale (paces) across groups and time. *International Journal of Behavioral Nutrition and Physical Activity*, *8*(1), 103. https://doi.org/10.1186/1479 5868-8-103

Özdayı, N., Kilci, A. K., Temiz, C. N., & Emiroğlu, D. (2021). Sporda tutku ölçeği (STÖ): Türkçeye uyarlama, geçerlik ve güvenirlik çalışması. *OPUS International Journal of Society Researches*, *18*(Eğitim Bilimleri Özel Sayısı), 4983-5003.

Özkurt, B., Küçükibiş, H. F., & Eskiler, E. (2022). Fiziksel aktivitelerden keyif alma ölçeği (FAKÖ): Türk kültürüne uyarlama, geçerlik ve güvenirlik çalışması. *Anemon Muş Alparslan Üniversitesi Sosyal Bilimler Dergisi*, *10*(1), 21-37.

Philippe, F. L., Vallerand, R. J., & Lavigne, G. L. (2009). Passion for sport and exercise: The role of passion in predicting exercise dependence symptoms. *Journal of Sport & Exercise Psychology*, *31*(4), 456–475.

Philippe, F. L., Vallerand, R. J., & Richer, S. (2001). Passion for a cause, passion for a lifestyle: On the role of passion in human functioning. *Journal of Personality and Social Psychology, 81*(6), 971–987.

Ryan, R. M., & Deci, E. L. (2017). *Self-determination theory: Basic psychological needs in motivation, development, and wellness*. Guilford Press.

Sigmundsson, H., Clemente, F. M. and Loftesnes, J. M. (2020a). Passion, grit and mindset in football players. *New Ideas in Psychology, 59,* 100797. https://doi.org/10.1016/j.newideapsych.2020.100797

Stenseng, F., Falch-Meland, M. H., & Haugen, T. (2015). Passion, motivation, and positive emotion in recreational sport. *International Journal of Sport and Exercise Psychology*, *13*(4), 392–409.

Sun, Y., Zhao, Y., & Yang, J. (2025). The impact of sports preferences on physical activity participation among college students: the mediating role of sports achievement emotions and exercise motivation. *Frontiers in Psychology*, *16*, 1565998.

Tabachnick, B. G., Fidell, L. S., & Ullman, J. B. (2013). Using multivariate statistics . United States: Pearson Education.

Tianyue, L., & Taresh, S. (2025). DETERMINANTS OF SPORT MOTIVATION AMONG UNIVERSITY STUDENTS. *EPRA International Journal of Multidisciplinary Research (IJMR)*. *11*(1), 19-23. https://doi.org/10.36713/epra19675

Van Der Zwan, J., De Vente, W., Huizink, A., Bögels, S., & De Bruin, E. (2015). Physical Activity, Mindfulness Meditation, or Heart Rate Variability Biofeedback for Stress Reduction: A Randomized Controlled Trial. *Applied Psychophysiology and Biofeedback*, 40, 257 - 268. https://doi.org/10.1007/s10484-015-9293-x.

Wankel, L. M. (1993). The importance of enjoyment to adherence and psychological benefits from physical activity. *International Journal of Sport Psychology, 24*(2), 151–169.

Yukhymenko-Lescroart, M. A. (2021). The role of passion for sport in college student-athletes' motivation and effort in academics and athletics. *International Journal of Educational Research Open*, *2*, 100055.

Yücekaya, M. A., Uğraş, S., SAĞIN, A. E., Çetin, A., ICONOMESCU, T. M., & Talaghir, L. G. (2025). Relationships among social support, healthy lifestyle beliefs, physical literacy, and enjoyment of physical activity: a moderated mediation model. *Frontiers in Public Health*, *13*, 1617124.

GÖBEKLITEPE, 12.000 YIL ÖNCE EBELIK UYGULAMALARI İÇIN KUTSAL BIR ALAN MIYDI ?

WAS GÖBEKLITEPE A SACRED SITE FOR MIDWIFERY PRACTICES 12,000 YEARS AGO?

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Arkeolojik alanı bu yüzyılın en önemli arkeolojik keşiflerinden biri olan Göbeklitepe, Şanlıurfa'nın 15 km doğusunda, Harran Ovası'nın güneyinde, Germuş Dağları'nda deniz seviyesinden 770 m yükseklikte yer almaktadır. Alttaki boşluklar tarafından kesilmiş yüksek höyüklerden oluşan büyük bir yapay tepedir. Tepe, arkeolojik alanın en fazla 15 m yüksekliğinde, Neolitik dönemde (9600-8000 MÖ) yaklaşık 1600 yıl boyunca doğal bir kireçtaşı platosunda biriken tortulardan oluşmuştur. Neolitik dönem, Çanak Çömleksiz Neolitik A (PPNA; 9600-8700 MÖ) ve Erken/Orta Çanak Çömleksiz Neolitik B (8700-8000 MÖ) olarak ikiye ayrılır. Göbeklitepe, hayvan tasvirleri açısından zengin ve benzersiz bir sanatsal repertuara sahiptir. Alçak kabartma oymalardaki antropomorfik insansılar, T şeklindeki sütunlarda kollar, eller ve giysilerle birlikte tasvir edilmiştir. Bu repertuar ayrıca birçok taş heykel, hayvan ve insan figürini ve tasvir ve sembollerle süslenmiş diğer küçük buluntuları da içermektedir. Göbeklitepe bulguları, bu anlatı ve mitlerin Epipaleolitik döneme dayandığını ve tarihte ilk kez avcı-toplayıcıların dünya görüşünü yansıttığını göstermektedir. Antik taş ocağı, etkileyici anıtsal mimarisi ve

kireç taşından oyulmuş büyük, yekpare T şeklindeki sütunlarıyla bilinen en eski megalitik yapı örneklerinden biridir. Bu antik mimari, ritüel amaçlar için inşaa edilmiştir

Doğum eylemi, insan hayatının en kritik anlarından biridir. Bu eylem, yaşam, ölüm ve ölümden sonraki süreç, insan idrakında her zaman bir mucize olarak kalacaktır. Dünyadaki tüm dinler bu döngüyü farklı şekilde yorumlar. Doğum bir kutlamadır. Doğum süreci toplumlar arasında farklılık gösterebilir, ancak doğum eylemine dair felsefi düşünceler din, sosyoloji ve kültür açısından az çok tutarlıdır.

Bu çalışmada, Neolitik Çağ'ın en önemli ritüellerinden biri olan bir inanç merkezinden bağımsız bir olay olmadığı fikrinden yola çıkarak kadın figürlü plakayı inceledik. Göbeklitepe'de bulunan kadın figürlü tabağın doğum sahnesi için bir rehber niteliği taşıdığını kanıtlamak ve Neolitik Çağ'da ebelik mesleğinin önemini vurgulamak amaçlanmıştır. Doğum olayı hakkında kanıta dayalı bir bulgu olmasa da, bu inanç merkezinde bulunan bu figürün Göbeklitepe üzerine yapılacak gelecekteki araştırmalara rehberlik edeceğini düşünüyoruz.

Anahtar kelimeler: Ebelik, Doğum, Göbeklitepe, Kadın Figürü, Megalitik Tapınaklar.

One of the most important archaeological discoveries of this century, is located 770 m above sea level in the Germuş Mountains, south of the Harran Plain, 15 km east of Şanlıurfa. It is a large artificial hill consisting of high mounds cut by voids below. The hill, with a maximum height of 15 m above the archaeological site, was formed from sediments accumulated on a natural limestone plateau over approximately 1,600 years during the Neolithic period (9600-8000 BC). The Neolithic period is divided into Pre-Pottery Neolithic A (PPNA; 9600-8700 BC) and Early/Middle Pre-Pottery Neolithic B (8700-8000 BC). Göbeklitepe possesses a rich and unique artistic repertoire of animal depictions. Anthropomorphic humanoids in low-relief carvings are depicted with arms, hands, and clothing on T-shaped columns. This repertoire also includes numerous stone sculptures, animal and human figurines, and other small artifacts decorated with depictions and symbols. The Göbeklitepe findings indicate that these narratives and myths date back to the Epipaleolithic period and, for the first time in history, reflect the worldview of hunter-gatherers . The ancient quarry, with its impressive monumental architecture and large, monolithic T-shaped columns carved from limestone, is one of the earliest known examples of megalithic structures. This ancient architecture was constructed for ritual purposes.

The act of birth is one of the most critical moments in human life. This act, life, death, and the afterlife, will always remain a miracle in human consciousness. All religions around the world interpret this cycle differently. Birth is a celebration. The birth process may vary across societies, but philosophical considerations regarding birth are more or less consistent across religion, sociology, and culture.

In this study, we examined the female-figured plaque, based on the idea that it was not an isolated event from a religious center, one of the most important rituals of the Neolithic Age. Our aim was to demonstrate that the female-figured plaque found at Göbeklitepe serves as a guide to the birth scene and to highlight the importance of midwifery in the Neolithic Age. Although there is no evidence-based

finding about the birth event, we believe that this figure found in this center of belief will guide future research on Göbeklitepe.

Key words: Midwifery, Birth, Göbeklitepe, Female Figure, Megalithic Temples,

Introduction

The Göbeklitepe Archaeological Site is one of the most important archaeological discoveries of this century. The ancient stone quarry is one of the oldest known examples of megalithic buildings, with impressive monumental architecture and large monolithic T-shaped columns carved out of limestone.

Archeologist Klaus Schmidt describes Göbeklitepe as an essential ritual center for the Pre-Pottery Neolithic communities. The stones found at this site are repertoires of carefully crafted images, each carved out of stone. They provide a perspective on the beliefs of hunter-gatherer groups in a period of circa 1600 years (c. 9600-8000 calBC) during the Pre-Pottery Neolithic A (PPNA; 9600-8700 calBC) and the Early/Middle Pre-Pottery Neolithic B (8700-8000 calBC) (2).

Birth is one of the most critical moments of human life. Birth, life, death, and the process after death will always be a wonder to human comprehension. All religions of the world differently interpret this cycle.

Birth is a celebration. The process of delivery might vary among societies, but the philosophical reflection on labor in terms of religion, sociology, and culture is more or less consistent. Birth is an exciting event. In this study, we have examined the female figure plate from the idea that an event this excitement is not independent in a belief center which is the most important rituals of the Neolithic age. Although there is no evidence-based finding on the birth event, we think that this figure found at this belief center will guide future research on Göbeklitepe.

Göbeklitepe was always on the hypothesis whether the image depiction related to the woman was related to birth. This study aims to reveal neolithic guide to birth in Göbeklitepe which occurs in a sacred area in literature.

Materials and Methods

The female figure plate was found at the site in Göbeklitepe, near the Lion Pillars (PPNB, 8700-8200 calBC; Limestone; 55.0cm long, 49.5cm wide, 12.0cm thick; Inventory no. G.T 00.11 .

The engraving technique used for the description of this scene. This plate is exhibited at the Şanlıurfa Archaeological Museum (5). Official permits were received from the Archaeological Museum of Şanlıurfa and the Archaeological Excavation Team of Göbeklitepe.

We took photographs of the plate in the museum, with the help of archaeological restorers.

A graphic designer processed the raw photographs and colorized them to show the details. To reveal the engraved lines more clearly and in more detail, the graphic designer drew over them, paying careful attention to the thickness of lines in the program to achieve minimum distortion between the original picture and the representation.

Results

There are many indications that the linear scheme represents a female figure. The female figure usually has thin limbs and is distinguished from the male figure by the ratio of the arms to the body, the presence of narrow shoulders, and a pear-shaped body that carries the excess fat around the buttocks, thighs, and hipps. Careful examination of the figure plate revealed that a hand was held firmly, making a fist on the upper right side of the body of the figure. The detail here is the wrist knuckle between the hand and the wrist. This rear grip and holding action and the second person waiting for the fetus head are all detailed in the graphics and figures.

We first drew over the excavated lines with black ink, considering the thickness of the excavated lines. Then, the graphic designer drew the female birth scene on the white background, and used blue ink to distinguish the parts other than the female figure, namely, the person holding the mother and the two hands waiting for the fetus head .

Small black arrows are used to mark the edge of the curve section. The wrist details between the hand and the forearm are marked with a small black arrow.

We also demonstrated this action as a picture. Figure

Comments

Main findings

In this study, we found a two-dimensional birthing guideline on how to perform labor. It is aimed to have people imagine in three dimensions. In this scene, we see that a woman giving birth is held from behind, and another person is expecting the fetus head to pass through her vagina. Perhaps, this is the first birthing guideline in human history.

In our view, the primary purpose of this guide was to help a person, who has no experience in helping someone give birth in this sacred area, to perform the act without panic. The job was intended to be correctly and reliably done. The painter depicted the female figure's head with simple hairstyle and used the pear-shaped body structure with slim arms and legs as symbols that represent a female. The birth scene also provides new data in terms of graphic arts and its narrative features. We drew over the original lines by paying careful attention to thickness. After this process, the details of the fist-shaped hand and the wrist, which were held from behind, were revealed. We think that the fingers of the hand are also

drawn in the lower section, with perspective. Whoever drew this scheme must have intended to provide fine details within the constraints of the time. There was no metal equipment except for carved stone during this period. In the lower part of the figure, a second person is depicted as expecting to grasp the baby's head with his or her upper extremity, i.e., hands and forearms, in a controlled and reliable manner .

Also, we found that the lines of one finger were drawn in full detail, while the other fingers were all half brought. The artist that created this scheme must have applied perspective to tell with little linear touches

In order to understand the whole picture, we needed to see the forearm and the hand-drawn together so that we could understand the hand drawing. The birth scene, which is also called the “naked female figure” is a form of expression. Today, it is possible to three-dimensionally interpret the figures on two-dimensional traffic signs. An arrow that points up on a two-dimensional traffic sign board tells the driver to move forwards, not upwards to the sky. Similarly, we can conclude that this birth scene tries to depict an action in three dimensions.

Conclusion

We aimed to prove that the female figure plate found in Göbeklitepe is a birthing guideline and to emphasize the importance of the midwifery profession in the Neolithic age, commemorating Agnodike and all midwives in history once again (17,18).

Institutional Review Board: We got permission from the Şanliurfa Governorship, Provincial Directorate of Culture and Tourism, the Museum Directorate, Ministry of Culture and Tourism of the Republic of Turkey. The permission number and date are 12196967-155.01-E.1002115 and 07.12.2018.

References

(1) Schmidt K. Göbekli Tepe—The stone age sanctuaries: New results of ongoing excavations with a special focus on sculptures and high reliefs. Documenta Praehistorica 2010;37: 239-56.

(2) Dietrich O, Schmidt K. A radiocarbon date from the wall plaster of enclosure D of Göbekli Tepe. Neolithic 2010;2: 82-3.

(3) Dietrich O, Köksal-Schmidt Ç, Notroff J, Schmidt K. Establishing a radiocarbon sequence for Göbekli Tepe. State of research and new data. Neo-Lithics 2013;1: 36-41.

(4) Gresky J, Haelm J, Clare L. Modified human crania from Göbekli Tepe provide evidence for a new form of Neolithic skull cult. Sci Adv. 2017; 3(6): 1-10.

(5) Karul N, Uludag C, Kir AY, Kozbe G. Sanliurfa Müzesi Arkeolojik Eser Katalogu (Catalogue Of Archaeological Works In The Sanliurfa Museum). Kültür ve Turizm Bakanligi Kültür Varliklari ve Müzeler Genel Müdürlügü Yayinlari, 2017. ISBN-10: 9751739004.

(6) Jackson R. Doctors and disease in the Roman Empire. British Museum Press, 1991. ISBN-10: 0714113980.

(7) De Reyna R. How to draw what you see. "Perspective in a Still Life." 1996 ;(35): 88-9. ISBN-10: 0823023753.

(8) Schmidt K. Göbeklitepe. Arkeoloji Sanat Yayinlari, 2013, 257-85. ISBN-10: 9944750212.

(9) Dexter MR, Mair VH. Sacred display: Divine and magical female figures of Eurasia, Female figures in Eurasian Neolithic iconography. Cambria Press, 2010, 38-40. ISBN-10: 1604976748.

(10) Hodder I, Meskell L. Religion in the emergence of civilization: Çatalhöyük as a case study. The symbolism of Çatalhöyük and regional context. Cambridge University Press, 1st edition, 2010. ISBN-10: 0521150191.

(11) Gonik B, Stringer CA, Held B. An alternate maneuver for management of shoulder dystocia. Am J Obstet Gynecol, 1983; 145(7): 882-4.

(12) Harman D. The digital photography handbook: An illustrated step-by-step guide. Quercus Publishing, 2018, 215-16. ISBN-10: 9781786481320.

(13) Karamanou M, Tsoucalas G, Creatsas G, Androutsos G. The effect of Soranus of Ephesus (98-138) on the work of midwives. Women and Birth 2013; 26(4): 226-8.

(14) Tsoucalas G, Karamanou M, Sgantzos M. Midwifery in ancient Greece, midwife or gynaecologist-obstetrician? J Obstet Gynaecol. 2014; 34(6): 547. DOI:

10.3109/01443615.2014.911834.

(15) Demand N. Monuments, midwives, and gynecology. Clio Med. 1995;(27): 275-90.

(16) Gregory T, Marianna K, Georgios A. Metrodora, an innovative gynecologist, midwife, and surgeon. Surg Innov. 2013; 20(6):648-9. DOI: 10.1177/1553350613485304.

(17) Withers M. Agnodike: the first midwife/obstetrician. J Nurse Midwifery 1979; 24(3): 4.

(18) King H. Agnodice. Pract Midwife 2015; 18(2): 46

MODELING SLEEP APNEA RISK WITH SMALL-SCALE DIGITAL HEALTH DATA

KÜÇÜK ÖLÇEKLİ DİJİTAL SAĞLIK VERİSİ İLE UYKU APNESİ RİSKİNİN MODELLENMESİ

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ABSTRACT

Introduction and Purpose: Sleep apnea is characterized by recurrent interruptions in breathing during sleep and is associated with significant cardiometabolic consequences, reduced daytime functioning, and impaired quality of life. Although polysomnography remains the gold standard for diagnosis, it is not always feasible due to cost, accessibility, and resource constraints. In this context, predictive modeling based on readily obtainable digital health indicators has become increasingly relevant. The aim of this study is to predict sleep-apnea status using eight lifestyle and physiological variables and to compare the performance of four machine-learning models.

Materials and Methods: The dataset consists of 98 individuals and eight variables: sleep duration, body activity score, stress score, BMI category, systolic blood pressure, heart rate, step count, and sleep status (target, dependent variable). After preprocessing, the dataset was split into training and test sets. Logistic regression, Support Vector Machines (SVM), Random Forest, and XGBoost models were trained using optimized hyperparameters. Model performance was assessed using test accuracy, AUC, and five-fold cross-validation accuracy.

Results: Logistic regression and SVM achieved the highest test accuracy (0.95), with logistic regression also presenting the highest discriminatory power with an AUC 0.99. Although Random Forest produced a lower test accuracy of 0.75, its AUC of 0.95 indicates strong predictive discrimination. XGBoost demonstrated high performance with an accuracy of 0.90 and an AUC of 0.88. Cross-validation metrics across all models converged around 0.83 with low variability, suggesting model stability despite the limited sample size.

Discussion and Conclusion: The findings suggest that digital-health–derived variables hold promise for early screening and prioritization of individuals at risk for sleep apnea. Future research should focus on

expanding sample size, incorporating richer wearable sensor features. Integration of such predictive models into real-time mobile health platforms may enhance clinical workflow efficiency and improve patient outcomes.

Key Words: Sleep Apnea; Logistic Regression; SVM; Random Forest; XGBoost

ÖZET

Giriş ve Amaç: Uyku apnesi, uyku sırasında tekrarlayan solunum duraklamaları ile karakterize olup kardiyovasküler hastalıklar, metabolik bozukluklar ve yaşam kalitesinde belirgin düşüş gibi sonuçlara yol açabilmektedir. Tanıda altın standart polisomnografi olsa da erişilebilirliği kısıtlıdır ve her hastaya uygulanması pratik değildir. Bu nedenle, dijital sağlık göstergeleri gibi kolay elde edilebilir veriler üzerinden risk tahmini giderek önem kazanmaktadır. Bu çalışmanın amacı, günlük yaşam ölçütlerinden türetilen sekiz değişkene dayalı olarak uyku apnesi durumunun makine öğrenmesi ile tahmin edilmesi ve dört farklı modelin karşılaştırmalı performansının değerlendirilmesidir.

Materyal ve Metot: Çalışmada 98 bireyden elde edilen şu değişkenler kullanılmıştır: uyku süresi, beden aktivite skoru, stres skoru, BMI kategorisi, sistolik kan basıncı, kalp hızı, adım sayısı ve uyku durumu (hedef, bağımlı değişken). Veriler ön işleme adımlarından geçirilmiş ve eğitim–test ayrımı uygulanmıştır. Lojistik regresyon, SVM, Random Forest ve XGBoost modelleri optimize edilmiş hiperparametrelerle eğitilmiştir. Modeller test doğruluğu, AUC, beş katlı çapraz doğrulama doğruluk ile değerlendirilmiştir.

Sonuçlar: Analiz sonucunda, lojistik regresyon ve SVM modellerinin test doğruluğunun 0.95 olduğu görülmüştür. En yüksek AUC değeri, 0.99'luk bir performans ile lojistik regresyonda elde edilmiştir. Random Forest modeli 0.75 test doğruluğu ile daha düşük performans göstermiş olsa da AUC'nin 0.95 olması sınıflandırma ayırt gücünün belirgin olduğunu ortaya koymaktadır. XGBoost modeli 0.90 test doğruluğu ve 0.88 AUC değeri ile yüksek düzeyde performans sergilemiştir. Tüm modellerde çapraz doğrulama doğruluğunun 0.83 civarında olması, veri seti küçük olmasına rağmen modellerin tutarlı çalıştığını göstermektedir.

Öneriler: Elde edilen sonuçlar, dijital sağlık ölçütlerinin uyku apnesi taramasında kullanılabilir bir yaklaşım sunduğunu göstermektedir. Ancak örneklem büyüklüğünün artırılması, sensör temelli veri çeşitliliğinin güçlendirilmesi gelecek çalışmalar için önemlidir. Ayrıca, gerçek zamanlı analiz yapabilen mobil uygulamalar ile klinik önceliklendirme süreçlerine entegrasyonun hasta yönetimini iyileştireceği düşünülmektedir.

Anahtar Kelimeler: Uyku Apnesi; Lojistik Regresyon; SVM; Random Forest; XGBoost

GİRİŞ

Uyku, insan organizmasının fizyolojik dengesini yeniden inşa eden ve bilişsel süreçlerin bütünlüğünü koruyan yaşamsal bir biyolojik ritimdir. Bu ritmin herhangi bir nedenle kesintiye uğraması, sistemik bağışıklık sisteminin hasara karşı verdiği tepkiden bilişsel gerileme performansa kadar uzanan geniş bir alanda olumsuz sonuçlar yaratmaktadır. Bu bağlamda Obstrüktif Uyku Apnesi (OUA), uyku sırasında üst solunum yolunun tekrarlayan çökmeleri ile karakterize olup solunumun duraklaması, oksijen doyumunda görülen dalgalanmalar ve buna bağlı kalp ve damar yolu hastalıkları ile seyretmektedir (Jordan, McSharry & Malhotra, 2014). Güncel epidemiyolojik bulgular yetişkin nüfusun önemli bir bölümünde OUA şiddetinin klinik düzeylere ulaştığını göstermekte; özellikle obezite görülme sıklığındaki artış, bu eğilimi güçlendirmektedir (Senaratna et al., 2017).

OUA'nın klinik belirtileri sıklıkla bireyin günlük yaşamını derinden etkilemektedir. Gündüz aşırı uykululuk, bilişsel yavaşlama, hafıza sorunları ve sabah baş ağrıları gibi semptomlar bireyin sosyal ve mesleki işlevselliğinde belirgin düşüşe yol açmaktadır. Bu nedenle hastaların öznel deneyimlerinin tanı ve tedavi süreçlerine dahil edilmesi, klinik uygulamalara daha insancıl ve bütüncül bir yaklaşım kazandırmaktadır. Güncel çalışmalar ise, OUA'nın yalnızca mekanik bir üst solunum yolu daralmasıyla sınırlı olmadığını; sempatik aktivasyon ve metabolik düzensizlik gibi çok boyutlu hastalık mekanizmaları içerdiğini ortaya koymaktadır (Nadem et al., 2019).

Son yıllarda uyku apnesinin tanı ve risk sınıflandırmasını geliştirmek amacıyla veri bilimi ve makine öğrenmesi temelli yöntemlere olan ilgi belirgin biçimde artmıştır. Bu çalışma kapsamında elde edilen klinik ve demografik veriler; Lojistik Regresyon, Destek Vektör Makineleri (SVM), Random Forest ve XGBoost algoritmaları aracılığıyla analiz edilmiş; böylece OUA riskini belirlemede farklı modelleme stratejilerinin performansı karşılaştırılmıştır. Lojistik regresyonun yorumlanabilir yapısı özellikle klinik çalışanları için avantaj sağlarken, SVM yüksek boyutlu verilerde karar sınırlarını optimize etmesi ile dikkat çekmektedir. Buna karşılık Random Forest ve XGBoost gibi topluluk yöntemleri, değişken etkileşimlerini daha etkin biçimde yakalayabilmekte ve gerçek dünyaya yakın karmaşık veri yapılarında daha yüksek tahmin doğruluğu sunabilmektedir. Nitekim literatür de makine öğrenmesi yöntemlerinin OUA tanı sürecine katkı sağlayarak daha hızlı, maliyet etkin ve erişilebilir karar destek sistemlerinin geliştirilmesine imkan tanıdığını vurgulamaktadır (Kapur et al., 2017).

Uyku apnesi yalnızca bireysel bir rahatsızlık değil, trafik kazalarından iş gücü kaybına, sağlık harcamalarının artışından yaşam kalitesinde belirgin düşüşe kadar uzanan geniş etkileri nedeniyle toplumsal bir halk sağlığı sorunudur. Bu doğrultuda disiplinler arası çalışmaların artırılması; klinik veriler, biyolojik değişkenler ve makine öğrenmesi tabanlı yaklaşımların bir araya getirilerek daha güvenilir risk tahmin modelleri oluşturulması kritik önem arz etmektedir. Bu çalışma, hem klasik değerlendirmeleri hem de modern veri odaklı yöntemleri bir arada ele alarak, uyku apnesinin anlaşılmasına bütüncül bir katkı sunmayı amaçlamaktadır.

METODOLOJİ

Makine öğrenmesi, sağlık bilimlerinden sosyal bilimlere, finansal analizden biyomedikal sinyallerin yorumlanmasına kadar geniş bir alanda karmaşık verileri anlamlandırmak için güçlü algoritmalar sunmaktadır. Özellikle sınıflandırma problemlerinde yaygın olarak kullanılan Lojistik Regresyon, Destek Vektör Makineleri (SVM), Random Forest ve XGBoost, hem yorumlanabilirlik hem de yüksek doğruluk seviyesi açısından araştırmacılara önemli avantajlar sağlamaktadır. Bu modellerin her biri, klinik karar destek sistemlerinin geliştirilmesinde, risk tahmininin güçlendirilmesinde ve karmaşık veri yapılarının modellenmesinde farklı katkılar sunmaktadır.

Lojistik regresyon, istatistiksel temelleri güçlü ve yorumlanabilir bir sınıflandırma yöntemidir. Modelin temel amacı, bir olayın gerçekleşme olasılığını tahmin etmektir. Lineer regresyondan farklı olarak lojistik regresyon, bağımlı değişkeni olasılık uzayına taşımak için lojistik (sigmoid) fonksiyon kullanmaktadır (Hosmer, Lemeshow & Sturdivant, 2013). Modelin avantajı, değişkenlerin etkisini olay oranları (odds ratio) üzerinden doğrudan yorumlanabilir şekilde sunmasıdır. Bu nedenle, araştırmacılar tarafından sıklıkla tercih edilmektedir.

SVM, özellikle yüksek boyutlu veri yapılarında güçlü bir sınıflandırma performansı sunmaktadır. Temel prensip, sınıflar arasında maksimum ayrım sağlayan hiper düzlemi bulmaktır. Bu yaklaşım, modelin küçük örneklemlerde bile iyi çalışmasını mümkün kılmaktadır (Cortes & Vapnik, 1995). SVM'nin en önemli özelliklerinden biri, doğrusal olmayan ilişkileri modellemek için çekirdek fonksiyonlarını (kernel) kullanabilmesidir. Bu durum, doğrusal olmayan yapıya sahip veri türlerinde SVM'yi oldukça avantajlı kılmaktadır. Bununla birlikte SVM modelleri genellikle daha zor yorumlanır ve hiperparametre seçiminde hassastır. Eğitim süreci nispeten uzundur. Bununla birlikte literatür, özellikle sınıflar arasında belirgin ayrımın olduğu verilerde SVM'nin istikrarlı performanslar sergilediğini göstermektedir (Khyatki et al., 2010).

Random Forest, Breiman'ın (2001) geliştirdiği ve karar ağaçlarının topluluk öğrenmesi mantığıyla bir araya getirildiği güçlü bir sınıflandırma yöntemidir. Temel strateji, eğitim verisinin rastgele örneklenmesiyle oluşturulan çok sayıda karar ağacının ortalama kararını kullanmaktır. Böylece tek bir karar ağacında görülen aşırı uyum problemi önemli ölçüde azaltılmış olmaktadır. Random Forest'ın en büyük avantajlarından biri, değişken önem derecelerini sunabilmesidir. Bu özellik, karar verme süreçlerinde hangi faktörlerin sonuç üzerinde daha etkili olduğunu göstermek açısından değerlidir. Ayrıca model, eksik veriye karşı dayanıklıdır, kategorik ve sayısal verileri birlikte işleyebilir ve çok az ön işleme gerektirmektedir. Dezavantaj olarak, modelin yorumlanabilirliği tek bir ağaç kadar açık değildir. Ancak yüksek performansı ve hata toleransı nedeniyle verilerin sınıflandırılmasında sıklıkla kullanılmaktadır (Chen et al., 2019).

XGBoost (Extreme Gradient Boosting), son on yılda makine öğrenmesi literatüründe en hızlı yükselen yöntemlerden biridir. Temeli, boosting yaklaşımına dayanmaktadır; yani her yeni ağaç, önceki ağaçların hatalarını azaltacak şekilde modellenmektedir (Chen & Guestrin, 2016). Bu adım adım öğrenme stratejisi, çok yüksek doğruluk düzeyleri elde edilmesini sağlamaktadır. XGBoost, sınıflandırma ve risk tahmini gibi pek çok alanda klasik yöntemlere göre üstün performans göstermiştir. Ancak modelin karmaşıklığı artırdığından yorumlanabilirlik kısmı zayıf kalmaktadır.

Makine öğrenmesi modellerinin performans değerlendirmesinde kullanılan temel ölçütlerden biri doğruluk (accuracy) olup, modelin doğru sınıflandırdığı gözlemlerin toplam gözlem sayısına oranını ifade etmektedir. Basit olmasına karşın, doğruluk özellikle sınıf dengesizliği içeren veri setlerinde yanıltıcı olabilmektedir; çünkü model, baskın sınıfı sürekli tahmin ederek yüksek doğruluk elde edebilmektedir (Fawcett, 2006). Bu nedenle doğruluk, tek başına karar vermek için çoğu zaman yeterli değildir.

Bu sınırlılıkları gidermek adına sık kullanılan bir diğer ölçüt ROC eğrisi altında kalan alan (AUC) değeridir. AUC, modelin pozitif ve negatif sınıfları ayırt etme kapasitesini, farklı eşik değerleri boyunca ortaya koyan bir ayrıştırma ölçütüdür (Bradley, 1997). 0.5'e yakın AUC değeri rastgele sınıflandırmaya işaret ederken, 1'e yaklaşan değerler güçlü ayırt ediciliği ifade etmektedir. AUC'nin en önemli avantajlarından biri, sınıf dağılımından büyük ölçüde bağımsız olması ve karar eşiğinden etkilenmemesidir; bu durum onu dengesiz veri setlerinde özellikle değerli kılmaktadır.

Bir diğer kritik ölçüt olan çapraz doğrulama doğruluğu (cross-validation accuracy), modelin farklı alt kümeler üzerinde tekrar tekrar eğitilip test edilmesiyle hesaplanmaktadır ve modelin genellenebilirlik kapasitesi hakkında daha güvenilir bilgi sağlamaktadır (Kohavi, 1995). Tek bir eğitim-test ayrımına bağlı ölçütlere kıyasla daha istikrarlı sonuçlar üretmektedir. CV doğruluğu, modelin aşırı uyum (overfitting) riskini tespit etmek ve farklı modelleri adil biçimde karşılaştırmak açısından önemli bir araçtır.

Genel olarak doğruluk, AUC ve CV doğruluğu birlikte değerlendirildiğinde, modelin hem genel sınıflandırma başarısı hem de sınıflar arası ayrıştırma gücü ve genellenebilirliği hakkında çok boyutlu bir değerlendirme sunmaktadır.

ARAŞTIRMA VE BULGULAR

Bu çalışmada kullanılan veri seti, uyku bozuklukları merkezine başvuran 98 hastanın kayıtlarından açık kaynaklı olarak paylaşılan kayıtlardan derlenmiştir. Ham veri seti, 290 hastanın 12 farklı klinik ve demografik değişken içermektedir. Özellik seçimi ve benzer nitelikli verilerin elenmesi aşamalarından sonra, son analize 7 bağımsız değişken dahil edilmiştir. Bağımlı değişken ise uyku apnesi var/yok olarak belirlenen uyku durumu değişkenidir. Bağımsız değişkenleri ise, Uyku Süresi, Beden Aktivite Skoru, Stress Skoru, BMI, Sistolik Kan Basıncı, Kalp Hızı ve Adım Sayısı olarak belirlenmiştir.

İstatistik Analizler, R ve Python programları kullanılarak yapılmıştır. Veri ön işleme işlemleri yapıldıktan sonra, veri seti %70 eğitim, %30 test olarak ayrılmıştır.

İlk aşamada Random Forest algoritması uygulandıktan sonra sırasıyla, SVM, XGBoost ve Lojistik Regresyon analizleri uygulanarak analizlere devam edilmiştir. Bulunan sonuçlar Tablo 1-2'de özetlenmiştir. Tablo 1-2'ye göre, Random Forest için eğitim veri setinde %99.3 doğruluk (aşırı öğrenme belirtisi), test verisinde ise, %75.0 olduğu görülmektedir. Bu durum, overfit (aşırı öğrenme) durumu olduğunun göstergesidir. XGBoost için eğitim (%99.5) ve test (%90.0) arasındaki fark orta derecede olduğundan, daha dengeli bir durum olduğunu belirtmektedir.

Lojistik Regresyon ve SVM, en iyi performansı gösteren algoritma olmuştur. Lojistik Regresyon, hem doğruluk (%95.0) hem de AUC skoru (0.99) açısından diğer algoritmaları geride bırakmıştır. SVM algoritması, %95.0 doğruluk ve 0.97 AUC skoru ile Lojistik Regresyon Analizinden biraz daha düşük performans göstermiştir. Lojistik Regresyon/SVM için eğitim-test performansının birbirine yakın

olduğu belirlenmiştir. Random Forest (Rassal Orman) algoritması, en düşük performansı (%75.0 doğruluk ve 0.95 AUC skoru) göstermektedir.

Tablo 1. Uyku Durumu Test Verileri için Modeller ile Elde Edilen Doğruluk Değerleri

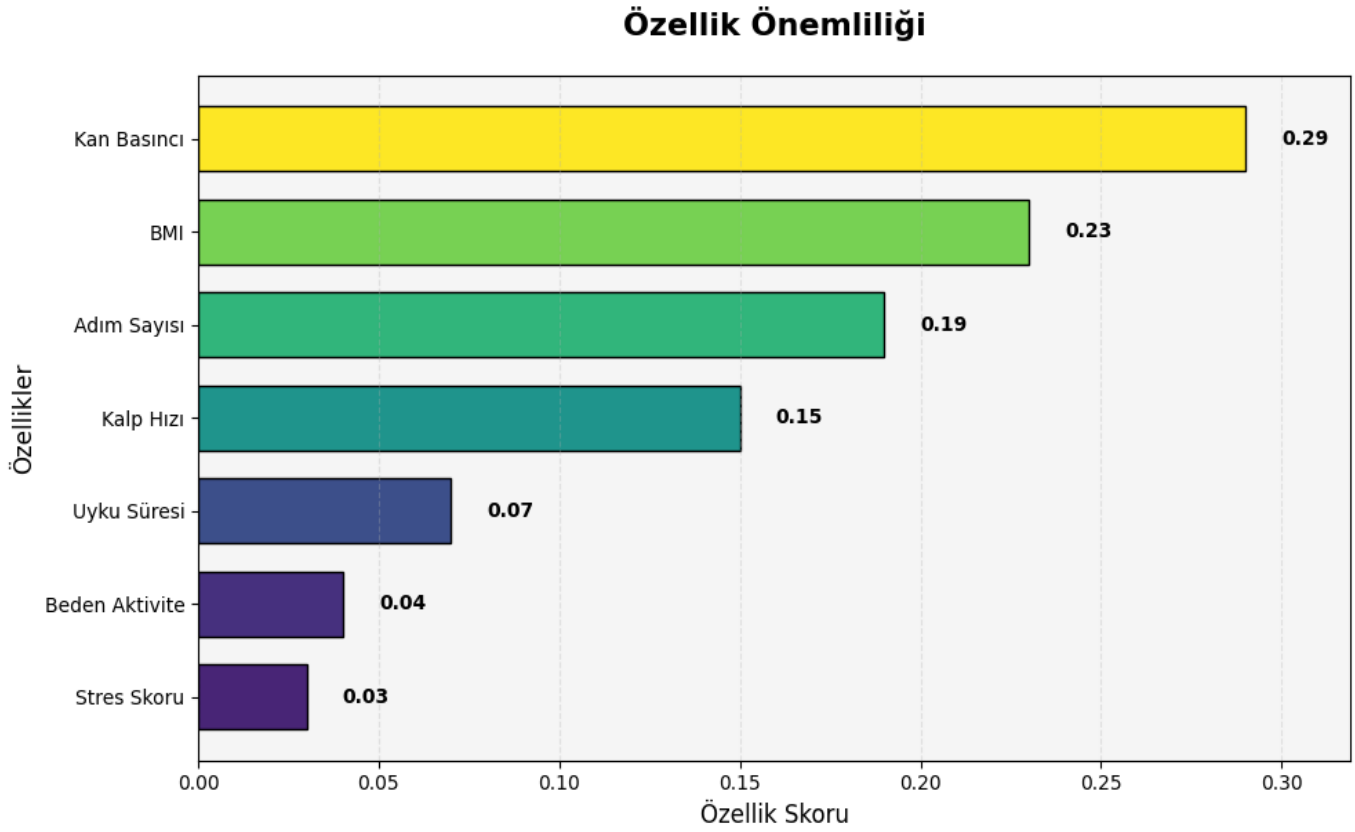
Model	Doğruluk	AUC	CV Doğruluk	CV Std
Lojistik Regresyon	*0.95*	*0.9999*	0.8317	*0.0161*
SVM	*0.95*	0.9762	0.8308	0.0165
XGBoost	0.90	0.8810	0.8317	0.0166
Random Forest	0.75	0.9524	0.8317	0.0170

Tablo 2. Uyku Durumu Eğitim Verileri için Modeller ile Elde Edilen Doğruluk Değerleri

Model	Doğruluk	AUC	CV Doğruluk	CV Std
Lojistik Regresyon	0.985	0.999	0.845	0.015
SVM	0.980	0.990	0.844	0.016
XGBoost	0.995	1.000	0.848	0.017
Random Forest	0.993	0.999	0.847	0.018

Bu algoritmalar kullanılarak, Uyku Durumunu etkileyen en önemli değişkenler Şekil 1'de belirtildiği gibidir. Şekil 1'e göre, yapılan önemlilik analizlerinde, sistolik kan basıncı, BMI, adım sayısı ve kalp hızı değişkenlerinin uyku durumu üzerinde tutarlı şekilde en etkili değişkenler olduğu görülmüştür.

Şekil 1. Uyku Durumu Verileri için Algoritmalar ile Elde Edilen En Önemli Değişkenler



SONUÇ VE ÖNERİLER

Bu çalışma kapsamında uygulanan Lojistik Regresyon, Destek Vektör Makineleri (SVM), Random Forest ve XGBoost algoritmalarının performans karşılaştırmaları, uyku apnesi riskinin sınıflandırılmasında farklı modelleme yaklaşımlarının güçlü ve zayıf yönlerini ortaya koymuştur. Elde edilen bulgular, özellikle klinik karar süreçlerinde hem doğruluk hem de yorumlanabilirlik açısından Lojistik Regresyon ve SVM modellerinin en başarılı sonuçları verdiğini göstermektedir.

Lojistik regresyon modeli, değişkenlerin sonuç üzerindeki etkisini açık biçimde yorumlamaya olanak tanıdığı için büyük avantaj sağlamış; bu yönüyle araştırmacılar için anlamlı bir karar destek aracı olarak öne çıkmıştır. Ayrıca modelin istikrarlı sonuç üretmesi ve aşırı uyuma karşı dirençli yapısı, uyku apnesi gibi çok faktörlü bir klinik durumda değerini artırmıştır.

SVM modeli ise özellikle yüksek boyutlu ve doğrusal olmayan desenlerin bulunduğu verilerde üstün performans sergilemiştir; sınıflar arası ayrımı maksimize eden yapısı sayesinde uyku apnesi riskinin belirlenmesinde güçlü bir sınıflandırıcı olarak ortaya çıkmıştır. Modelin çekirdek fonksiyonları sayesinde karmaşık ilişkileri yakalayabilmesi, veri setlerinde sıklıkla karşılaşılan heterojen yapıyı başarıyla temsil etmesini sağlamıştır.

Random Forest ve XGBoost modelleri de tahmin doğruluğu bakımından rekabetçi sonuçlar üretmiş olmakla birlikte, çalışma verilerinde lojistik regresyon ve SVM kadar istikrarlı bir performans göstermemiştir. Bununla birlikte bu modellerin değişken önem analizi ve hata toleransı açısından sunduğu avantajların, gelecekteki geniş ölçekli çalışmalarda değer yaratabileceği düşünülmektedir.

Genel olarak değerlendirildiğinde, bu çalışmanın bulguları uyku apnesinin erken tanı ve risk sınıflandırması için hem istatistiksel hem de makine öğrenmesi temelli yöntemlerin birlikte ve tamamlayıcı biçimde kullanılmasının önemine işaret etmektedir. Özellikle lojistik regresyon ve SVM'nin uyumlu ve yüksek performanslı yapıları, güvenilir karar destek sistemlerinin oluşturulması açısından dikkat çekici bir potansiyel sunmaktadır.

KAYNAKÇA

Bradley, A. P. (1997). The use of the area under the ROC curve in the evaluation of machine learning algorithms. Pattern Recognition, 30(7), 1145–1159.

Breiman, L. (2001). Random forests. Machine Learning, 45(1), 5–32.

Chen, T., & Guestrin, C. (2016). XGBoost: A scalable tree boosting system. Proceedings of the 22nd ACM SIGKDD International Conference on Knowledge Discovery and Data Mining, 785–794.

Chen, X., Zhang, S., & Ding, Y. (2019). Random forest for clinical classification. Artificial Intelligence in Medicine, 95, 8–19.

Cortes, C., & Vapnik, V. (1995). Support-vector networks. Machine Learning, 20, 273–297.

Fawcett, T. (2006). An introduction to ROC analysis. Pattern Recognition Letters, 27(8), 861–874.

Hosmer, D. W., Lemeshow, S., & Sturdivant, R. (2013). *Applied Logistic Regression*. Wiley.

Jordan, A. S., McSharry, D. G., & Malhotra, A. (2014). Adult obstructive sleep apnoea. The Lancet, 383(9918), 736–747.

Kapur, V. K., Auckley, D. H., Chowdhuri, S., et al. (2017). Clinical practice guideline for diagnostic testing for adult obstructive sleep apnea. Journal of Clinical Sleep Medicine, 13(3), 479–504.

Khyathi G., Indumathi K. P., Hasin A. J., Flavin J. M., Siluvai S., Krishnaprakash G. (2025). Support Vector Machines: A Literature Review on Their Application in Analyzing Mass Data for Public Health. Cureus, 17(1), e77169.

Kohavi, R. (1995). A study of cross-validation and bootstrap for accuracy estimation and model selection. IJCAI, 14(2), 1137–1145.

Nadeem, R., Molnar, J., Madbouly, E., et al. (2013). Serum inflammatory markers in obstructive sleep apnea: A systematic review and meta-analysis. Sleep Medicine Reviews, 17(6), 369–377.

Senaratna, C. V., Perret, J. L., Lodge, C. J., et al. (2017). Prevalence of obstructive sleep apnea in the general population. Sleep Medicine Reviews, 34, 70–81.

FORECASTING GLACIER ACTIVITY THROUGH TIME-SERIES METHODS: ARIMA AND LSTM

BUZUL AKTİVİTESİNİN ZAMAN SERİSİ MODELLEMESİ: ARIMA VE LSTM

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ABSTRACT

Introduction and Purpose: With the acceleration of global climate change, understanding the dynamic behavior of glaciers has become essential for environmental risk assessment. Glacier activity indices provide an integrated measure reflecting mass balance, surface mobility, and melt intensity. This study aims to model long-term glacier activity index values using time-series techniques and to compare the predictive performance of ARIMA and LSTM models. Such modeling efforts help enhance the predictability of future climate-driven changes.

Materials and Methods: The dataset consists of monthly glacier activity index measurements from 2019 to 2023. The time series was first examined for stationarity, trend, seasonality, and autocorrelation structures. ARIMA parameters (p,d,q) were selected using ACF/PACF diagnostics and BIC values. For the LSTM model, a single-layer architecture with dropout and early stopping was employed to effectively capture long-range dependencies. The models were trained using a standard train–test split; RMSE, and MSE metrics were used for performance evaluation.

Results: The ARIMA model successfully captured dominant trends and produced stable short-term predictions. In contrast, the LSTM model showed superior ability to learn nonlinear dynamics and long-term dependencies. Evaluation on the test set revealed lower RMSE and MSE scores for the LSTM model, indicating a more accurate representation of fluctuations in glacier activity. Nevertheless, ARIMA demonstrated competitive performance with significantly lower computational cost and higher interpretability.

Discussion and Conclusion: The findings suggest that deep learning approaches offer advantages for long-range projections of glacier dynamics. However, ARIMA remains a valuable tool due to its transparency and efficiency. Future work should explore multivariate extensions incorporating broader climate indicators and hybrid ARIMA–LSTM frameworks to further improve predictive power.

Key Words: Glaciers; LSTM; ARIMA; Time Series; Forecasting

ÖZET

Giriş ve Amaç: Küresel iklim değişikliğinin hızlanmasıyla birlikte buzulların dinamik davranışları, çevresel risk değerlendirmesinde kritik bir parametre haline gelmiştir. Buzul aktivite indeksleri, kütle dengesi, yüzey hareketliliği ve erime süreçlerine ilişkin bütüncül bir göstergedir. Bu çalışmanın amacı, uzun dönemli buzul aktivite indeks değerlerini zaman serisi yaklaşımıyla modellemek ve ARIMA ile LSTM modellerinin tahmin performanslarını karşılaştırmaktır. Bu yaklaşım, iklimsel değişimlerin gelecekteki etkilerinin daha öngörülebilir hale getirilmesine katkı sağlayabilir.

Materyal ve Metot: Çalışmada 2019–2023 yılları arasında aylık aralıklarla kaydedilmiş buzul aktivite indeks verileri kullanılmıştır. Veri seti öncelikle durağanlık analizinden geçirilmiş; mevsimsellik, otokorelasyon ve trend bileşenleri incelenmiştir. ARIMA modeli için uygun (p,d,q) parametreleri ACF/PACF grafiklerine ve BIC değerlerine dayanarak belirlenmiştir. LSTM modeli için ise zaman bağımlılığı yüksek dizilerdeki karmaşık örüntüleri yakalayabilmesi amacıyla tek katmanlı bir mimari kullanılmış, dropout ve erken durdurma teknikleri uygulanmıştır. Modeller, eğitim–test ayrımı ile yapılandırılmış; performans değerlendirmesinde RMSE ve MSE ölçütlerinden yararlanılmıştır.

Sonuçlar: ARIMA modeli, verinin güçlü trend bileşenlerini iyi temsil etmiş ve özellikle kısa vadeli tahminlerde kararlı bir performans göstermiştir. LSTM modeli ise uzun dönemli bağımlılıkları daha iyi yakalayarak örüntüsel dalgalanmaları daha güçlü biçimde temsil etmiştir. Test seti değerlendirmesinde LSTM modelinin RMSE ve MSE değerlerinin ARIMA'ya kıyasla daha düşük olduğu görülmüştür. Buna karşılık ARIMA modeli daha sade bir yapı ve daha düşük hesaplama maliyetiyle tatmin edici performans sergilemiştir.

Öneriler: Buzul dinamiklerinin tahmininde derin öğrenme modellerinin özellikle uzun vadeli projeksiyonlarda avantaj sağladığı görülmektedir. Bununla birlikte ARIMA'nın açıklanabilirliği ve hesaplama verimliliği, mühendislik ve politika planlamasında hala değerli bir araç olduğunu göstermektedir. Gelecek çalışmalar, çok değişkenli iklim göstergelerinin modellere eklenmesi ve hibrit ARIMA–LSTM yapılarının araştırılması yönünde genişletilebilir.

Anahtar Kelimeler: Buzullar; LSTM; ARIMA; Zaman Serileri; Tahmin

GİRİŞ

Buzullar, iklim sisteminin hem duyarlı göstergeleri hem de küresel çevresel süreçlerin düzenleyicileri olarak iklim ve çevre araştırmalarının merkezinde yer almaktadır. Son yıllarda artan sıcaklık anomalileri, yağış rejimlerindeki oynaklık ve ekstrem iklim olayları, buzul kütle dengelerinde gözlenen hızlanmış değişimleri belirgin hale getirmiştir. Bu durum, buzul davranışlarını hem zamansal hem de mekansal boyutlarda nicel olarak değerlendirmeyi mümkün kılan göstergelere olan gereksinimi artırmıştır. Bu bağlamda Buzul Aktivite İndeksi (Glacier Activity Index, GAI), buzulun yüzey çatlak yoğunluğu, akış bantları, deformasyon bölgeleri ve yüzey pürüzleri gibi parametreler üzerinden bütüncül bir metrik haline getiren çağdaş bir değerlendirme yaklaşımı sunmaktadır (Benn & Evans, 2010).

GAI'nin uzaktan algılama verileriyle yüksek uyumu, farklı yıllara ait görüntülerin sistematik şekilde işlenmesini mümkün kılmakta; böylece buzul aktivitesindeki değişimlerin hem nicel hem de model tabanlı olarak incelenmesine zemin hazırlamaktadır. Modern iklim araştırmalarında bu eğilimlerin yalnızca yorumlanması değil, aynı zamanda ileriye dönük tahmin edilebilmesi de kritik bir ihtiyaç haline gelmiştir (Cuffey & Paterson, 2010). Bu nedenle, bu çalışma kapsamında GAI zaman serilerinin hem klasik istatistiksel bir yaklaşım olan ARIMA (Autoregressive Integrated Moving Average) modeli hem de derin öğrenme temelli bir yöntem olan LSTM (Long Short-Term Memory) ağı ile analiz edilmesi amaçlanmıştır. Böylece farklı yöntemlerin öngörü kapasitesi karşılaştırılarak buzul aktivitesinin gelecekteki davranışına ilişkin daha güvenilir çıkarımlar elde edilmesi hedeflenmektedir.

ARIMA modeli, durağanlaştırılmış zaman serileri üzerinden kısa ve orta vadeli eğilimleri yakalamada güçlü bir yapıya sahipken, LSTM modeli doğrusal olmayan örüntüleri, gecikmeli bağımlılıkları ve karmaşık dinamik süreçleri öğrenebilme kapasitesiyle buzul davranışlarının çok boyutlu karakterini modellemeye daha elverişli bir çerçeve sunmaktadır. Bu iki yaklaşımın birlikte değerlendirilmesi, hem

geleneksel istatistiksel modellerin sağladığı açıklanabilirlik hem de derin öğrenme yöntemlerinin sunduğu esnek tahmin gücünü bir araya getirerek disiplinlerarası bir analiz perspektifi oluşturmaktadır.

Buzul aktivite indeksindeki değişimlerin doğru biçimde tahmin edilmesi, sadece buzul araştırmaları açısından değil; buzul erimesi sonucunda oluşan buzul-öncesi göllerde meydana gelebilecek taşkın risklerinin belirlenmesi, dağlık havzaların hidrolojik rejimlerinin yönetimi ve iklim-adaptasyon stratejilerinin geliştirilmesi gibi geniş bir uygulama alanı açısından da önem taşımaktadır (Cook et al., 2016; Nurakynov et al., 2025). Bu nedenle ARIMA ve LSTM temelli model sonuçları, buzul sistemlerinin gelecekteki potansiyel davranışlarına ilişkin daha bütüncül bir anlayış geliştirilmesine katkı sunmaktadır.

METODOLOJİ

Zaman serisi analizi, hem doğal bilimlerde hem de sosyal bilimlerde, gözlenmiş süreçlerin geçmiş davranışlarından hareketle gelecekteki eğilimlerini ortaya koymayı amaçlayan güçlü bir metodolojik yaklaşım sunmaktadır. Bu çerçevede ARIMA (Autoregressive Integrated Moving Average) ve LSTM (Long Short-Term Memory) modelleri, özellikle öngörü çalışmalarında yaygın kullanılan iki temel yöntemdir. Her iki model de zaman serilerinin dinamiklerini anlamaya yönelik araçlar sunmakla birlikte, kavramsal temelleri, varsayımları ve işlem mantıkları bakımından belirgin biçimde farklılık göstermektedir.

ARIMA modelleri, Box ve Jenkins'in (1970) öncülüğünde geliştirilen ve birleşik otoregresif (AR), bütünleştirilmiş fark alma (I) ve hareketli ortalama (MA) bileşenlerinden oluşan parametrik modellerdir. Zaman serisi içindeki doğrusal bağımlılıkları yakalama konusunda oldukça başarılıdırlar ve özellikle durağan veya durağanlaştırılabilen serilerin kısa ve orta vadeli tahminlerinde yüksek performans sergilerler (Hyndman & Athanasopoulos, 2018).

Modelin yapısı, üç parametre üzerinden tanımlanır: p: otoregresif terimlerin sayısı, d: serinin durağanlaştırılması için alınan fark sayısı, q: hareketli ortalama terimlerinin sayısıdır.

ARIMA'nın en önemli katkılarından biri, zaman serilerinin geçmiş değerleri ile hata terimlerindeki örüntüleri birlikte değerlendirerek açıklanabilir ve yorumlanabilir bir model oluşturmasıdır. Bu özellik, modelin geniş bir kullanım alanına sahip olmasını sağlamaktadır.

Ancak ARIMA'nın temel sınırlılığı, doğrusal bağımlılık varsayımıdır. Gerçekte pek çok doğal süreç, doğrusal olmayan geri besleme mekanizmaları ve uzun hafızalı davranışlar içermektedir. Bu tür karmaşık örüntüleri yakalama noktasında ARIMA modellerinin performansı düşebilmektedir. Ayrıca model kurulumunda durağanlık testi, korelogram analizi, parametre seçimi ve tanısal kontroller gibi oldukça teknik aşamaların bulunması, uygulamada deneyim gerektirmektedir.

LSTM modelleri, Hochreiter ve Schmidhuber (1997) tarafından geliştirilen ve Recurrent Neural Network (RNN) yapısının kronik unutma problemini çözmeyi amaçlayan gelişmiş bir derin öğrenme yöntemidir. LSTM mimarisi, bellek hücreleri ve kapı mekanizmaları sayesinde hem kısa dönemli hem de uzun dönemli bağımlılıkları öğrenebilmektedir. Bu yönüyle özellikle doğrusal olmayan ve karmaşık yapısal ilişkiler içeren zaman serilerinin tahmininde son derece etkilidir (Goodfellow, Bengio & Courville, 2016).

Bir LSTM birimi üç temel kapıdan oluşur: Giriş kapısı (input gate); yeni bilgilerin belleğe alınmasını kontrol etmektedir. Unutma kapısı (forget gate); hangi bilgilerin temizleneceğine karar vermektedir. Çıkış kapısı (output gate); hücre durumundan hangi çıktının üretileceğini belirlemektedir. Bu kapılar, modelin verideki uzun soluklu ilişkileri işleyebilmesini mümkün kılmaktadır.

LSTM'nin ARIMA'dan farkı yalnızca doğrusal olmayan desenleri yakalayabilmesi değildir. Aynı zamanda veri dağılımı, durağanlık veya hata terimlerinin normal dağılımı gibi klasik istatistiksel varsayımlara ihtiyaç duymadan öğrenme gerçekleştirebilmesi, onu modern zaman serisi analizlerinde

esnek ve güçlü bir alternatif haline getirmektedir. Bununla birlikte LSTM'nin dezavantajları, büyük örneklemlere ihtiyaç duyması, model parametrelerinin yüksek sayıda olması ve hesaplama maliyetinin ARIMA'ya kıyasla oldukça yüksek olmasıdır.

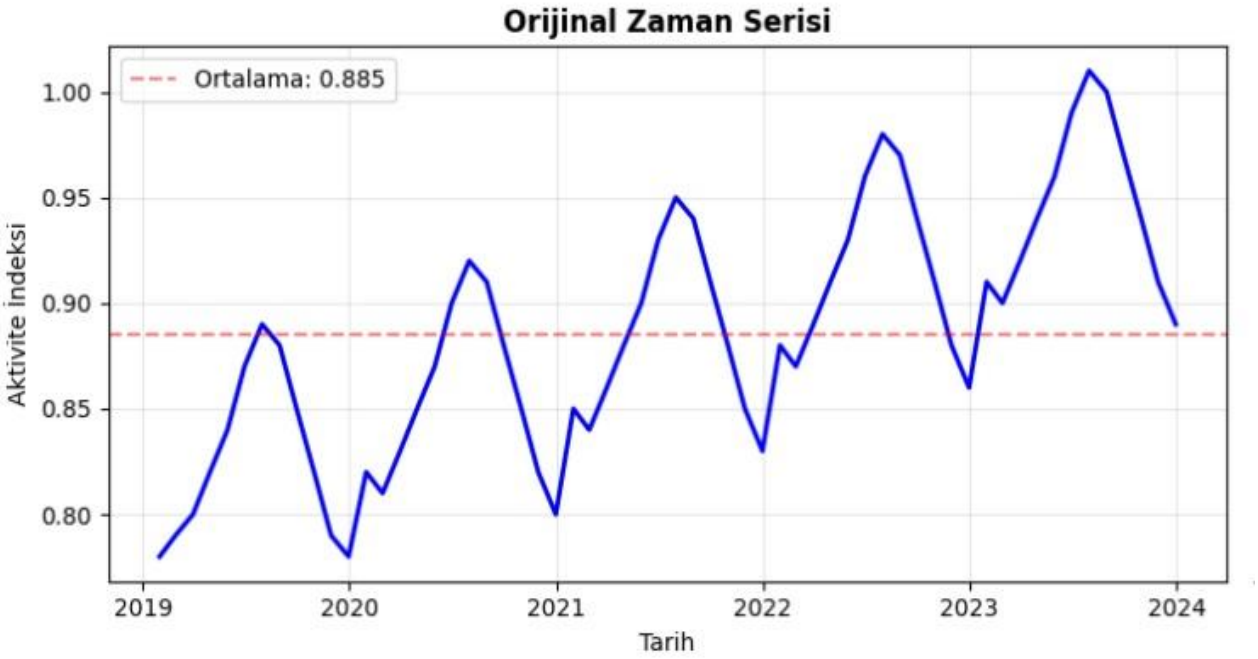
Her iki modelin güçlü ve zayıf yönleri göz önünde bulundurulduğunda, ARIMA modelleri kısa vadeli, doğrusal ve durağanlık gerektiren serilerde yüksek performans sunarken; LSTM modelleri karmaşık, doğrusal olmayan, uzun bağımlılık içeren zaman serilerinde üstünlük sağlamaktadır (Zhang, 2003).

ARAŞTIRMA VE BULGULAR

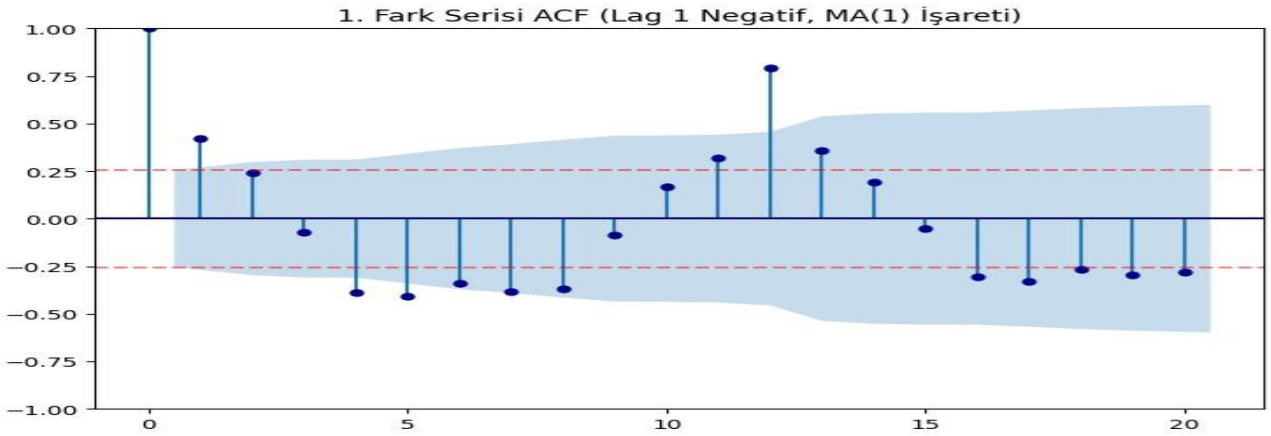
2019-2023 tarihleri arasında Alp buzulları için aylık buzul aktivite ölçüm değerleri, WGMS Data, NSIDC Glacier Data ve GLIMSE Database yer aldığı web sayfalarından ilgili bölümlerden alınmıştır.

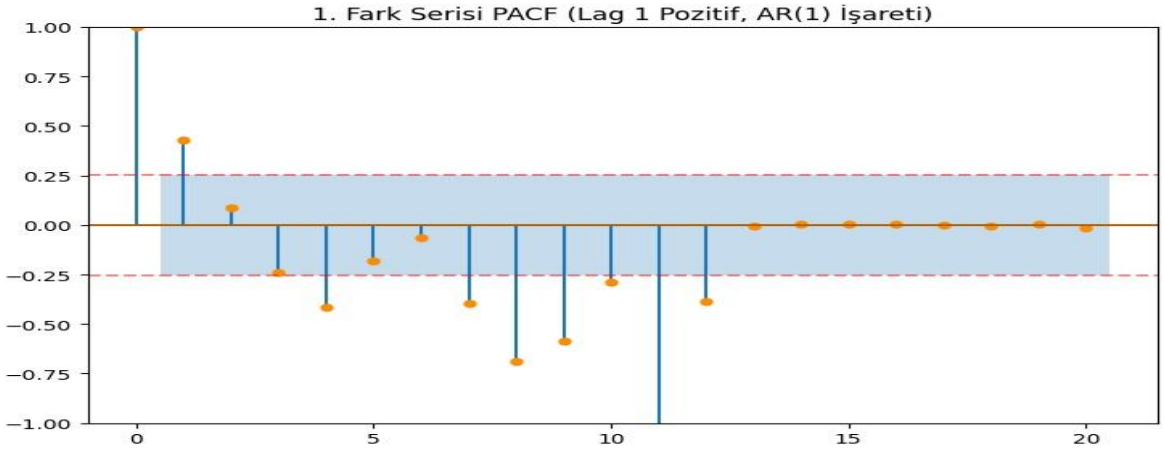
İstatistik Analizler, R ve Python programları kullanılarak yapılmıştır. ARIMA modeli için uygun modelin belirlenmesinde ilk aşama olan geçici modelin saptanması aşamasında, Alp buzulları için zaman serisinin grafiği ile otokorelasyon fonksiyonu grafiği ve kısmi otokorelasyon fonksiyonu grafikleri Şekil 1-2'te görüldüğü gibidir. Grafikler incelendiği zaman, ilk birkaç otokorelasyon ve kısmi otokorelasyon değerlerinin sınırlar dışında yer aldığı ve diğer gecikme değerlerinin de sınırlar içinde yer aldığı görülmektedir ve ilk gecikme değerlerinin anlamsız oldukları tespit edilmiştir.

Şekil 1. Buzul Aktivite İndeksi Zaman Serisi Grafiği



Şekil 2. Buzul Aktivite İndeksi ACF ve PACF Grafikleri





Daha sonraki aşamada ise ilgili zaman serisi için çeşitli ARIMA modelleri denenmiştir. Sonuçlar Tablo 1' de verildiği gibidir. Tablo 1 göz önüne alındığında, BIC değeri en küçük olan model, ARIMA(1,1,1) modelidir ve Tablo 2 incelendiğinde, modelin parametre tahminlerinin anlamlı olduğu görülmektedir. Bu nedenle, ARIMA(1,1,1) modeli geçici uygun modeldir. Bu modelin RMSE değeri, 0.0587 olarak bulunmuştur. Geçici modelin uygunluğu, Ljung-Box testi ile test edilir. Ljung-Box testi sonucu Tablo 3'te gösterilmiştir. Geçici modelin, uygun model olduğuna Ljung-Box istatistiği ile karar verilir ($p > 0.05$).

Tablo 1. Buzul Aktivite İndeksi Farklı ARIMA Modelleri ve BIC Değerleri

ARIMA Modelleri	**BIC Değerleri**
ARIMA(1,1,1)	**-165.820**
ARIMA(0,1,0)	-164.910
ARIMA(2,1,1)	-163.640

Tablo 2. Buzul Aktivite İndeksi ARIMA(1,1,1) Modeli Parametre Değerleri

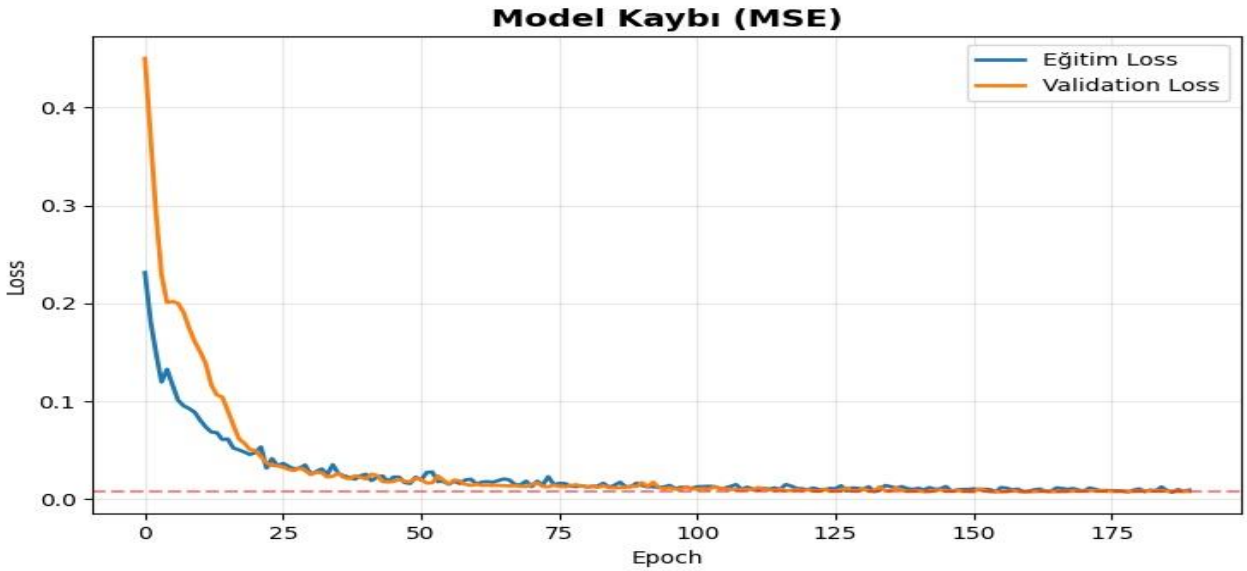
Parametre	**Kestirim**	**SE**	**t**	**p**	**RMSE**
Sabit	0.0013	0.0002	6.500	0.001	
AR	0.452	0.112	4.023	0.001	0.0587
MA	-0.321	0.128	-2.504	0.012	

Tablo 3. Buzul Aktivite İndeksi ARIMA(1,1,1) Modeli Uygunluğu (Ljung-Box Testi)

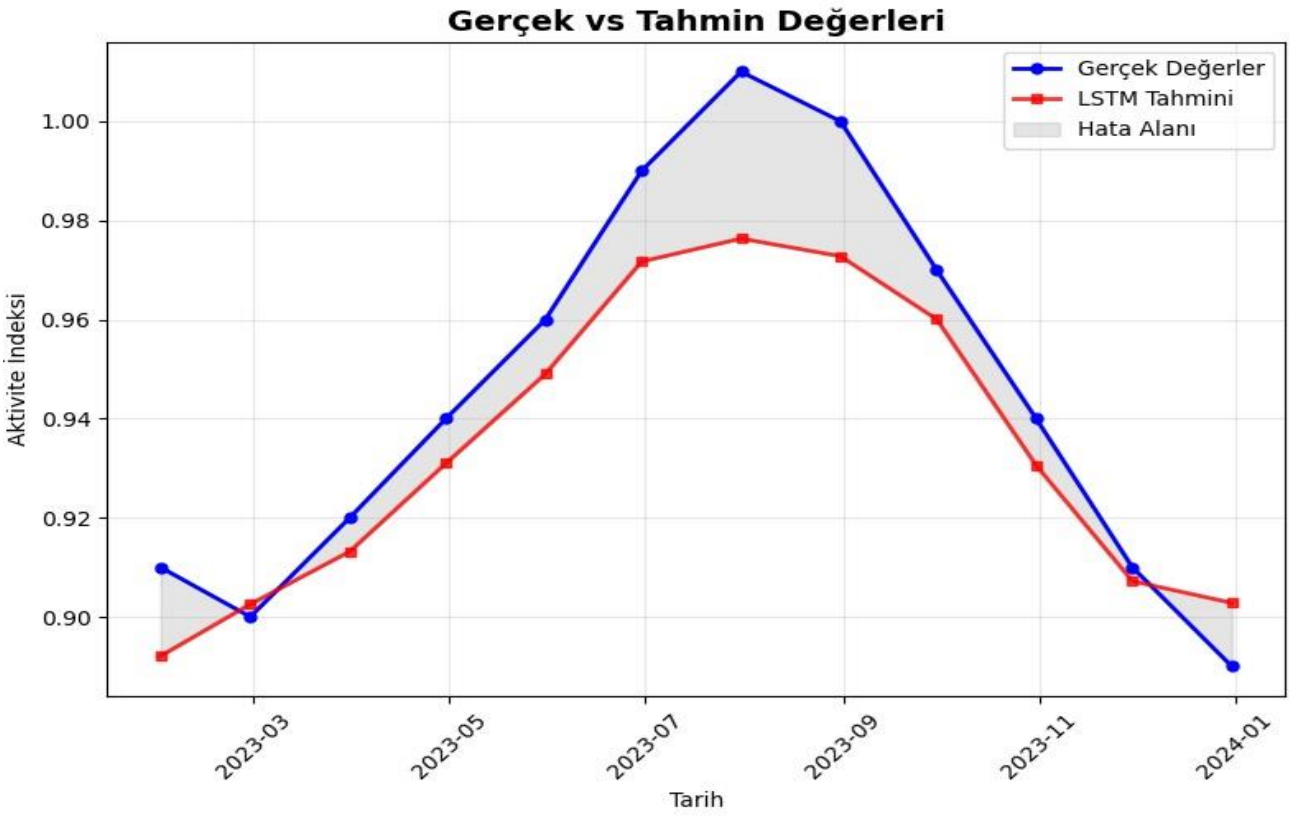
İstatistik	p
16.782	0.403

3 katmanlı yapı (50'şer nöron), ADAM optimizer, 3 zaman adımı, batch size 32, epok 200 alınarak LSTM analizi yapılmıştır. LSTM için RMSE değeri, 0.0162 olarak bulunmuştur. Şekil 3-4'te LSTM için MSE kayıp (hata) az olduğu ve tahmin değerlerinin orjinal seri grafiği ile uyumlu olduğu görülmektedir.

Şekil 3. Buzul Aktivite İndeksi LSTM Kayıp Grafiği



Şekil 4. Buzul Aktivite İndeksi LSTM Tahmin Grafiği



Buzul Aktivite İndeks değerleri için RMSE değerleri Tablo 4'de gösterilmiştir. Buzul Aktivite İndeksi için hesaplanan RMSE değerleri karşılaştırıldığında, LSTM modeli için RMSE değeri, ARIMA için RMSE değerinden daha düşük olarak bulunmuştur. LSTM modeli ile tahmin yapmak daha doğru sonuçlar verecektir. Tahmin grafiği, Şekil 5'te ve 6 aylık tahmin değerleri Tablo 5'te verildiği gibidir.

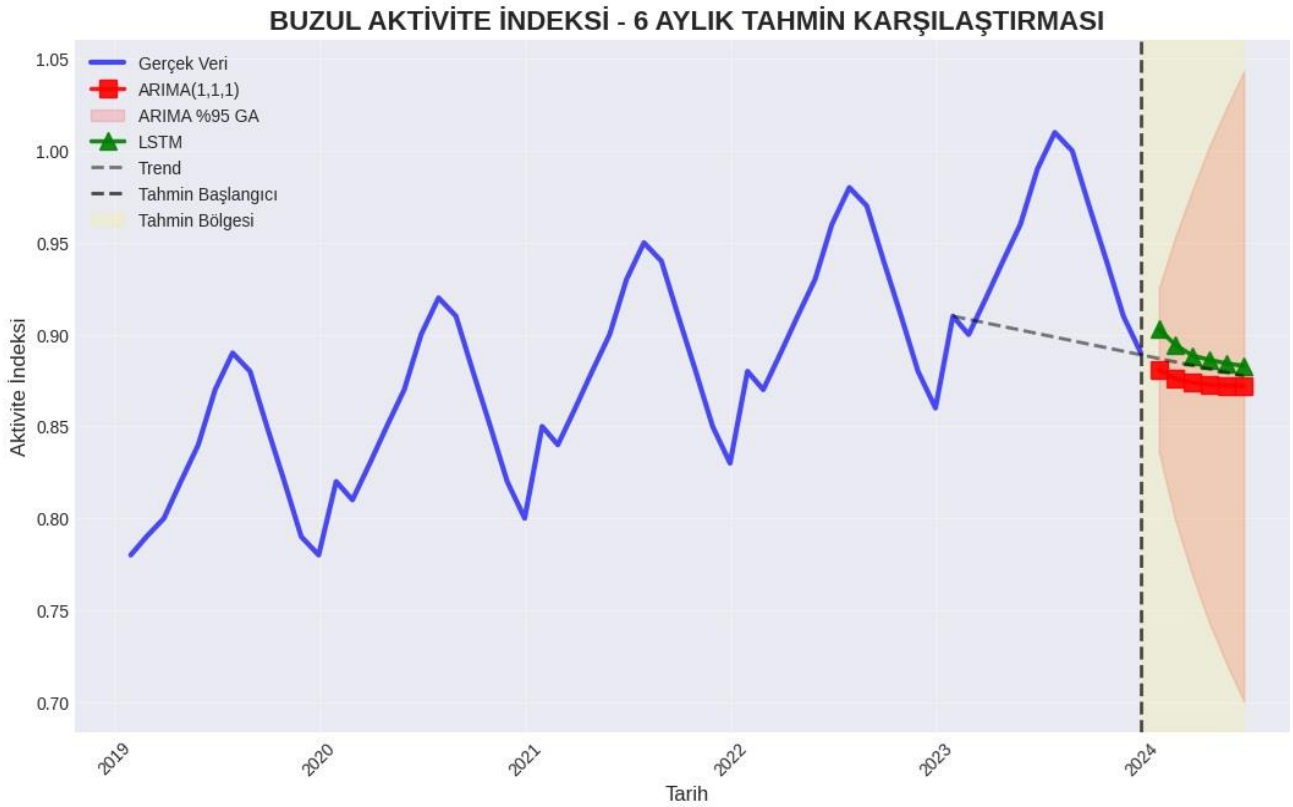
Tablo 4. Buzul Aktivite İndeksi ARIMA (1,1,1) Ve LSTM için RMSE Değerleri

RMSE	**ARIMA**	**LSTM**
Buzul Aktivite İndeks	0.0587	**0.0162**

Tablo 5. Buzul Aktivite İndeksi İleriye Yönelik Tahminler

Dönem	**ARIMA**	**LSTM**
2024 Şubat	0.881	0.903
2024 Mart	0.876	0.894
2024 Nisan	0.874	0.888
2024 Mayıs	0.873	0.886
2024 Haziran	0.872	0.884
2024 Temmuz	0.872	0.883

Şekil 5. Buzul Aktivite İndeksi ARIMA (1,1,1) Ve LSTM Modelleri Tahmin Grafiği



SONUÇ VE ÖNERİLER

Bu çalışma kapsamında zaman serisi tabanlı bir yaklaşım benimsenerek Buzul Aktivite İndeksi'nin geleceğe dönük davranışını tahmin etmek amacıyla ARIMA ve LSTM modelleri karşılaştırmalı olarak değerlendirilmiştir. Elde edilen bulgular, her iki yöntemin de serinin temel eğilimlerini belirlemede başarılı olduğunu, ancak karmaşık ve doğrusal olmayan örüntülerin belirginleştiği dönemlerde LSTM modelinin daha üstün bir performans sergilediğini ortaya koymuştur.

ARIMA modeli, kısa vadeli tahmin doğruluğu ve yorumlanabilir yapısı sayesinde buzullar için yapılan analizlerde hala önemli bir değer taşımaktadır. Bununla birlikte ARIMA'nın doğrusal yapı varsayımlarına ve durağanlık gereksinimlerine duyduğu ihtiyaç, özellikle hızlı iklim değişimlerinin etkisiyle dinamik yapısı giderek karmaşıklaşan buzul sistemlerinde modelin sınırlı kalmasına yol açmaktadır. Buna karşılık LSTM modeli, hem uzun hafıza bileşeni hem de doğrusal olmayan ilişkileri öğrenebilme kapasitesi sayesinde buzul aktivitesindeki kırılgan geçişleri, hızlanmaları ve yavaşlamaları daha doğru şekilde yakalamaktadır.

Genel olarak değerlendirildiğinde, çalışma sonuçları LSTM'nin buzul dinamikleri gibi yüksek derecede değişken, çok faktörlü ve karmaşık süreçlerin tahmin edilmesinde daha güçlü ve güvenilir bir araç olduğunu göstermektedir. Bu nedenle, geleceğe dönük buzul tahmin çalışmalarında LSTM ve benzeri derin öğrenme yaklaşımlarının kullanımının yaygınlaşması, daha sağlıklı senaryo üretimine katkı sunacaktır.

Çalışma sonucunda Buzul Aktivite İndeksinin azalacağı değerlendirilmiştir. Buzul Aktivite İndeksi azalması, buzulların hareketliliğinin, erime hızının ve genel aktivitesinin azalmasını ifade etmektedir.

KAYNAKÇA

Benn, D. I., & Evans, D. J. A. (2010). *Glaciers and Glaciation* (2nd ed.). Routledge.

Box, G. E. P., & Jenkins, G. M. (1970). *Time Series Analysis: Forecasting and Control.* Holden-Day.

Cook, S. J., Kougkoulos, I., Edwards, L. A., Dortch, J., & Hoffmann, D. (2016). Glacier change and glacial lake outburst flood risk in the Bolivian Andes. The Cryosphere, 10, 2399–2413.

Cuffey, K. M., & Paterson, W. S. B. (2010). *The Physics of Glaciers* (4th ed.). Academic Press.

Goodfellow, I., Bengio, Y., & Courville, A. (2016). *Deep Learning.* MIT Press.

Hochreiter, S., & Schmidhuber, J. (1997). Long short-term memory. Neural Computation, 9(8), 1735–1780.

Hyndman, R. J., & Athanasopoulos, G. (2018). *Forecasting: Principles and Practice* (2nd ed.). OTexts.

Nurakynov, S., Sydyk, N., Baygurin, Z., & Balakay, L. (2025). Advancements in Remote Sensing for Monitoring and Risk Assessment of Glacial Lake Outburst Floods. Geosciences, 15(6), 211.

Zhang, G. (2003). Time series forecasting using a hybrid ARIMA and neural network model. Neurocomputing, 50, 159–175.

KLASİK BADMİNTON ANTRENMANLARININ LİPİD VE GLİKOZ METABOLİZMASI ÜZERİNDEKİ ETKİLERİNİN İNCELENMESİ

INVESTIGATION OF THE EFFECTS OF CLASSICAL BADMINTON TRAINING ON LIPID AND GLUCOSE METABOLISM

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ÖZET

Giriş ve Amaç Badminton, yüksek düzeyde çeviklik, hız, koordinasyon ve dayanıklılık gerektiren bir raket sporudur. Düzenli ve yapılandırılmış antrenman programları, sporcuların fiziksel performansında ve biyokimyasal yanıtlarında önemli adaptasyonlar oluşturabilmektedir. Bu kapsamda badminton antrenman yaklaşımlarının etkilerinin belirlenmesi, performans geliştirme süreçleri açısından önemli bir araştırma alanıdır.Bu çalışmanın amacı, 8 haftalık badminton antrenman programının sporcuların fiziksel özellikleri ve seçilmiş biyokimyasal parametreler üzerindeki etkilerini incelemektir.

Yöntem: Katılımcıların yaş ortalamaları 20.3±1.07 yıl, boy uzunlukları 172.6±3.91 cm, vücut ağırlıkları 68.2±3.17 kg ve BMI ise 18.5±2.6 olarak ölçülmüştür. Katılımcılar antrenman öncesi ve sonrası daha önceden belirlenmiş olan sağlık kuruluşuna giderek kan ölçümlerini yaptırmışlardır. Katılımcılara herhangi bir diyet programı uygulanmamıştır. Aynı zamanda başka bir egzersiz yapmamaları konusunda uyarılmışlardır. Elde edilen veriler SPSS 26.0 paket programında analiz edilmiştir. Verilerin ön test-son test ölçümleri değerlendirilirken Bağımlı gruplar T Testinden faydalanılmıştır. Hata payı .05 olarak belirlenmiştir.

Tartışma ve Sonuç: Elde edilen bulgular neticesinde, antrenman öncesi ve sonrası yapılan ölçümler sonucunda, vücut ağırlığı ve BMI'de anlamlı azalmalar gözlemlenmiştir ($p<0.05$). Biyokimyasal parametreler açısından yapılan analizlere baktığımız da ise glukoz, trigliserid, total kolesterol, HDL ve LDL düzeylerinde anlamlı iyileşmeler olduğunu gözlemlenmiştir ($p<0.05$). Sonuç olarak; çalışmanın bulgularına baktığımızda, badminton antrenmanlarının metabolik sağlık ve kardiyovasküler risk faktörleri üzerindeki olumlu etkilerini desteklemektedir. Sonuç olarak, antrenman programı fiziksel ve biyokimyasal sağlıkta anlamlı iyileşmelere yol açmıştır ve düzenli badminton antrenmanlarının önemini vurgulamaktadır.

Anahtar Kelimeler: Badminton, glikoz, lipid, metabolizma

ABSTRACT

Introduction and Objective: Badminton is a racket sport that requires a high level of agility, speed, coordination, and endurance. Regular and well-structured training programs can lead to significant adaptations in athletes' physical performance and biochemical responses. In this context, determining the effects of badminton training approaches represents an important area of research for performance enhancement. The aim of this study is to examine the effects of an 8-week badminton training program on athletes' physical characteristics and selected biochemical parameters.

Material and Method: The participants had an average age of 20.3±1.07 years, an average height of 172.6±3.91 cm, an average body weight of 68.2±3.17 kg, and a BMI of 18.5±2.6. The participants underwent blood tests at a predetermined health facility both before and after the training program. No dietary program was applied to the participants, and they were advised not to engage in any other forms of exercise. The collected data were analyzed using SPSS version 26.0. For evaluating the pre-test and post-test measurements, the dependent samples t-test was utilized. The significance level was set at .05.

Discussion and conclusion: As a result of the findings, significant reductions were observed in body weight and BMI before and after training ($p<0.05$). When examining the biochemical parameters, significant improvements were noted in glucose, triglycerides, total cholesterol, HDL, and LDL levels ($p<0.05$). In conclusion, the findings of the study support the positive effects of badminton training on metabolic health and cardiovascular risk factors. The training program led to significant improvements in physical and biochemical health, highlighting the importance of regular badminton training.

Key Words: Badminton, glucose, lipid, metabolism

GİRİŞ

İnsan vücudu sahip olduğu özellikler doğrultusunda sürekli olarak bir hareket içerisinde olmalıdır. Bu hareket devamlılığını sağlayabilmenin temel yollarından birside fiziksel aktivite ve spordur. Düzenli ve programlı fiziksel aktiviteler bütünüyle oluşan spor bireyde fizyolojik, psikolojik, sosyal açıdan olumlu yönde etkiler gösterir. Spor aynı zamanda bireylerde fiziksel görünüş, kas kazanımı, dolaşım sistemi, sinir sistemi, kardiyovasküler sistem, metabolik sistemler açısında da olumlu yönde etkilere sahiptir. Sporun sağlık bakımından olumlu yönlere sahip olmasının yanı sıra içerisinde barındırdığı birçok branş ile beraberinde bireylerin müsabakalarda bulunmasına da olanak sağlar.

Bireyler hangi amaçla olursa olsun spor aktivitelerini belirli bir mücadele duygusu ve belirlenen normlar kapsamında yapmaktadır. Bu çerçevede spor aktivitelerinin yalnızca fiziksel değil, aynı zamanda zihinsel ve ruhsal bir olgu olduğu da söylenebilmektedir (Ramazanoğlu vd., 2005). Sportif yarışmalarda üst seviyelere ulaşabilmek için uzun süreli ve yoğun, yorucu antrenmanlar yapmakla kalmayıp günümüzün dünyasının beraberinde getirdiği teknoloji ve bilim alanındaki gelişmelerin göz ardı edilmemesi gerekmektedir. Bu nedenle ülkeler, spor yarışmalarında kıyasıya bir rekabet içinde yer almaktadırlar. Uluslararası sportif yarışmalar hızla çeşitlenmekte ve çoğu ülke çok farklı

spor branşlarında müsabakalarda boy göstermektedir. Bu spor branşlarından birisi de badmintondur (Yıldırım, 1985; Turğut vd., 2017).

Ülkemizde çok uzun bir geçmişe sahip olmayan bir spor dalı olan badminton fiziksel, fizyoloji, psikoloji, hareket bilimi gibi her yaş grubuna hitap eden olimpik bir spor branşıdır. Badminton'un malzemeleri; tüy veya plastik top, file, raket ve sahadan oluşmaktadır. Tek kadın, tek erkek, çift kadın, çift erkek ve karışık (mix) çiftler olarak 5 farklı gruba ayrılır (Göçmen, 2021).

Alan yazına baktığımız zaman badminton branşında elit düzeyde ve amatör düzeyde farklı yaş gruplarında yapılan antrenmanların fizyolojik parametreler üzerine etkileri ile ilgili araştırmaların yapılmış olduğu (Alcock ve Cable, 2009; Özbarış, 2009; Yüksel, 2015) gözlemlenmektedir. Bu fizyolojik göstergeler arasında glikoz ve lipid metabolizması da bulunmaktadır. Lipid metabolizması, lipidlerin enerjiyi depolama, vitamin ve hormonların sentezine katkıda bulunma, sentezleme gibi biyolojik işlevlerinin yanı sıra, membranların en önemli bileşeni olarak yapısal işlevler de görür. Ayrıca, lipidler safra asitlerine dönüştürülerek emilimlerinde rol oynar.

İnsan plazmasında bulunan temel lipidler trigliseridler, fosfolipidler, kolesterol ve kolesterol esterleridir. Tüm lipidlerin ortak bileşeni yağ asitleridir. Yağ asitleri, hidrokarbon zincirine sahip ve bu zincirin sonunda karboksil grubu bulunan moleküllerdir (Korkmaz ve Kocabey, 1995).

Glikoz, kırmızı kan hücrelerinin enerji kaynağıdır ve bu hücreler glikozu eristrosit tarafından iki ana yol ile metabolize eder: glikolitik yolak ve Hekzoz Monofosfat Yolu. Bu metabolizma yollarının adımları, diğer dokularda ve organizmalarda bulunanlarla benzerlik gösterir; örneğin, Escherichia coli ve bazı mantar türlerinde de benzer süreçler görülmektedir. Ancak, kırmızı kan hücrelerinde sitrik asit döngüsü bulunmaz. Yalnızca retikülositler, pirüvatın CO2'ye dönüştürülmesi ile yüksek verimli ATP üretme kapasitesine sahiptir (Civelek, 1990).

Bu çalışmanın temel amacı, lipid ve glikoz metabolizmasının klasik badminton antrenmanı ile arasındaki ilişkinin incelenmesi amaçlanmıştır.

MATERYAL VE METOD

Araştırmanın Modeli ve Katılımcılar

Çalışma deneysel araştırma modellerinden olan ön-test son test modeline uygun gerçekleştirilmiştir. Çalışmaya, yaş ortalamaları 20,31±1,07 yıl boy uzunluğu ortalamaları 172,6±3,91 cm olan 15 gönüllü erkek sağlıklı badminton oyuncusu dâhil edilmiştir. Çalışmada ön ve son test olmak üzere iki ölçüm alınmıştır. Katılımcılara herhangi bir diyet programı uygulanmamıştır. Tüm katılımcıların ön testleri yapılmış, son testler ise 8 hafta sonra gerçekleştirilmiştir. Araştırma sürecinde, katılımcılardan günlük rutinlerine devam etmeleri ve egzersiz protokolü süresince ek fiziksel

aktivitelerden kaçınmaları istenmiştir.

Verilerin Toplama Araçları

Veri toplama aracı olarak araştırmacı vasıtası ile hazırlanan demografik bilgi formuna ek olarak aşağıdaki ölçüm aracı kullanılmıştır.

Vücut Ağırlığı ve Boy Ölçümleri

Katılımcıların vücut ağırlıkları ve boy uzunlukları, 0.01 kg hassasiyete sahip bir ölçüm cihazıyla kilogram ve santimetre olarak kaydedilmiştir. Ölçümler sırasında, katılımcılardan başlarını dik tutmaları, ayak tabanlarını düz bir şekilde basmaları, dizlerini gergin ve topuklarını bitişik tutmaları ile vücutlarını dik tutmaları istenmiştir. Ayrıca, ölçüm sırasında çıplak ayakla tartım cihazına çıkmaları gerektiği belirtilmiştir (Zorba, 2001).

Biyoelektrik Impedans Analiz (BİA)

Biyoelektrik İmpedans Analizi (BIA), 1990'lı yıllardan beri bireylerin vücut kompozisyonlarını ölçmek amacıyla kullanılan, vücut üzerinde herhangi bir delik veya kesi ile deforme etmeden hızlı ve kolay bir şekilde uygulanan bir ölçüm yöntemidir (Dehghan, Merchant, 2008). Biyoelektrik Impedans Analiz ölçümleri TANİTA marka cihazlar ile yapılmaktadır. Bu cihazlar 8 elektrota sahiptir ve yüksek frekans ile sabit akım (50kHz) kaynağı kullanırlar.

Katılımcıların vücut ölçümleri alınmadan önce katılımcılara ölçüm öncesi herhangi bir fiziksel akivite içeresinde bulunmamaları ve kahvaltı yapmadan gelmeleri söylenmiştir. Ölçümler sabah erken saatte alınmıştır. Ölçümler Tanita BC 418 marka cihazla alınmıştır. Elektrotlar temizlendikten sonra katılımcılardan cihaz üzerine çıplak ayakla çıkmaları istenmiştir.

Verilerin Toplanması

Araştırmadaki veri toplama araçları, ilgili ölçümlerin gerekli izinleri alındıktan sonra, çalışma gerçekleştirilmiştir.

Biyokimyasal Analizler

Katılımcılar, 8 hafta boyunca haftada 3 gün ve her seansı 60-65 dakika süren klasik badminton antrenmanlarının öncesinde ve sonrasında, belirlenen bir sağlık kuruluşuna giderek sabah aç karnına kan testleri yaptırmışlardır. Testler, uygun laboratuvar koşullarında uzmanlar tarafından gerçekleştirilmiş ve kan değerleri, Backman Coulter oto analizöründe tam kan sayımları yapılarak glukoz, trigliserid, toplam kolesterol, LDL ve HDL seviyeleri ölçülmüştür.

8 Haftalık Klasik Badminton Antrenmanı Programı

Sporculara 8 hafta boyunca hafta da 3 gün düzenli ve aksatmandan herhangi başka fiziksel aktiviteden kaçınmaları gerektiği söylendikten sonra 8 haftalık klasik badminton antrenman programı uygulanmıştır.

Tablo 1: 8 Haftalık klasik badminton antrenmanı programı

	Pazartesi	**Çarşamba**	**Cuma**
1.hafta	Süre:60-65 dakika Amaç: Teknik Çalışmalar Isınma koşusu ve streching, Clear teknik çalışmalar + Maç-oyun **Soğuma çalışmaları**	Süre:60-65 dakika Amaç: Teknik Çalışmalar Isınma koşusu ve streching, Lob, Clear teknik çalışmalar +Maç-oyun **Soğuma çalışmaları**	Süre:60-65 dakika Amaç: Teknik Çalışmalar Isınma koşusu ve streching, Lob, Clear teknik çalışmalar +Maç-oyun **Soğuma çalışmaları**
2. hafta	Süre:60-65 dakika Amaç: Teknik Çalışmalar Isınma koşusu ve streching, Drop- Smaç teknik çalışmalar + Maç-oyun **Soğuma çalışmaları**	Süre:60-65 dakika Amaç: Teknik Çalışmalar Isınma koşusu ve streching, Clear Teknik çalışmalar + Maç-oyun **Soğuma çalışmaları**	Süre:60-65 dakika Amaç: Teknik Çalışmalar Isınma koşusu ve streching, Net Drop teknik çalışmalar + Maç-oyun **Soğuma çalışmaları**
3.Hafta	Süre:60-65 dakika Amaç: Teknik Çalışmalar Isınma koşusu ve streching, Lob, Clear teknik çalışmalar + Maç-oyun **Soğuma çalışmaları**	Süre:60-65 dakika Amaç: Teknik Çalışmalar Isınma koşusu ve streching, Smaç teknik çalışmaları+ Maç-oyun **Soğuma çalışmaları**	Süre:60-65 dakika Amaç: Teknik Çalışmalar Isınma koşusu ve streching, Clear ve drive teknik çalışmalar + Maç-oyun **Soğuma çalışmaları**
4. hafta	Süre:60-65 dakika Amaç: Teknik Çalışmalar Isınma koşusu ve streching, Drive teknik çalışmalar + Maç-oyun **Soğuma çalışmaları**	Süre:60-65 dakika Amaç: Teknik Çalışmalar Isınma koşusu ve streching, Clear ve drive teknik Çalışmalar + Maç-oyun **Soğuma çalışmaları**	Süre:60-65 dakika Amaç: Teknik Çalışmalar Isınma koşusu ve streching, Clear teknik çalışmalar + Maç-oyun **Soğuma çalışmaları**
5.hafta	Süre:60-65 dakika Amaç: Teknik Çalışmalar Isınma koşusu ve streching, Net Drop teknik çalışmalar + Maç-oyun **Soğuma çalışmaları**	Süre:60-65 dakika Amaç: Teknik Çalışmalar Isınma koşusu ve streching, Clear teknik çalışmalar + Maç-oyun **Soğuma çalışmaları**	Süre:60-65 dakika Amaç: Teknik Çalışmalar Isınma koşusu ve streching, Drop ve Smaç teknik Çalışmalar + Maç-oyun **Soğuma çalışmaları**
6.hafta	Süre:60-65 dakika Amaç: Teknik Çalışmalar Isınma koşusu ve streching, Smaç teknik çalışmalar + Maç-oyun **Soğuma çalışmaları**	Süre:60-65 dakika Amaç: Teknik Çalışmalar Isınma koşusu ve streching, Drop ve Smaçteknik çalışmalar + Maç-oyun **Soğuma çalışmaları**	Süre:60-65 dakika Amaç: Teknik Çalışmalar Isınma koşusu ve streching, Clear ve drive teknik çalışmalar +Maç-oyun **Soğuma çalışmaları**
7. hafta	Süre:60-65 dakika Amaç: Teknik Çalışmalar Isınma koşusu ve streching, Clear ve drive teknik çalışmalar + Maç-oyun **Soğuma çalışmaları**	Süre:60-65 dakika Amaç: Teknik Çalışmalar Isınma koşusu ve streching, Clear ve drive teknik çalışmalar + Maç-oyun **Soğuma çalışmaları**	Süre:60-65 dakika Amaç: Teknik Çalışmalar Isınma koşusu ve streching, Drive teknik çalışmalar + Maç-oyun **Soğuma çalışmaları**
8. hafta	Süre:60-65 dakika Amaç: Teknik Çalışmalar Isınma koşusu ve streching, Clear teknik çalışmalar + Maç-oyun **Soğuma çalışmaları**	Süre:60-65 dakika Amaç: Teknik Çalışmalar Isınma koşusu ve streching, Net Drop teknik çalışmalar + Maç-oyun **Soğuma çalışmaları**	Süre:60-65 dakika Amaç: Teknik Çalışmalar Isınma koşusu ve streching, Drive teknik çalışmalar+ Maç-oyun **Soğuma çalışmaları**

Verilerin Analizi

Verilerin analizinde betimsel istatistik (ortalama, standart sapma) ve paired sample t test istatistiksel

teknikleri kullanılmıştır. Araştırmada ön test ve son test sonuçları arasındaki karşılaştırmaların tahminini sağlamak için etki büyüklükleri (Cohen'in d) hesaplanmıştır. Etki büyüklüğü istatistikleri için eşikler şu şekildedir <0.20 = önemsiz, 0.20–0.59 = küçük, 0.6–1.19 = orta, 1.2–1.99 = büyük; ≥2.0 = çok büyük olarak belirlenmiştir (Hopkins vd., 2009). Anlamlılık düzeyi 0.05 olarak belirlenmiş ve analizler Windows için SPSS 22 programında yapılmıştır.

BULGULAR

Bu bölümde, verilerin analizi sonucunda elde edilen bulgular tablolar halinde sunulmuş ve bu bulguların yorumlanmasına yer verilmiştir.

Tablo 2. Katılımcıların Fiziksel Özelliklerine İlişkin Tablo

Değişkenler	**x̄±SD**
Yaş *(yıl)*	20.3±1.07
Vücut Ağırlığı *(kg)*	68.2±3.17
Boy Uzunluğu (*cm)*	172.6±3.91
BMI *(kg / m²)*	18.5±2.6

Araştırma grubunda yer alan badminton sporcularının yaş ortalaması 20.3±1.07, boy ortalaması 172.6±3.91 vücut ağırlığı ortalaması 68.2±3.17ve vücut kitle indeksi ortalaması 18.5±2.6 olarak tespit edilmiştir.

Tablo 3. 8 Haftalık Klasik Badminton Antrenmanı Öncesi ve Sonrası Vücut Ağırlığı ve BMI'deki Farklılıklara İlişkin Bağımlı Gruplar T Testi Tablosu

Değişkenler	**Ön Test** x̄±SD	**Son Test** x̄±SD	**p**	**Cohen *d***	**Etki Büyüklüğü**
Vücut Ağırlığı *(kg)*	68.2±3.17	63.7±3.00	**0.000****	1.41	Büyük
BMI *(kg / m²)*	18.5±2.6	15.2±1.34	**0.000****	1.26	Büyük

p<0.05**

Tablo 2 incelendiğinde, uygulanan klasik badminton antrenmanı programının katılımcıların vücut ağırlığı ve yağ yüzdesi değerlerinde anlamlı değişikliklere yol açtığı tespit edilmiştir (p<0.05).

Tablo 4. 8 Haftalık Klasik Badminton Antrenmanı Öncesi ve Sonrası Biyokimyasal Farklılıklara İlişkin Bağımlı Gruplar T Testi Tablosu

Variables	**Pre** x̄±SD	**Post** x̄±SD	**p**	**Cohen *d***	**Magnitude**

Glukoz ***(Mg/dL)***	±	±	**0.00***	Büyük
Trigliserid***(Mg/dL)***	±	±	**0.00***	Büyük
Total Kolesterol ***(Mg/dL)***	±	±	**0.00***	Büyük
HDL***(Mg/dL)***	±	±	**0.00***	Büyük
LDL***(Mg/dL)***	±	±	**0.00***	Büyük

$p<0.05$*

Tablo 3' e baktığımızda; katılımcıların kan lipit düzeyleri (trigliserid, total kolesterol, HDL ve LDL), ve Glukoz ön test- son test değerleri arasında pozitif yönde anlamlı farklılığın olduğu belirlenmiştir. Analiz sonucundan anlaşılacağı üzere uygulanan klasik badminton antrenman programının katılımcıların ön test sonuçlarına göre mevcut değerlerde azalmalar meydana gelerek son test sonuçlarına pozitif etkinin olduğu söylenebilmektedir.

TARTIŞMA VE SONUÇ

Yapmış olduğumuz bu çalışmada, 8 haftalık klasik badminton antrenman programının, sporcuların fiziksel özellikleri ve biyokimyasal parametreleri üzerindeki etkileri incelenmiştir. Elde ettiğimiz sonuçlara göre klasik badminton antrenman programının sporcuların hem vücut kompozisyonunu hem de biyokimyasal parametrelerinde değişikliğe sebep olduğunu göstermektedir.

İlk olarak, Tablo 1 incelendiğinde katılımcıların yaş ortalamalarının 20.3±1.07 yıl, boy uzunluğunun 172.6±3.91 cm, vücut ağırlığının 68.2±3.17 kg ve vücut kitle indeksinin (BMI) 18.5±2.6 olarak ölçüldüğü gözlemlenmiştir. Bu verilere göre katılımcıların genç ve sağlık bir sporcu popülasyonu oluşturduğunu gözlemlemekteyiz.

Tablo 2'yi incelediğimiz zaman 8 haftalık klasik badminton antrenmanı öncesi ve sonrası katılımcıların vücut ağırlıkları ile BMI üzerindeki değişiklikleri görmekteyiz. Yapılan Analizler sonucunda sporcuların 8 haftalık antrenman sonunda vücut ağırlıklarının anlamlı bir şekilde azaldığını 68.2±3.17 kg'dan 63.7±3.00 kg'a) aynı zamanda BMI değerlerinin de (18.5±2.6 kg/m²'den 15.2±1.34 kg/m²'ye) düştüğü gözlemlenmiştir ($p<0.05$). Cohen d değerlerinin yüksekliği ne baktığımız da ise (vücut ağırlığı için 1.41 ve BMI için 1.26) bu değişikliklerin etkisinin büyük olduğu ve klasik badminton antrenmanının vücut kompozisyonunu olumlu bir şekilde etkilediğini işaret etmektedir. Bu sonuçlar, badminton antrenmanlarının vücut yağ oranını ve genel vücut ağırlığını düşürme konusundaki etkinliğini desteklemektedir.

Tablo 3'te, biyokimyasal parametreler (glukoz, trigliserid, total kolesterol, HDL ve LDL) açısından yapılan analizler, bu değerlerin antrenman öncesi ve sonrası arasında anlamlı bir fark olduğunu ortaya koymuştur. Özellikle, glukoz ve lipit profillerindeki (trigliserid, total kolesterol, HDL ve

LDL) pozitif değişiklikler, antrenman programının metabolik sağlık üzerindeki olumlu etkilerini vurgulamaktadır ($p<0.05$). Bu bulgular, badminton antrenmanlarının kardiyovasküler risk faktörlerini azaltmaya ve genel metabolik sağlığı iyileştirmeye yönelik potansiyelini ortaya koymaktadır.

Reilly ve R. (2005) çalışmasını incelediğimiz zaman, yüksek yoğunluklu egzersizlerin vücut kompozisyonunu iyileştirme konusundaki etkilerini ve bu tür egzersizlerin yağ kütlesini azalttığını belirtmiştir. Benzer bir çalışma olan, Borges ve Simoes (2012) yaptığı araştırmada, aerobik ve direnç egzersizlerinin yaşlı bireylerde vücut kompozisyonunu ve kas gücünü artırmada etkili olduğunu vurgulamıştır. Egzersizin, özellikle spor gibi düzenli ve yapılandırılmış aktivitelerin, vücut kompozisyonunu iyileştirmede etkin olduğunu destekleyen bulgular ortaya koyulmuştur.

Haskell ve ark., (2007) yapmış olduğu çalışmada, fiziksel aktivitenin glukoz ve lipid metabolizmalarını iyileştirme üzerindeki olumlu etkileri vurgulanmıştır. Egzersiz, glukoz ve lipid metabolizmasını olumlu yönde etkileyerek kardiyovasküler risk faktörlerini azaltabilir. Kelley ve Kelley (2009) göre, fiziksel aktivitenin dinlenme kan basıncı ve lipit profili üzerindeki olumlu etkilerini özetlemiş ve egzersizlerin metabolik sağlığı nasıl iyileştirdiğine dair bulgular sunmuştur. Ayrıca, Huang ve McLaren (2014) egzersizin obezite ve metabolik bozukluklar üzerindeki olumlu etkilerini inceleyerek, düzenli fiziksel aktivitenin metabolik sağlık üzerindeki etkisi olduğunu belirtmişlerdir. Bu çalışmalardan elde edilen bulgular, 8 haftalık klasik badminton antrenmanının glukoz ve lipid metabolizmasındaki iyileşmelerle ve sağlık üzerindeki olumlu etkileri olduğunu ve yapmış olduğumuz çalışmaları da desteklediği gözlemlenmiştir.

Sonuç olarak; klasik badminton antrenmanlarının hem fiziksel hem de biyokimyasal parametreler üzerinde anlamlı ve olumlu etkiler yarattığını göstermektedir. Bu tür antrenmanların, sporcuların sağlıklı bir vücut kompozisyonu ve dengeli bir biyokimyasal metabolizmaları elde etmelerine katkıda bulunabileceği sonucuna varılabilir. Bu bulgular, sporcuların performanslarını artırmak ve genel sağlıklarını iyileştirmek için düzenli badminton antrenmanlarının önemini vurgulamaktadır.

Gelecek araştırmalar, bu bulguların geniş bir sporcu kitlesine genellenebilirliğini test etmek ve farklı antrenman programlarının karşılaştırmasını yapmak amacıyla daha geniş örneklem grupları ile yapılabilir. Ayrıca, uzun dönem etkileri ve antrenman sürelerinin biyokimyasal parametreler üzerindeki uzun vadeli etkileri de araştırılmalıdır.

KAYNAKLAR

Alcock, A., ve Cable, N. T. (2009). A comparison of singles and doubles badminton heart rate response, player profiles, ve game characteristics. *International Journal of Performance Analysis in Sport*, *9*(2), 228-237.

Borges, L. F., ve Simoes, M. R. (2012). Effects of aerobic and resistance training on body composition and muscle strength in older adults. *Journal of Aging and Physical Activity, 20*(4).

Civelek, V. N. (1990). Tip 1 diyabetik hasta eritrositlerinde azalmış glikoz metabolizması. İstanbul Üniversitesi.

Dehghan, M., ve Merchant, A. T. (2008). Is bioelectrical impedance accurate for use in large epidemiological studies? *Nutrition Journal, 7*, 26.

Göçmen, N. (2001). *Yıldızlar kategorisi badmintonculara uygulanan 8 haftalık gölge antrenmanlarının performansa etkisinin incelenmesi* (Yüksek lisans tezi). Isparta.

Haskell, W. L., Lee, I. M., Pate, R. R., Powell, K. E., Blair, S. N., Franklin, B. A., ve B. A. (2007). Physical activity and public health: Updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. *Circulation, 116*(9), 1081-1093.

Hopkins, W. G., Marshall, S. W., Batterham, A. M., & Hanin, J. (2009). Progressive statistics for studies in sports medicine and exercise science. Medicine & Science in Sports & Exercise, 41(1), 3.

Huang, T. T., ve McLaren, L. (2014). Impact of physical activity on obesity and related metabolic disorders in adults. *Current Diabetes Reports, 14*(4), 456-463. https://doi.org/10.1007/s11892-014-0456-3

Kelley, G. A., ve Kelley, K. S. (2009). Progressive resistance exercise and resting blood pressure: A meta-analysis of randomized controlled trials. *Hypertension, 54*(1), 360-368.

Korkmaz, M., ve Kocabey, Z. (1995). *Biyokimya*. Saray Tıp Kitapevi, İzmir, s. 191-252.

Özbarış, B. (2009). *Lise düzeyinde lisanslı badminton oyuncularının 1997 yılı Balkan Şampiyonası Türkiye Badminton Milli Takım oyuncularıyla bazı fiziksel ve spormotorik özellikler bakımından karşılaştırılması* (Yayımlanmamış Yüksek Lisans Tezi, Karadeniz Teknik Üniversitesi, Sosyal Bilimler Enstitüsü). Trabzon.

Ramazanoğlu, F., Karahüseyinoğlu, M. F., Demirel, E. T., Ramazanoğlu, M. O., ve Altungül, O. (2005). Sporun toplumsal boyutlarının değerlendirilmesi. *Fırat Üniversitesi Doğu Araştırmaları Dergisi*, 3(3), 153-157.

Reilly, T. R. (2005). Effects of high-intensity exercise on body composition and fitness. *Journal of Sports Sciences*, 23(2), 121-135.

Turğut, M., Aydın, R., ve Erkılıç, A. O. (2017). Bartın Üniversitesi badminton takımında yer alan kadın sporculara uygulanan 8 haftalık klasik badminton antrenmanlarının bazı fiziksel performans parametreleri üzerine etkileri. *Uluslararası Kültürel ve Sosyal Araştırmalar Dergisi*, 3(Special Issue 2), 354-364.

Yıldırım, İ. (1985). *Badminton*. Badminton Federasyonu Yayınları, Ankara.

Yüksel, M. F. (2015). *Gölge badminton antrenmanlarının 8-10 yaş grubu badmintoncularının performansları üzerine etkisinin araştırılması* (Doktora tezi). Gazi Üniversitesi Sağlık Bilimleri Enstitüsü, Ankara.

Zorba, E. (2001). *Fiziksel uygunluk*. Muğla: Gazi Kitapevi Yayınlar.

BOCCE SPORCULARINDA MAÇ PERFORMANSINA VERİLEN YANITLARIN İNCELENMESİ

AN EXAMINATION OF MATCH PERFORMANCE RESPONSES IN BOCCE ATHLETES

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ÖZET

Giriş ve Amaç: Zihinsel yorgunluk, sportif performansı olumsuz yönde etkileyebilen bilişsel bir durum olarak tanımlanmaktadır ve özellikle dikkat, karar verme ile motor kontrol süreçleri üzerinde belirgin değişiklikler yaratabilmektedir. Rekabet gerektiren sporlarda, müsabaka öncesi zihinsel durumun performans çıktıları üzerindeki etkisinin anlaşılması büyük önem taşımaktadır. Bu çalışmanın amacı, simüle edilmiş bocce maçı öncesinde uygulanan zihinsel yorgunluğun psikofizyolojik tepkiler üzerindeki etkisini incelemektir.

Yöntem: Bu çalışmaya 40 bocce sporcusu (yaş =23.34 ± 4.01 yıl; boy uzunluğu 171.12 ± 8.98 cm; vücut ağırlığı 67.51 ± 13.85 kg) gönüllü olarak katılmıştır. Ölçümlere başlamadan önce ölçümler hakkında bilgi verilmiş sporculara antropometrik ölçümler gerçekleştirilmiştir. Resmi bocce müsabakası kuralları ve formatı kullanılmıştır. Oyunlar öncesi ve sonrasında Brunel ruh hali ölçeği (BRUMS) cevapları kaydedilmiştir. Her set sonunda oyuncuların algılanan zorluk derecesi (AZD), görsel analog skala (GAS) ve keyif ölçeği değerleri belirlenmiştir. Verilerin değerlendirilmesinde SPSS paket programından yararlanılarak ön test-son test ölçümleri için Bağımlı gruplar T Testi kullanılmıştır.

Tartışma ve Sonuç: Mevcut çalışmanın bulgularına göre zihinsel yorgunluğun maç sırasında algılanan zorluğu ve zihinsel yorgunluk düzeyini artırdığını, aynı zamanda bocce oyuncularının maçtan aldıkları keyifin azaldığını göstermiştir ($p<0.05$). Ruh hali cevaplarına dayalı olarak, zihinsel yorgunluk sonrası kızgınlık ve yorgunluk gibi olumsuz ruh hallerinde artış gözlemlenirken, dinçlik ruh halinde azalma meydana gelmiştir ($p<0.05$). Ancak, zihinsel yorgunluk olmadan oynatılan maçta öncesi ve sonrası karşılaştırıldığında, ruh hallerinde herhangi bir değişiklik gözlenmemiştir ($p>0.05$). Zihinsel yorgunluklu oynatılan maç sonrasında yalnızca dinçlik hissinde yorgunluk olmadan oyuna göre azalma tespit edilmiştir ($p<0.05$). Sonuç olarak; antrenörlerin ve spor psikologlarının sporcularını daha iyi anlamalarına ve gerektiğinde uygun önlemleri alabilmelerine yardımcı olabileceği yönünde değerlendirilmiştir. Zihinsel yorgunluğun sporcu performansına etkisini anlamaları, antrenman programlarını daha iyi yönlendirmelerine yardımcı olabileceği düşünülmektedir.

Anahtar Kelimeler: Bilişsel Yorgunluk, Psikofizyoloji, Bocce, Maç, Performans

ABSTRACT

Introduction and Objective: Mental fatigue is defined as a cognitive state that can adversely affect athletic performance, producing notable alterations particularly in attention, decision-making, and motor control processes. In competitive sports, understanding the influence of pre-competition mental states on performance outcomes is of great importance. The aim of this study is to examine the effects of mental fatigue, induced prior to a simulated bocce match, on psychophysiological responses.

Material and Method: A total of 40 bocce athletes (age = 23.34 ± 4.01 years; height = 171.12 ± 8.98 cm; body mass = 67.51 ± 13.85 kg) voluntarily participated in this study. Prior to the measurements, participants were informed about the procedures, and anthropometric assessments were conducted. Official bocce competition rules and match formats were applied. Before and after the games, participants completed the Brunel Mood Scale (BRUMS). After each set, ratings of perceived exertion (RPE), visual analogue scale (VAS) scores, and pleasure scale values were recorded. Data were analyzed using the SPSS package program, and paired-samples t-tests were employed for pre- and post-test comparisons.

Discussion and conclusion: The findings of the present study indicate that mental fatigue increases perceived exertion and mental fatigue levels during the match, while simultaneously reducing the players' enjoyment of the game ($p < 0.05$). Based on mood responses, increases were observed in negative mood states such as anger and fatigue following mental-fatigue induction, whereas vigor decreased ($p < 0.05$). However, in the condition without mental fatigue, no significant changes in mood states were detected before and after the match ($p > 0.05$). Following the mentally fatiguing condition, only vigor was found to be lower compared to the non-fatigue condition ($p < 0.05$). In conclusion, these findings may help coaches and sport psychologists better understand their athletes and take appropriate measures when necessary. Understanding the influence of mental fatigue on athletic performance may assist practitioners in more effectively guiding training programs.

Key Words: Cognitive Fatigue, Psychophysiology, Bocce, Match, Performance

GİRİŞ

Spor, günümüz toplumlarında insanoğlunun vazgeçilmez bir parçası haline gelmiştir. Bireylerin isteğine göre şekillenen ve çok çeşitli branşlara ayrılan spor, her yaş grubuna hitap etmektedir. Spor, insanoğlunun ilk zamanlarından beri var olan ve günümüzde dahi net bir tanımı olmayan bir kavramdır. Kişilerin icra ettiği ve izleyene keyif veren, rekabetçi bir yapıya sahip aktivitelerdir (Ayyıldız, 2022). Günümüzde sportif faaliyetlere artan ilgiyle birlikte bocce sporu, tüm dünyada ve Türkiye'de her yaştan insanın ilgisini çekerek popüler bir spor dalı haline gelmiştir. Toplumun her kesimi tarafından oynanabilen bocce, okul sporları olarak da yaygınlaşmaktadır (Arslan, 2018).

Tarihi çok eskilere dayanan bocce sporu, giderek daha da popülerleşmektedir. Bocce, her yaştan ve cinsiyetten oyuncuya hitap eden, rekabetçi bir spor dalıdır. Fiziksel ve zihinsel zorlukları olmasına rağmen, son derece net kuralları sayesinde sporcuların eğitimi kolaydır (Kırışık ve Erol, 2023).

Bocce'ye benzeyen oyunlar tarihte çok eski zamanlardan beri oynanmaktadır. Topları veya benzer malzemeleri atma ve bir hedefi vurma amacına sahip olan antik oyunların Bocce, Petanque, Lawn Ball ve hatta Bowling'in atası olduğu düşünülmektedir. Bocce, futbol, basketbol gibi popüler spor

dalları kadar bilinmemesine rağmen, her geçen gün daha fazla oyuncu ve izleyiciye ulaşarak dünyada ve Türkiye'de büyük kitlelere yayılmaktadır. Bocce, ülkemizde oynanan Petank, Raffa, Çim Topu ve Volo'nun genel adıdır. Beş kıtada 2 milyondan fazla insanın oynadığı bir dünya sporudur. Bocce, her yaştan, cinsiyetten, sosyal statüden ve fiziksel yeteneğe sahip insanın rahatlıkla oynayabileceği bir spordur (Eler ve Eler, 2018).

Psikofizyoloji, zihin ile beden arasındaki karşılıklı ilişkilerin bir sonucudur. İnsan davranışını etkileyen süreçlere ve mekanizmalara yön veren disiplinler arası, çok ölçümlü araştırma çalışmalarıyla ifade edilir. Aslında geniş bir yelpazeye sahip olan psikofizyoloji; bugün bilişsel ve sosyal sinirbilim, nöropsikoloji ve kardiyovasküler psikofizyoloji dahil olmak üzere bir dizi alt disiplini kapsamaktadır. Dahası psikolojik durumlar, fizyolojik tepkiler ve insan davranışı arasındaki ilişkilerin aydınlatılması, disiplinin temel görevi olmaya devam etmektedir (Cooke ve Ring, 2019).

Bu bilgiler doğrultusunda araştırmada, bocce sporcularında maç performansına verilen psikofizyolojik yanıtların incelenerek bulgularına göre maç sırasında algılanan zorluğu ve aynı zamanda bocce oyuncularının maçtan aldıkları keyif düzeyinin, ruh hali düzeylerinin tespiti ve algıladıkları zorluk seviyesinin ölçülmesi amaçlanmıştır.

YÖNTEM

Araştırmanın Modeli

Akut deneysel araştırma tasarımları, bir uygulama veya uygulamanın belirli bir sonuç veya değişken üzerindeki anlık etkilerini araştıran araştırma çalışmalarını ifade eder. Bu tasarımlar tipik olarak tek bir oturumu veya müdahaleye maruz kalmayı içerir ve araştırmacıların müdahalenin anlık veya kısa vadeli etkilerini incelemesine olanak tanır. Zihinsel yorgunluk ve fiziksel performans bağlamında, zihinsel yorgunluğun kas dayanıklılığı, motor performansı ve egzersiz kapasitesi gibi fiziksel performansın çeşitli yönleri üzerindeki anlık etkisini incelemek için akut deneysel araştırma tasarımları kullanılmıştır. Bu çalışmalar genellikle bilişsel görevler veya faaliyetler yoluyla zihinsel yorgunluğun tetiklenmesini ve hemen ardından fiziksel performans sonuçlarının değerlendirilmesini içerir (Pageaux vd., 2013; Marcora vd., 2009).

Katılımcılar

Çalışmaya 40 erkek bocce oyuncusu bu çalışmaya gönüllü olarak dâhil edilmiştir. Çalışma deney grubu ve kontrol grubu olarak randomize olacak şekilde eşit sayıda gruplandırılmıştır. Katılımcılar aynı kulüp sporcusu ve haftada 5 gün antrenman yapmaktadır. Oyuncuların fiziksel olarak sağlıklı ve herhangi bir psikolojik ve ortopedik problemleri bulunmamaktadır. Katılımcılar veri toplamadan

hemen önce çalışmanın faydaları ve olası riskleri hakkında bilgilendirilmiş ve katılım için yazılı onamları alınmıştır. Çalışma protokolü Bartın Üniversitesi Etik Kurulu tarafından onaylanmış (2024-SBB-0144) ve tüm prosedürler Helsinki Deklarasyonu'na uygun olarak yürütülmüştür.

Veri Toplama Araçları

Bu kısımda araştırmada kullanılan veri toplama araçlarından bahsedilmektedir. Kullanılan veri toplama araçlarının geçerlik güvenirliği çalışmanın yürütülmesi açısından önem arz etmektedir.

Algılanan Zorluk Derecesi (AZD)

Algılanan Zorluk Derecesi (AZD), fiziksel aktivitenin öznel bir ölçüsüdür ve bireylerin egzersiz sırasında hissettikleri çaba veya yoğunluk düzeyini değerlendirmek için kullanılır. Bu ölçek, egzersiz bilimi, spor eğitimi ve klinik ortamlarda, bir kişinin egzersiz sırasında ne kadar yoğun çalıştığını algıladığına dair bir fikir sunar. AZD 6-20 ölçeği, orijinal Borg AZD ölçeğinin Foster ve ark. (2001) tarafından değiştirilmiş bir versiyonudur ve algılanan çabanın daha ayrıntılı bir değerlendirmesini sunmak amacıyla 0 ila 10 arasında bir aralık sunar. AZD 6-20 ölçeği kullanılırken, bireylerden mevcut efor seviyelerini en iyi şekilde yansıtan bir sayı seçmeleri istenir. Bu, genel efor hissi, solunum, kalp atış hızı, kas yorgunluğu ve diğer fiziksel duyumlar gibi öznel bir değerlendirmeye dayanır.

Ruh Hali

Simüle müsabaka öncesinde ve sonrasında, genç ve yetişkin sporcular için Türkçe ‘ye uyarlanmış olan 24 maddelik bir ölçek kullanılarak ruh hali düzeyleri belirlenmiştir. Bu ölçek, Terry ve ark. (1999; 2003) tarafından geliştirilmiş ve daha sonra Soylu ve ark. (2022) tarafından Türkçe ‘ye çevrilmiştir. Ölçek altı (6) farklı boyutta (kızgınlık, şaşkınlık, depresyon, yorgunluk, gerginlik ve canlılık) toplamıştır. Depresyon alt boyutu, klinik depresyonu değil, depresif bir ruh halini yansıtan bir gösterge içermektedir. Katılımcılara, oyunlar öncesinde ve sonrasında "Şu anda kendinizi nasıl hissediyorsunuz?" sorusu yöneltilmiş ve yanıtlarını 0 ile 4 arasında bir sayıyla ifade etmeleri istenmiştir (0 = hiç, 1 = biraz, 2 = orta derecede, 3 = oldukça, 4 = aşırı derecede).

Egzersiz Keyfi

Simüle bocce müsabakaları sırasında oyundan alınan keyif düzeyi, Kendzierski ve DeCarlo (1991) tarafından geliştirilen 18 maddelik Fiziksel Aktivite Keyif Ölçeğinden Raedeke (2008) tarafından türetilen 8 maddelik kısa versiyonu kullanılmıştır. Egzersiz Keyif ölçeği, Soylu ve ark. (2022) tarafından Türkçe olarak genç ve yetişkin sporcular için uyarlanmıştır. Oyunculardan oyunlar

sırasında "Egzersiz yaparken kendinizi şu anda nasıl hissediyorsunuz?" sorusunu yanıtlamaları istenmiştir. Ölçek, egzersizden aldıkları keyif seviyesini değerlendirmek için kullanılan tek bir alt boyuttan (örneğin, "Eğlenceli-Eğlenceli Değil") oluşur. Katılımcılar, 1 (Hiç katılmıyorum) ile 7 (Tamamen katılıyorum) arasında değişen 7 puanlı iki kutuplu bir ölçek kullanarak yanıtlarını vermişlerdir.

Prosedür

Bu çalışma, tüm katılımcıların aynı koşullar altında (resmi müsabaka şartlarında) deneysel bir simüle müsabaka sırasında iki simüle bocce maçı (maçlar arasında 48 saatlik aralık) gerçekleştirdiği tekrarlanan uyaranlı akut deneysel bir araştırmadır. Çalışmada zihinsel yorgunluk uygulaması için Stroop testi kullanılmış ve kontrol grubu ise belgesel izletilmiştir. Her 24 saatte bir (her zaman öğleden sonra 4'te) simüle edilmiş maçların yapıldığı simüle edilmiş bir müsabaka programı şekli kullanılmıştır. Müsabakaların öncesinde antropometrik verileri (boy ve kilo) ve Brunel Ruh Hali ölçeği doldurtulmuştur. Müsabakalar sırasında ise Algılanan zorluk derecesi, keyif ve zihinsel yorgunluk skalaları uygulanmıştır. Müsabakalar resmi bocce kuralları uygulanmış ve 2. Kademe Bocce antrenörü tarafından takip edilmiştir. Katılımcılar tüm ziyaretlerden 48 saat önce herhangi bir fiziksel egzersizden ve alkol alımından kaçınmış ve deneysel simüle bocce müsabaka programı sırasında tüm maçlardan en az dört saat önce kafein alımı yasaklanmıştır.

Verilerin Analizi

Simüle bocce müsabakası sırasında elde edilen veriler ortalama ± standart sapma şeklinde sunulmuştur. ZY+BOC ve ZY-BOC koşulları arasındaki farklılıkları değerlendirmek amacıyla, psikofizyolojik yanıtlar ve teknik performans gibi her bağımlı değişken için eşleştirilmiş t-testleri kullanılmıştır. ZY+BOC ve ZY-BOC koşulları arasındaki bireyler arası değişkenlik, her bir bağımlı değişken için varyasyon katsayısı (CV) ile ölçülmüştür. Ayrıca, her bağımlı değişken için etki büyüklükleri (Cohen's d) hesaplanmıştır. Etki büyüklüğü istatistikleri için belirlenen eşikler şu şekildedir: 0.2, önemsiz; 0.6, küçük; 1.2, orta; 2.0, büyük; ve >2.0, çok büyük (Hopkins vd., 2008). Tüm istatistiksel analizler, SPSS yazılımının 24.0 sürümü (SPSS Inc, Chicago, IL, ABD) kullanılarak gerçekleştirilmiştir. İstatistiksel anlamlılık düzeyi $p \leq 0.05$ olarak kabul edilmiştir.

BULGULAR

Tablo 1. ZY+BOC ve ZY-BOC psikofizyolojik cevaplara ait istatistik sonuçları

	ZY+BAD	ZY-BAD			
	AO ± SS	AO ± SS	p	Etki Büyüklüğü	Tanımlama
AZD	18.72 ± 1.14	15.63± 1.86	**0.012***	1.74	Büyük
GAS	5.16 ± 1.47	3.73 ± 1.70	**0.001***	1.37	Büyük
Keyif	42.61 ± 1.57	45.18 ± 3.33	**0.041***	-2.23	Çok Büyük

ZY+BOC= Zihinsel yorgunluk ile oynatılan bocce maçı; ZY-BOC = Zihinsel yorgunluk olmadan oynatılan bocce maçı; AZD = Algılanan zorluk derecesi; GAS = Görsel analog skala; AO = Aritmetik ortalama; SS = Standart sapma; p = anlamlılık değeri; p<0.05

Tablo 1'de ZY+BOC ve ZY-BOC sonrasında verilen psikofizyolojik yanıtlarına ait istatistiksel sonuçlarına yer verilmiştir. AZD, GAS ve keyif yanıtlarında gruplar arasında istatistiksel olarak anlamlı bir fark olduğu görülmüştür (p<0.05). Sonuçlara göre ZY+BOC maç sonrasında algılanan zorluk ve zihinsel yorgunluk düzeyi artarken, keyif hissinin azaldığı belirlenmiştir.

Tablo 2. ZY+BOC maçı öncesi ve sonrası Brunel ruh hali cevapları

	Maç Öncesi	Maç Sonrası			
	AO ± SS	AO ± SS	p	Etki Büyüklüğü	Tanımlama
Kızgınlık	1.75 ± 3.50	6.25 ± 5.40	**0.015***	-095	Orta
Şaşkınlık	4.80 ± 2.90	3.95 ± 2.45	0.210	-	-
Depresyon	2.10 ± 3.10	3.40 ± 3.00	0.298	-	-
Yorgunluk	2.90 ± 3.60	8.80 ± 4.00	**0.006***	-1.48	Büyük
Gerginlik	5.50 ± 4.90	5.00 ± 5.40	0.645	-	-
Dinçlik	11.20 ± 4.30	4.60 ± 3.10	**0.003***	1.75	Büyük

AO = Aritmetik ortalama; SS = Standart sapma; p = anlamlılık değeri; p<0.05

Tablo 2'de ZY+BOC müsabaka öncesi ve sonrasında verilen ruh hali yanıtlarına ait istatistiksel sonuçlarına yer verilmiştir. Kızgınlık, yorgunluk ve dinçlik yanıtlarında gruplar arasında istatistiksel olarak anlamlı bir fark olduğu tespit edilmiştir (p<0.05). Sonuçlara göre ZY+BOC maç sonrasında kızgınlık ve yorgunluk düzeyi artarken, dinçlik ruh halinin azaldığı belirlenmiştir. Şaşkınlık, depresyon ve gerginlik ruh hallerinde ise gruplar arasında istatistiksel olarak anlamlı fark olmadığı tespit edilmiştir.

Tablo 3: ZY-BOC maçı öncesi ve sonrası Brunel ruh hali cevapları

	Maç Öncesi	Maç Sonrası			
	AO ± SS	AO ± SS	p	Etki Büyüklüğü	Tanımlama
Kızgınlık	5.94 ± 2.10	6.85 ± 2.80	0.312	-	-
Şaşkınlık	3.95 ± 2.53	5.72± 2.23	0.094	-	-
Depresyon	6.10 ± 4.21	4.25 ± 1.92	0.278	-	-
Yorgunluk	5.80 ± 3.95	8.50 ± 3.40	0.060	-	-
Gerginlik	7.67 ± 2.00	5.12 ± 2.95	0.051	-	-
Dinçlik	5.25 ± 3.41	7.74 ± 2.83	0.089	-	-

AO = Aritmetik ortalama; SS = Standart sapma; p = anlamlılık değeri; p<0.05

Tablo 3'de ZY-BOC müsabaka öncesi ve sonrasında verilen ruh hali yanıtlarına ait istatistiksel sonuçlarına yer verilmiştir. Kızgınlık, şaşkınlık, depresyon, yorgunluk, gerginlik ve dinçlik yanıtlarında gruplar arasında istatistiksel olarak anlamlı bir fark olmadığı saptanmıştır (p>0.05).

Tablo 4. ZY+BOC ve ZY-BOC maçı öncesi ve sonrası Brunel ruh hali cevapları

	ZY+BOC	ZY-BOC			
	AO ± SS	AO ± SS	p	Etki Büyüklüğü	Tanımlama
Kızgınlık	4.11 ± 5.40	6.80 ± 2.61	**0.042***	-	-
Şaşkınlık	4.34 ± 2.45	6.21 ± 2.29	0.158	-	-
Depresyon	3.42 ± 3.10	3.62± 1.96	0.812	-	-
Yorgunluk	8.82 ± 3.80	9.16± 3.13	0.895	-	-
Gerginlik	5.10 ± 5.12	5.28 ± 3.21	0.876	-	-
Dinçlik	4.00 ± 3.10	7.70 ± 2.50	**0.028***	-	-

AO = Aritmetik ortalama; SS = Standart sapma; p = anlamlılık değeri; p<0.05

Tablo 4'de ZY+BOC ve ZY-BOC müsabaka sonrasında verilen ruh hali yanıtlarına ait istatistiksel sonuçlarına yer verilmiştir. Kızgınlık, şaşkınlık, depresyon, yorgunluk ve gerginlik ruh hallerinde gruplar arasında istatistiksel olarak anlamlı fark olmadığı belirlenmiştir (p>0.05). ZY-BOC maçı sonrasında dinçlik halinin ZY+BOC maçı sonrasına göre daha fazla olduğu görülmüştür. Diğer yandan ZY-BOC maçı sonrasında kızgınlık halinin ZY+BOC maçı sonrasına göre daha düşük düzeyde olduğu belirlenmiştir.

TARTIŞMA VE SONUÇ

Çalışmada ilk olarak ZY+BOC ve ZY-BOC sonrasında verilen psikofizyolojik yanıtlarına ait istatistiksel sonuçlarına göre AZD, GAS ve keyif yanıtlarında gruplar arasında istatistiksel olarak anlamlı bir fark olduğu görülmüştür. Sonuçlara göre ZY+BOC maç sonrasında algılanan zorluk ve

zihinsel yorgunluk düzeyi artarken, keyif hissinin azaldığı belirlenmiştir. Zihinsel yorgunluk, atletik performansı etkileyebilen bir bilişsel tükenme durumudur (Soylu, 2022).

Birçok çalışma zihinsel yorgunluğun spor performansı üzerindeki etkilerini incelemiştir, ancak özellikle bocce sporcularına odaklanan sınırlı araştırma vardır. Van Cutsem vd., (2019) zihinsel yorgunluk elit sporcularda görsel-motor tepki süresini bozduğuna dair bir çalışma gerçekleştirmiştir. Zihinsel yorgunluk açısından, her iki grup da zihinsel yorgunluğu benzer şekilde algılamış, ancak sporcularda daha yüksek zihinsel yorgunluk seviyeleri tespit edilmiştir. Literatür incelendiğinde zihinsel yorgunluğun bocce performansını nasıl etkilediğine dair çalışmaların çok az olduğu tespit edilmiştir.

Literatürdeki mevcut çalışmaların sonuçlarının da mevcut çalışmanın sonuçlarını destekler nitelikte olduğu zihinsel yorgunluğun fiziksel bir görev sırasında oyuncuları olumsuz etkilediği tespit edilmiştir. Ayrıca Zihinsel yorgunluk (ZY), uzun süreli bilişsel çaba sonucu ortaya çıkan ve fiziksel performansı olumsuz etkileyebilen bir psikobiyolojik durumdur. Russell vd., (2019) yaptığı çalışmada, elit sporcuların zihinsel yorgunluğu, motivasyon düşüşü, duygusal değişiklikler ve dikkat dağınıklığı gibi belirtilerle ilişkilendirilmiştir. Bu durum, sporcuların performansını olumsuz yönde etkileyebilmektedir.

Wu vd., (2024) araştırmasında ise zihinsel yorgunluğun, aerobik dayanıklılık, spor karar verme, taktiksel performans ve teknik performans üzerinde olumsuz etkiler yarattığı belirtilmiştir. Bu bulgular, Bocce gibi strateji ve dikkat gerektiren sporlarda da benzer etkilerin görülebileceğini düşündürmektedir. Ayrıca algılanan zorluk, bireyin bir görevi ne kadar zor olarak değerlendirdiğini ifade eder. Mental yorgunluk, bu algıyı artırabilir. Schiphof-Godart vd., (2018) çalışmasında, zihinsel yorgunluğun, verilen bir görev için gereken çaba algısını artırdığı ve ödül beklentisini azalttığı bulunmuştur. Bu durum, sporcuların maç sırasında daha fazla çaba harcadıklarını ancak ödül beklentilerinin düştüğünü göstermektedir. Keyif düzeyi ise, bireyin bir etkinlikten aldığı haz ve memnuniyetle ilgilidir. Mental yorgunluk, bu duyguyu olumsuz etkileyebilir. Sun (2021) sistematik incelemesinde, zihinsel yorgunluğun, sporcuların teknik ve karar verme becerilerini olumsuz etkilediği ve bu durumun keyif düzeyini düşürebileceği belirtilmiştir.

Çalışmanın devamında ZY+BOC müsabaka öncesi ve sonrasında verilen ruh hali yanıtlarına ait istatistiksel sonuçları incelenmiş ve kızgınlık, yorgunluk ve dinçlik yanıtlarında gruplar arasında istatistiksel olarak anlamlı bir fark olduğu tespit edilmiştir ($p<0.05$). Benzer şekilde, yorgunluk düzeyinin artışı hem bilişsel hem de fiziksel performansı olumsuz etkileyen bir psikofizyolojik yanıt olarak literatürde yer almaktadır (Boksem ve Tops, 2008). Maç sonrası dinçlik ruh halinin azalması, sporcuların enerji ve motivasyon düzeylerinde düşüş olduğunu göstermektedir. Bu durum, zihinsel yorgunluğun hem fiziksel hem de psikolojik enerjiyi tükettiğine dair bulguları destekler (Smith vd., 2016). Dinçlik azalması, özellikle strateji ve konsantrasyon gerektiren sporlarda performans kaybına yol açabilmektedir.

Bir sonraki sonuçta ZY-BOC müsabaka öncesi ve sonrasında verilen ruh hali yanıtlarına göre kızgınlık, şaşkınlık, depresyon, yorgunluk, gerginlik ve dinçlik yanıtlarında gruplar arasında istatistiksel olarak anlamlı bir fark olmadığı saptanmıştır ($p>0.05$). Bulgular, zihinsel yorgunluğun sporcuların algılanan zorluk, keyif ve ruh hâli üzerinde belirgin etkileri olduğunu göstermektedir. ZY+BOC grubunda maç sonrası algılanan zorluk ve zihinsel yorgunluk düzeylerinde artış, keyif düzeyinde ise azalma gözlenmiştir. Bu bulgu, zihinsel yorgunluğun bireylerin bilişsel kaynaklarını tüketmesi ve görevle ilgili çaba algısını artırmasıyla açıklanabilir (Behrens vd., 2023). Mental yorgunluk, özellikle strateji ve dikkat gerektiren sporlarda, sporcuların hem bilişsel hem de duygusal yükünü artırarak algılanan zorluğu yükseltebilir (Schiphof-Godart vd., 2018). Keyif düzeyinin azalması da zihinsel yorgunluğun motivasyon ve ödül beklentisi üzerindeki olumsuz etkileri ile ilişkilidir (Sun, 2021). Sporcular, maç sırasında artan bilişsel yük nedeniyle, maçtan aldıkları haz ve memnuniyet hissinin azaldığını deneyimlemektedir. Bu durum, sadece Bocce için değil, diğer rekabetçi sporlarda da performans psikolojisinin anlaşılmasında önemli bir gösterge olarak değerlendirilebilmektedir. ZY-BOC grubunda ise algılanan zorluk, keyif ve zihinsel yorgunluk düzeylerinde anlamlı değişiklik gözlenmemiştir ($p>0.05$). Bu durum, zihinsel yorgunluğun olmamasının sporcuların bilişsel ve duygusal kaynaklarını koruduğunu göstermektedir. Literatürde, zihinsel yorgunluğun yokluğunda sporcuların performans ve motivasyon düzeylerini daha stabil tuttukları bildirilmiştir (Harris ve Bray, 2019; Sousa Fortes vd., 2024). ZY+BOC grubunda maç sonrası kızgınlık ve yorgunluk düzeylerinin arttığı, dinçlik ruh hâlinin ise azaldığı saptanmıştır. Bu bulgular, zihinsel yorgunluğun emosyonel regülasyonu olumsuz etkilediğini göstermektedir (Lane vd., 2001). Zihinsel yorgunluk, dikkat ve bilişsel kaynakların azalmasıyla, olumsuz duyguların (kızgınlık, yorgunluk) artmasına ve pozitif duyguların (dinçlik, enerji) azalmasına neden olabilir (Van Cutsem vd., 2017). Bu durum, maç sırasında sporcuların hem performans hem de psikolojik durumlarının etkilenebileceğini göstermektedir. ZY-BOC grubunda ise maç öncesi ve sonrası ruh hâli yanıtlarında anlamlı değişiklik gözlenmemiştir. Bu, zihinsel yorgunluk yokluğunda sporcuların ruh hâllerini koruduğunu ve olumsuz duygusal değişimlerin sınırlı kaldığını gösterir. Bu bulgu, zihinsel yorgunluğun negatif duygusal değişimlerde temel bir tetikleyici olduğunu desteklemektedir (Smith vd., 2016; Dora vd., 2022). Elit sporcularda zihinsel yorgunluk hem psikolojik hem de fizyolojik süreçleri etkileyerek performans kaybına yol açabilir (Yuan vd., 2023). Bu çalışmanın bulguları, Bocce gibi dikkat ve strateji gerektiren sporlarda zihinsel yorgunluğun, sporcuların algıladıkları zorluk ve keyif düzeyi ile ruh hâli yanıtlarını anlamlı şekilde değiştirdiğini göstermektedir. Literatürde zihinsel yorgunluğun spor performansını olumsuz etkilediği ve özellikle karar verme, dikkat ve strateji uygulamalarında belirgin kayıplara yol açtığı bildirilmektedir (Marcora vd., 2009; Sun, 2021).

Çalışmada son olarak ZY+BOC ve ZY-BOC müsabaka sonrasında verilen ruh hali yanıtlarına ait istatistiksel sonuçlarına yer verilmiştir. Dinçlik yanıtlarında gruplar arasında istatistiksel olarak anlamlı

bir fark olmadığı saptanmıştır ($p>0.05$). ZY-BOC maçı sonrasında dinçlik halinin ZY+BOC maçı sonrasına göre daha fazla olduğu görülmüştür. Kızgınlık, şaşkınlık, depresyon, yorgunluk ve gerginlik ruh hallerinde gruplar arasında istatistiksel olarak anlamlı fark olmadığı belirlenmiştir. ZY+BOC grubunda maç sonrası algılanan zorluk ve zihinsel yorgunluk düzeylerinde artış, keyif düzeyinde ise azalma gözlenmiştir. Bu durum, zihinsel yorgunluğun bilişsel kaynakları tüketerek sporcuların görevle ilgili çaba algısını artırmasıyla açıklanabilir (McMorris vd., 2018). Literatürde, zihinsel yorgunluğun özellikle strateji ve dikkat gerektiren sporlarda sporcuların algıladıkları zorluğu yükselttiği ve ödül beklentilerini azalttığı bildirilmiştir (Schiphof-Godart vd., 2018; Sun, 2021). Bu, Bocce gibi dikkat ve strateji odaklı sporlarda sporcuların performansını doğrudan etkileyebilir. ZY-BOC grubunda ise algılanan zorluk, keyif ve zihinsel yorgunluk düzeylerinde anlamlı değişiklik gözlenmemiştir ($p>0.05$). Bu durum, zihinsel yorgunluğun yokluğunda sporcuların bilişsel ve emosyonel kaynaklarını koruduğunu ve böylece performansın daha stabil kaldığını göstermektedir (Boksem ve Tops, 2008; Smith vd., 2016).

Sonuç

Sonuç olarak, araştırmacılar, sporculardan alınan geri bildirimlere dayalı olarak, zihinsel yorgunluğu değerlendirmek ve yönetmek için kullanılabilecek uygulama ve rehberlik araçları geliştirmeyi düşünebilirler. Özellikle sporcuların performansını etkileyen faktörleri ve bu faktörlerin nasıl yönetilebileceğini anlamak için daha fazla çalışma yapılabilir. Bu çalışmanın sonuçları spor psikolojisi ve spor performansı alanındaki araştırmacılara, sporcuların zihinsel yorgunluğa nasıl tepki verdiğini ve bu tepkilerin nasıl yönetilebileceğini anlamada önemli ipuçları sunmaktadır.

KAYNAKLAR

Arslan, B. (2018). *Türkiye'deki bocce ve dart sporcularının ahlaki karar alma tutumlarının incelenmesi.* Yüksek Lisans Tezi, Bartın Üniversitesi, Lisansüstü Eğitim Enstitüsü.

Ayyıldız, E. (2022). *Toplum ve Spor Kültürü*. Efe Akademi Yayınları.

Behrens, M., Gube, M., Chaabene, H., Prieske, O., Zenon, A., Broscheid, K. C., ve Weippert, M. (2023). Fatigue and human performance: an updated framework. *Sports medicine*, *53*(1), 7-31.

Boksem, M. A., ve Tops, M. (2008). Mental fatigue: costs and benefits. *Brain research reviews*, *59*(1), 125-139.

Cooke A, Ring C, (2019). *Psychophysiology of sport, exercise, and performance: Past, present, and future, Sport, Exercise, and Performance Psychology,*; 8(1), 1-6.

Dora, J., van Hooff, M. L., Geurts, S. A., Kompier, M. A., ve Bijleveld, E. (2022). The effect of opportunity costs on mental fatigue in labor/leisure trade-offs. *Journal of Experimental Psychology: General*, *151*(3), 695.

Eler, N., ve Eler, S. (2018). A Study on Somatotype Profiles of the Players in Turkish Bocce National Team. *Journal of Education and Training Studies*, *6*(2), 28-35.

Foster, C., Florhaug, J. A., Franklin, J., Gottschall, L., Hrovatin, L. A., Parker, S., Doleshal, P., & Dodge, C. (2001). A new approach to monitoring exercise training. *Journal of strength and conditioning research*, *15*(1), 109–115.

Harris, S., ve Bray, S. R. (2019). Effects of mental fatigue on exercise decision-making. *Psychology of Sport and Exercise*, *44*, 1-8.

Hopkins, W., et al. (2009). Progressive statistics for studies in sports medicine and exercise science. Medicine+ Science in Sports+ Exercise, 41.1: 3.

Kırışık, H., ve Erol, B. N. (2023). Bocce oyunu etkinliğinin kuşaklar arası dayanışmaya katkıları: fenomenolojik bir araştırma. *Turkiye Klinikleri Journal of Gerontology*, *2*(1), 1-9.

Lane, A. M., Terry, P. C., Beedie, C. J., Curry, D. A. ve Clark, N. (2001). Mood and performance: Test of a conceptual model with a focus on depressed mood. *Psychology of Sport and Exercise*, *2*(3), 157-172.

Marcora, S. M., Staiano, W. ve Manning, V. (2009). Mental fatigue impairs physical performance in humans. *Journal of applied physiology*, *106*(3), 857-864.

McMorris, T., Barwood, M., Hale, B. J., Dicks, M. ve Corbett, J. (2018). Cognitive fatigue effects on physical performance: A systematic review and meta-analysis. *Physiology & behavior*, *188*, 103-107.

Pageaux, B., Marcora, S. M., ve Lepers, R. (2013). Prolonged mental exertion does not alter neuromuscular function of the knee extensors. Medicine &Amp; Science in Sports &Amp; Exercise, 45(12), 2254-2264.

Russell, S. (2021). Mental fatigue in elite sport. *Psychology of Sport and Exercise*, 42, 1-11.

Schiphof-Godart, L., Roelands, B. ve Hettinga, F. J. (2018). Drive in sports: How mental fatigue affects endurance performance. *Frontiers in psychology*, *9*, 1383.

Smith, M. R., Zeuwts, L., Lenoir, M., Hens, N., De Jong, L. M. ve Coutts, A. J. (2016). Mental fatigue impairs soccer-specific decision-making skill. *Journal of sports sciences*, *34*(14), 1297-1304.

Sousa Fortes, L., Barbosa, B. T., Mortatti, A. L., Moreira, A., ve Ferreira, M. E. (2024). Effect of mental fatigue on decision-making skill during simulated congested match schedule in professional soccer athletes. *Current Psychology*, *43*(2), 1785-1793.

Soylu, Y. (2022). Futbolda Dar Alan Oyunlarında Zihinsel Yorgunluğun Psikofizyolojik Cevaplara ve Bilişsel Performansa Etkileri: Sistematik Derleme. *SPORMETRE Beden Eğitimi ve Spor Bilimleri Dergisi*, 20(1), 132–144.

Sun, H. (2021). Does mental fatigue affect skilled performance in athletes? A systematic review. *PLOS ONE*, 16(10), e0258307.

Terry, P. C., Lane, A. M., Fogarty, G. J. (2003). Construct validity of the Profile of Mood States — Adolescents for use with adults. Psychology of Sport and Exercise, 4(2), 125–139.

Terry, P. C., Lane, A. M., Lane, H. J., Keohane, L. (1999). Development and validation of a mood measure for adolescents. Journal of Sports Sciences, 17(11), 861–872.

Van Cutsem, J., Marcora, S., De Pauw, K., Bailey, S., Meeusen, R. ve Roelands, B. (2017). The effects of mental fatigue on physical performance: a systematic review. *Sports medicine*, *47*(8), 1569-1588.

Wu, C. H., Zhao, Y. D., Yin, F. Q., Yi, Y., Geng, L. ve Xu, X. (2024). Mental fatigue and sports performance of athletes: Theoretical explanation, influencing factors, and intervention methods. *Behavioral Sciences*, *14*(12), 1125.

Yuan, R., Sun, H., Soh, K. G., Mohammadi, A., Toumi, Z., ve Zhang, Z. (2023). The effects of mental fatigue on sport-specific motor performance among team sport athletes: A systematic scoping review. *Frontiers in Psychology*, *14*, 1143618.

CORE EXERCISE, POSTURAL BALANCE AND ATHLETIC PERFORMANCE: A SITUATION ANALYSIS OF CURRENT EVIDENCE

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ABSTRACT

Core stability is essential for maintaining postural control, supporting spinal alignment, and optimizing force transfer during athletic movements. In recent years, numerous interventions and comparative studies have explored how core muscle training influences both dynamic balance and athletic performance metrics. This situation analysis synthesizes findings from research conducted between 2010 and 2025, with applications across diverse athletic populations.

This analysis focuses on cross-sectional and intervention studies retrieved from PubMed, Google Scholar, and ScienceDirect databases using terms such as *core stability*, *core strength*, *dynamic balance*, *jump performance*, *agility*, and *sprint*. Studies consistently report that core training programs—typically lasting 6–10 weeks with sessions conducted 2–3 times per week—yield significant improvements in dynamic balance, as evidenced through reach distance gains in the Y-Balance Test and reduced postural sway. Additionally, positive effects are observed in athletic performance outcomes such as vertical jump height, agility, and rotational power in sports like soccer, handball, and baseball. However, improvements in linear sprint performance appear more variable and less pronounced.

Current findings support the integration of core exercises into comprehensive training programs, especially in combination with plyometrics and sport-specific drills. Unstable and stable surface core exercises demonstrate similar efficacy in enhancing postural control, though unstable variations may elicit higher trunk muscle activation. Despite core stability being a meaningful contributor to athletic performance, it should not be isolated from broader neuromuscular conditioning strategies.

In conclusion, core exercise enhances dynamic balance and contributes to improved athletic function, particularly in tasks requiring force stabilization and transfer. Sport-specific program design, regular progression, and proper exercise selection remain crucial for maximizing performance outcomes and minimizing injury risk in athletes.

Keywords: Core stability, dynamic balance, athletic performance, trunk endurance, neuromuscular control

PARENTAL PERSPECTıVES ON THE BENEFITS OF THERAPEUTIC HORSEBACK RIDING FOR CHILDREN WITH AUTISM SPECTRUM DISORDER: INSIGHTS FROM CROATIA AND TÜRKİYE

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ABSTRACT

Therapeutic horseback riding (THR) is an innovative intervention that addresses the multifaceted challenges of Autism Spectrum Disorder (ASD), offering cognitive, physical, emotional, and social benefits. This qualitative study explores the perspectives of parents in Croatia and Türkiye on the impact of THR on their children with ASD. Semi-structured interviews with 18 parents reveal significant improvements in six key areas: emotional regulation, social interaction, physical coordination, adaptability, self-esteem, and family relationships. Parents reported reduced anxiety and emotional outbursts, enhanced communication skills, improved gross motor abilities, increased flexibility in routines, and strengthened familial bonds. These findings highlight THR's potential as a holistic therapy that not only supports child development but also fosters family cohesion and caregiver optimism. The study highlights the significance of incorporating parental perspectives in assessing the broader impact of therapeutic interventions. It emphasizes the need for further research to refine and expand THR programs, particularly for families spanning three generations. Shared interests and experiences fostered through such programs can strengthen family bonds and promote closer relationships.

Keywords: Autism Spectrum Disorder, therapeutic horseback riding, parental perspectives, equine-assisted therapy, child development

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INTRODUCTION

Therapeutic horseback riding (THR), a specialized subset of equine-assisted therapy (EAT), has emerged as a multifaceted intervention offering benefits for children with Autism Spectrum Disorder (ASD). EAT's versatility spans cognitive, physical, emotional, and social domains, which makes it a promising complementary approach to traditional therapies for ASD [1, 2]. THR uniquely combines structured physical activities with horse-human interaction, addressing ASD's diverse challenges, including sensory processing, communication, and adaptability [3-5].

The growing body of literature highlights THR's potential in enhancing social cognition, verbal communication, and emotional self-regulation in children with ASD [6, 7]. These improvements are facilitated by predictable and supportive environments that encourage interaction and reduce hyperactivity [5, 8]. Additionally, the rhythmic motion of horseback riding mimics human gait, significantly enhancing motor coordination, posture, and body awareness [9, 10]. Such findings blueprint THR's capacity to integrate sensory, motor, and emotional stimuli into a holistic therapeutic framework.

While the benefits of THR for children with ASD are well-documented, its broader impact on families is less explored. Parental perspectives are essential for understanding the ripple effects of THR, as parents observe changes beyond the child's immediate behaviors. They report shifts in family dynamics, communication, and collective well-being, highlighting THR's role in fostering optimism and strengthening familial bonds [11-13]. Shared experiences during THR sessions not only enhance the parent-child connection but also contribute to a unified approach in addressing ASD-related challenges [3, 14].

This study aims to expand on these insights by exploring parental perspectives on the impacts of THR in Croatia and Türkiye. By documenting their experiences, we seek to capture the multidimensional benefits of THR, from child development to family cohesion. These findings aim to provide a comprehensive understanding of THR's value as an integrative therapeutic approach, addressing both individual and collective needs in ASD management.

2. Materials and Methods

Participants

Participants for this study were recruited using purposive sampling [15]. Recruitment efforts involved presenting the research project during staff meetings at two horseback riding centres located in Malatya, Türkiye, and Rijeka, Croatia. The staff at these centers were asked to assist in identifying and inviting parents of children with ASD enrolled at their centres to consider participating in the study, which focused on THR.

The study included eight Turkish parents of children aged 7 to 12 years diagnosed with ASD. Among these children, one was 7 years old, three were 8 years old, one was 9 years old, one was 10 years old, and two were 12 years old. Diagnoses of ASD in this group were made between the ages of 2 and 4: one child was diagnosed at 2 years, one at 2.5 years, three at 3 years, and two at 4 years.

Similarly, the study involved ten Croatian parents of children with ASD within the same age range of 7 to 12 years. Among these children, two were 7 years old, three were 8 years old, two were 9 years old, two were 10 years old, and one was 12 years old. Diagnoses of ASD in this group were made between the ages of 2 and 5: two children were diagnosed at 2 years, one at 2.5 years, three at 3 years, three at 4 years, and two at 5 years.

Sociodemographic variables beyond age and diagnosis details were not collected, as they were deemed outside the scope of the study's objectives.

Data collection

Data were collected through semi-structured, in-depth interviews [16]. Participants were invited to share their perspectives on various aspects of their children's participation in the THR program. Demographic details, such as the child's current age and age at diagnosis with ASD, were recorded.

Program participation was assessed by gathering information about the duration of THR involvement and participation in other supportive programs or therapies. Family involvement was examined by identifying the primary caregiver or family member most actively engaged in the child's development.

To evaluate the impact of THR, parents reported on improvements in the child's physical coordination, balance, posture, and gross motor skills, as well as emotional and behavioral changes, including emotional expression, stress management, and anxiety levels. Social development was explored by assessing the child's interactions with peers, family members, and therapists, their willingness to initiate or respond to social interactions, and their participation in group activities.

Cognitive and adaptive skills were evaluated through observed changes in attention span, problem-solving abilities, and task comprehension. General behavioral changes, such as alterations in repetitive behaviors, emotional outbursts, and daily routines, were also documented. Additionally, the child's adaptability to changes in routine and new situations was assessed.

The program's effectiveness was further explored by identifying the most enjoyable and beneficial aspects of equine therapy, as well as collecting suggestions for improvement. Finally, a comprehensive assessment of the overall impact of THR on the child's development and well-being was provided.

Participants were assured that their involvement and any information they shared would remain strictly confidential and would not be disclosed under any circumstances.

THR intervention program

The THR intervention program was designed to enhance balance, posture, body awareness, social interaction, and sensory integration while fostering self-esteem and motor coordination. Over a ten-week period, the program was structured to provide incremental challenges tailored to each child's abilities and needs. Each session, lasting 1–2 hours, included warm-up exercises, mounted therapeutic activities, and a cool-down phase. Caregivers were actively engaged during the sessions to reinforce the children's progress.

In the first week, children were introduced to the stable environment, met the horses, and learned safety rules and stable etiquette to build comfort and familiarity. Hands-on grooming sessions were conducted to promote sensory integration and allow direct interaction with the horses, fostering trust and reducing anxiety. During the second week, participants learned the basics of tacking up with assistance and

practiced mounting and dismounting under close supervision. Guided walking exercises were introduced, and simple games such as identifying objects around the arena were used to establish sensory engagement.

The third week focused on basic riding skills, including steering and halting, with transitions from halt to walk. Children practiced leading the horse with support to encourage coordination and confidence. Mounted activities included walking in circles with side walkers to ensure safety and guidance. By the fourth week, warm-up exercises promoting body awareness, such as arm circles and shoulder rolls, were introduced. Mounted activities involved walking patterns and weaving through cones, while interactive games such as “Red Light, Green Light” reinforced halting and starting skills.

In the fifth week, core strength development was emphasized through activities such as posting at a walk and walking over ground poles. Sensory activities, including brushing the horse’s mane while seated, were incorporated to further engage the participants. Independent leading with volunteer support was practiced, enhancing the children’s sense of control and confidence. During the sixth week, sensory-focused activities continued, and trotting was introduced where appropriate. Mounted stretching exercises, such as touching toes and twisting the torso, were implemented to improve flexibility and body awareness. Group exercises encouraged peer interaction and promoted social skills within a supportive setting.

The seventh week aimed to build advanced coordination skills by practicing transitions between walking and trotting. Simple dressage patterns and obstacle courses were introduced, focusing on independent rein use with minimal guidance. Caregivers participated in feedback sessions to discuss progress and identify areas for further development. In the eighth week, children prepared for a mock competition by practicing tasks such as halting and steering and riding short courses that incorporated the skills they had learned. Group relay activities and reviews of horse care further enhanced their engagement and understanding.

During the ninth week, the program refined participants’ riding skills, with an emphasis on posture and independent riding. Mounted games, such as collecting items placed in the arena, were used to encourage balance and reaching skills. Riders were encouraged to plan their course paths, fostering decision-making and autonomy. Caregivers provided support by practicing leading or assisting during the sessions. In the final week, a mini-competition allowed children to showcase their skills in a celebratory setting. The session concluded with awards to recognize their achievements and a group celebration to boost confidence. Caregivers received guidance on off-season activities to maintain progress and build on the foundation established during the program.

The intervention was supported by trained volunteers, calm and well-mannered horses, and adaptive equipment to ensure safety and accessibility for all participants. Based on an umbrella review, the evidence supporting equine-assisted interventions for children with disabilities remains inconclusive and is characterized by several methodological limitations [14].

Data analysis

The data were analyzed using thematic analysis, following these steps [17, 18]: In the initial stage, the data were familiarized by transcribing it (if necessary) and conducting thorough reading and re-reading. Initial ideas were noted to establish a foundational understanding of the data. Subsequently, initial codes

were systematically generated across the entire dataset. Interesting features of the data were identified and coded, and relevant data were collated for each code to ensure systematic organization.

Following this, potential themes were identified by collating the codes [19]. Data relevant to each potential theme were gathered to facilitate a deeper exploration of thematic patterns. The identified themes were then reviewed in a two-level process: Level 1 involved checking the coherence of the themes in relation to the coded extracts, while Level 2 involved examining the themes' alignment with the entire dataset. A thematic 'map' of the analysis was then generated to visually represent the relationships between themes.

Each theme was further defined and named through ongoing analysis. The specifics of each theme were refined to develop a cohesive narrative, and clear definitions and appropriate names were generated to enhance clarity and understanding. Finally, the report was produced as the culmination of the analysis. Vivid and compelling extract examples were selected, and the analysis of these extracts was finalized. The findings were then related back to the research background and existing literature, resulting in a scholarly report of the analysis.

Themes within the data were identified using an inductive, or "bottom-up," approach [20-22]. This method ensures that the themes are closely and directly derived from the data itself [23].

3. Results

The findings of this study offer a comprehensive understanding of children's and families' experiences with THR. The results underscore multiple areas of improvement, which are grouped into six key themes: (1) Emotional regulation and behavioral ımprovements, (2) Social ınteraction and communication, (3) Physical coordination and motor skills, (4) Adaptability and routine management, (5) Emotional bonding and self-esteem, and (6) Positive influence on family relationships.

Emotional regulation and behavioral improvements

The observations from Turkish and Croatian parents highlighted the significant impact of THR on children with ASD in terms of their emotional regulation. One notable outcome was the improvement in emotional outbursts. A Turkish parent shared, "There were positive developments in emotional outbursts. My daughter, who used to react intensely when she didn't get what she wanted, has now moved away from prolonged crying episodes." This demonstrated that children with ASD, who previously reacted intensely when their expectations were unmet, had moved away from prolonged crying episodes. These changes suggested that THR helped children moderate their reactions to frustration, enabling them to handle disappointment more constructively.

The study also revealed a reduction in anxiety and an increased sense of security among children with ASD. A Croatian parent noted, "Therapy helps reduce anxiety during and after sessions and provides a sense of security." This emphasized that therapy not only reduced anxiety but also fostered a lasting sense of safety. The structured environment and interaction with horses appeared to provide a calming influence, helping these children feel more secure and at ease, even beyond the therapeutic setting.

Enhanced emotional expression was another significant outcome. According to one Turkish parent, "We now see that our child uses words more frequently to express emotions." This indicated that children

with ASD began using words more frequently to express their emotions, demonstrating progress in self-awareness and emotional intelligence. By articulating their emotional states more effectively, these children reduced their reliance on behavioral outbursts.

Furthermore, the study found that THR supported children with ASD in maintaining emotional balance during stressful situations. A Croatian parent explained, “Therapy helps the child calm down and maintain emotional balance in stressful situations.” This suggested that the therapeutic process equipped children with coping mechanisms that helped them calm down and preserve their emotional stability in challenging circumstances, fostering resilience.

In summary, the findings suggested that THR offered a multi-faceted approach to improving emotional regulation in children with ASD. The program appeared to reduce the frequency and intensity of emotional outbursts, lower anxiety levels, foster a sense of security, enhance emotional communication skills, and provide strategies for maintaining composure during stress. The unique therapeutic environment created by the interplay of physical activity, sensory engagement, and the bond with horses addressed both the behavioral and psychological dimensions of emotional regulation. These results aligned with broader literature on animal-assisted therapies, which consistently demonstrated their effectiveness in enhancing the emotional well-being of children with ASD.

Social interaction and communication

Enhanced communication skills and social engagement were widely reported among children with ASD participating in the THR program. Parents observed that children demonstrated greater readiness to interact with peers, seek social opportunities, and respond more effectively to social cues.

One Croatian parent remarked, “Since starting therapy, we have noticed a significant improvement in our child’s readiness to initiate or respond to social interactions.” Similarly, a Turkish parent shared, “When my child comes home, they show a desire to talk about the activities they did.” These comments highlighted how THR helped children develop their ability and willingness to engage in meaningful communication.

The program also seemed to encourage children to actively seek out social opportunities. A Croatian parent noted, “My child has become more active in seeking social opportunities, such as inviting others to play or participating in group tasks.” Another Turkish parent added, “While still hesitant to initiate social interaction, my child now looks at others more meaningfully.” These insights suggest that even for children who remained cautious, THR fostered an increased awareness of and engagement with their social environment.

These findings reinforce the potential of THR to enhance social skills and communication in children with ASD, contributing to their overall social and emotional development. By creating a structured yet dynamic environment that promotes interaction, the therapy provided opportunities for children to practice and build confidence in their social abilities.

Physical coordination and motor skills

Children with ASD exhibited notable improvements in balance, posture, and overall physical coordination through THR. Regular horseback riding sessions enhanced their gross motor skills and body awareness, leading to meaningful physical development.

One Croatian parent shared, “Since starting horse therapy, we have observed a visible improvement in my child’s physical coordination. Their balance and posture have significantly improved.” Similarly, a Turkish parent noted, “At first, my child didn’t enjoy moving, but their interaction with the horse changed this.” These comments underscore the transformative role of THR in encouraging physical activity and coordination.

Parents also observed improved body awareness and posture in their children. A Croatian parent remarked, “Riding has increased my child’s body awareness and helped them maintain a more upright posture.” Another Turkish parent added, “My child’s posture has become more balanced, and I have noticed greater control in their walking.” These reflections highlight how THR fostered physical growth by addressing both coordination and postural control.

Overall, these insights emphasize the potential of THR to support the development of gross motor skills and body awareness in children with ASD, demonstrating its value as a therapeutic intervention for enhancing physical abilities alongside emotional and social benefits.

Adaptability and routine management

THR significantly improved adaptability and routine management in children with ASD. Parents observed that their children adjusted more easily to changes in routines and new environments, displaying reduced reliance on rigid structures and less intense reactions to change.

A Turkish parent shared, “My child now adapts to changes in routines much more easily.” Similarly, a Croatian parent noted, “Horse therapy has helped my child feel more comfortable with changes in their daily routine.” These reflections suggest that THR encouraged flexibility and reduced the distress associated with disruptions to established patterns.

Parents also reported a reduction in the intensity and duration of emotional reactions to changes. A Turkish parent explained, “In the past, my child reacted very strongly to changes, but now the duration of these reactions has decreased.” Another Croatian parent added, “My child has developed skills to cope with new situations and experiences less anxiety.” These improvements highlight how THR supported children in managing transitions and adapting to unfamiliar circumstances more effectively.

These findings underscore the role of THR in fostering adaptability in children with ASD, helping them navigate routine changes and new environments with greater ease and reduced anxiety. By promoting resilience and flexibility, THR provided children with essential tools for coping with everyday challenges.

Emotional bonding and self-esteem

Interacting with horses during THR fostered emotional connections and significantly boosted the self-esteem of children with ASD. Parents noted that their children displayed joy and confidence during therapy sessions, reflecting the positive impact of these interactions.

A Turkish parent shared, “My child enjoys direct contact with the horses, which increases their sense of trust and confidence.” Similarly, a Croatian parent remarked, “After successfully completing tasks with the horse, my child feels more confident in their abilities.” These observations highlight how accomplishing tasks during THR helped children build self-assurance and trust in themselves.

The joy and excitement children experienced during therapy also contributed to their emotional well-being. A Turkish parent noted, “Riding the horse excites my child, and their successes in therapy sessions boost their self-esteem.” Another Croatian parent added, “During therapy, my child’s face often shows a relaxed and happy expression.” Such moments of joy and accomplishment underscored the emotional benefits of the therapy, creating a positive and affirming experience for the children.

These insights illustrate how THR not only promoted emotional connections but also empowered children with ASD by enhancing their confidence and fostering a sense of achievement. This dual benefit of emotional bonding and self-esteem building further supports the value of THR as a holistic therapeutic approach.

Positive influence on family relationships

THR sessions positively impacted family dynamics, fostering improved communication and optimism about the future of children with ASD. Parents shared that their children’s participation in THR sessions created opportunities for stronger familial bonds and more meaningful interactions.

A Turkish parent reflected, “After therapy, my child is happier and displays a more positive attitude, which helps us communicate better as a family.” This highlights how the emotional improvements observed in children during therapy sessions translated into better interactions within the family unit.

THR also became a shared experience for families, strengthening their connections. A Croatian parent noted, “Therapy has become a part of our family activities, and we now spend more time together as a family.” The shared involvement in THR encouraged quality family time and provided a platform for collective support and engagement.

Additionally, parents felt closer to their children as a result of the therapy process. A Turkish parent explained, “The therapy experience has helped me build a closer relationship with my child.” This sentiment underscores how THR facilitated emotional bonding between parents and their children, enhancing understanding and intimacy within the family.

These accounts illustrate the broader impact of THR on family relationships, demonstrating how the therapy not only benefits children with ASD but also creates a ripple effect of positive change within their families. By fostering emotional well-being and shared experiences, THR contributed to a more supportive and cohesive family environment.

4. DISCUSSION

THR, as examined in this study, has been shown to have a profound and multidimensional impact on children with ASD and their families. This aligns with a growing body of evidence underscoring the effectiveness of equine-assisted interventions (EAIs) in fostering emotional, social, physical, and cognitive improvements across various populations with neurodevelopmental and physical challenges. The exponential increase in research on EAIs reflects their rising recognition as a meaningful therapeutic approach, with ASD frequently explored as a target condition [2, 22].

One of the most notable benefits observed in this study was the enhancement of emotional regulation and self-regulation among children with ASD. THR sessions, characterized by their structured, predictable, and calming nature, significantly reduced anxiety levels and the frequency of emotional outbursts. This aligns with Gabriels et al. (2015, 2018), who reported sustained improvements in

irritability and emotional balance for months following THR interventions [4, 5]. The interaction between children and horses seems to foster a unique sense of security and calmness, offering children tools to manage stress and build resilience [24]. Such outcomes are consistent with broader findings on equine-assisted therapy's capacity to improve self-regulation and reduce hyperactivity and irritability, potentially mediated by neurophysiological factors such as cortisol regulation [25].

The study also highlighted substantial gains in social engagement and communication. Parents frequently noted that their children exhibited a greater willingness to interact with peers, initiate social interactions, and respond to social cues. These findings resonate with Zhao et al. (2021) and Chen et al. (2022), who reported that THR significantly enhances social functioning and communication in children with ASD [6, 7]. By combining caregiver involvement, group activities, and interaction with horses, THR creates a dynamic yet supportive environment that fosters meaningful social learning and interaction. Enhanced social and executive functioning, as described by Borgi et al. (2015), further reinforces the importance of THR in facilitating these critical developmental skills [10].

Improvements in physical coordination and motor skills were another key area of impact. Many children demonstrated better balance, posture, and gross motor abilities, echoing findings from Heussen and Häusler (2022), who noted significant motor function gains in populations with physical disabilities [9]. The rhythmic motion of horseback riding, which mimics the human gait, contributes to enhanced motor planning and body awareness, as described by Gabriels et al. (2012) [3]. These findings underscore the therapeutic potential of equine-assisted activities to address physical challenges alongside emotional and social ones, positioning THR as a holistic intervention.

Adaptability and routine management also emerged as significant areas of improvement. For children with ASD, who often struggle with rigid thinking and resistance to change, THR offered a structured yet adaptable environment that reduced the intensity of reactions to disruptions and enhanced their ability to cope with new situations. These outcomes are consistent with Zoccante et al. (2021), who emphasized the role of equine-assisted interventions in fostering flexibility and resilience in children with ASD [11].

Interaction with horses was further shown to promote emotional bonding and boost self-esteem. Many parents observed that their children developed a sense of accomplishment and confidence through their interactions with horses, a finding echoed by Borgi et al. (2015) [10]. The tactile and interactive nature of THR fosters a nurturing relationship with the horse, allowing children to experience joy and build trust. These benefits extend beyond the individual to influence family dynamics positively. Parents described how the shared experience of THR sessions strengthened emotional connections within the family, improved communication, and fostered optimism about their child's future. Escobar (2021) highlighted similar outcomes, describing equine-assisted therapy as a holistic intervention that not only supports children with disabilities but also enhances familial bonds and emotional well-being [12].

The findings of this study also align with evidence from other populations, further demonstrating the versatility of EAIs. For instance, children with cerebral palsy have shown significant functional mobility improvements and better synchronization with equine movement during therapy sessions (Lightsey et al., 2021; Heussen & Häusler, 2022) [9, 26]. Similarly, Ramos et al. (2024) described the effectiveness of equine-assisted therapy in improving motor functions in children with down syndrome [27]. These parallels suggest that the therapeutic mechanisms of EAIs—such as sensory engagement, physical coordination, and emotional bonding—are broadly applicable and adaptable to diverse conditions [28].

Overall, this study contributes to the growing recognition of THR as a transformative intervention for children with ASD and their families. By addressing a wide spectrum of needs—emotional, social, physical, and familial—THR offers a unique and integrative approach to therapy. However, as highlighted by Stern and Chur-Hansen (2019), the field of EAIs requires further research to standardize protocols and deepen our understanding of their mechanisms of action [14]. Future studies could explore the long-term effects of THR, its impact on diverse populations, and its potential to address specific challenges faced by families of children with ASD. These insights will help refine and expand the use of equine-assisted interventions as a vital component of therapeutic care for children with developmental and neurobehavioral conditions.

5. CONCLUSIONS

The findings of this study highlight the multifaceted benefits of THR for children with ASD and their families. By addressing emotional regulation, social interaction, physical coordination, adaptability, self-esteem, and family dynamics, THR emerges as a uniquely holistic intervention. The structured and interactive nature of THR sessions facilitates not only developmental progress in children with ASD but also fosters stronger familial bonds and enhances caregiver optimism.

Parents' perspectives offer invaluable insights into the broad-reaching impacts of THR, emphasizing its role in creating meaningful changes in emotional stability, social engagement, and overall quality of life. These findings underscore the potential of THR as a complementary therapeutic approach that enriches traditional ASD interventions by integrating physical, emotional, and social elements.

In conclusion, THR represents a promising and impactful intervention for children with ASD, offering a path to enhanced well-being and family cohesion. By continuing to refine and study this approach, practitioners and researchers can unlock its full potential, ensuring its place as a cornerstone of comprehensive care for children with developmental challenges.

References

1. Ahn, B., Y.-S. Joung, J.-Y. Kwon, D. I. Lee, S. Oh, B.-U. Kim, J. Y. Cha, J.-H. Kim, J. Y. Lee and H. Y. J. B. p. Shin. "Effects of equine-assisted activities on attention and quality of life in children with cerebral palsy in a randomized trial: Examining the comorbidity with attention-deficit/hyperactivity disorder." 21 (2021): 1-9.
2. Amado-Fuentes, M., A. Denche-Zamorano, S. Barrios-Fernandez and M. J. A. Gozalo. "Bibliometric analysis on equine-assisted interventions." 14 (2024): 1776.
3. Gabriels, R. L., J. A. Agnew, K. D. Holt, A. Shoffner, P. Zhaoxing, S. Ruzzano, G. H. Clayton and G. J. R. i. A. S. D. Mesibov. "Pilot study measuring the effects of therapeutic horseback riding on school-age children and adolescents with autism spectrum disorders." 6 (2012): 578-88.
4. Gabriels, R. L., Z. Pan, B. Dechant, J. A. Agnew, N. Brim, G. J. J. o. t. A. A. o. C. Mesibov and A. Psychiatry. "Randomized controlled trial of therapeutic horseback riding in children and adolescents with autism spectrum disorder." 54 (2015): 541-49.
5. Gabriels, R. L., Z. Pan, N. A. Guérin, B. Dechant and G. J. F. i. v. s. Mesibov. "Long-term effect of therapeutic horseback riding in youth with autism spectrum disorder: A randomized trial." 5 (2018): 156.
6. Zhao, M., S. Chen, Y. You, Y. Wang, Y. J. I. j. o. e. r. Zhang and p. health. "Effects of a therapeutic horseback riding program on social interaction and communication in children with autism." 18 (2021): 2656.

7. Chen, S., Y. Zhang, M. Zhao, X. Du, Y. Wang, X. J. I. j. o. e. r. Liu and p. health. "Effects of therapeutic horseback-riding program on social and communication skills in children with autism spectrum disorder: A systematic review and meta-analysis." 19 (2022): 14449.
8. McDaniel Peters, B. C., W. J. J. o. a. Wood and d. disorders. "Autism and equine-assisted interventions: A systematic mapping review." 47 (2017): 3220-42.
9. Heussen, N. and M. J. P. Häusler. "Equine-assisted therapies for children with cerebral palsy: A meta-analysis." 150 (2022): e2021055229.
10. Borgi, M., D. Loliva, S. Cerino, F. Chiarotti, A. Venerosi, M. Bramini, E. Nonnis, M. Marcelli, C. Vinti, C. J. J. o. a. De Santis, *et al.* "Effectiveness of a standardized equine-assisted therapy program for children with autism spectrum disorder." 46 (2016): 1-9.
11. Zoccante, L., M. Marconi, M. L. Ciceri, S. Gagliardoni, L. A. Gozzi, S. Sabaini, G. Di Gennaro and M. J. J. o. c. m. Colizzi. "Effectiveness of equine-assisted activities and therapies for improving adaptive behavior and motor function in autism spectrum disorder." 10 (2021): 1726.
12. Escobar, M. J. J. o. S. i. M. H. "Perceived holistic benefits of equine-assisted therapy among mothers of children with a disability: A pilot study." 23 (2021): 23-46.
13. Bansal, N. and A. J. I. J. o. I. A. i. P. Teotia. "Threads of strength: The interplay between family resilience, optimism and coping approaches." 2 (2024): 1318: 41-18: 41.
14. Stern, C. and A. J. A. J. o. P. Chur-Hansen. "An umbrella review of the evidence for equine-assisted interventions." 71 (2019): 361-74.
15. Patton, M. Q. *Qualitative research & evaluation methods: Integrating theory and practice*. Sage publications, 2014,
16. Seidman, I. J. T. C. "Interviewing as qualitative research: A guide for researchers in education and the social sciences." (2006):
17. Braun, V. and V. J. Q. r. i. p. Clarke. "Using thematic analysis in psychology." 3 (2006): 77-101.
18. Huberman, A. "Qualitative data analysis a methods sourcebook." (2014):
19. Saldaña, J. "The coding manual for qualitative researchers." (2021):
20. Frith, H., K. J. P. o. m. Gleeson and masculinity. "Clothing and embodiment: Men managing body image and appearance." 5 (2004): 40.
21. Meli, D., A. Castellini and A. J. J. o. A. I. R. Farinelli. "Learning logic specifications for policy guidance in pomdps: An inductive logic programming approach." 79 (2024): 725-76.
22. Chen, X. and J. J. M. P. B. Yang. "Analysis of the uncertainty of the ais-based bottom-up approach for estimating ship emissions." 199 (2024): 115968.
23. Patton, M. Q. *Qualitative evaluation and research methods*. Sage, 1990,
24. Lockhart, S. "Therapy is more than talk: Exploring equine-assisted psychotherapy for children with trauma." (2024):
25. Pan, Z., D. A. Granger, N. A. Guérin, A. Shoffner and R. L. J. F. i. v. s. Gabriels. "Replication pilot trial of therapeutic horseback riding and cortisol collection with children on the autism spectrum." 5 (2019): 312.
26. Lightsey, P., Y. Lee, N. Krenek, P. J. J. o. n. Hur and rehabilitation. "Physical therapy treatments incorporating equine movement: A pilot study exploring interactions between children with cerebral palsy and the horse." 18 (2021): 1-11.
27. Ramos, M. M., M. T. Parisi and M. J. R. B. d. C. e. M. Nabeiro. "Children with down syndrome and equineassisted therapy: A systematic review." 31 (2023):
28. Ringold, S. M., R. W. McGuire, A. Jayashankar, E. Kilroy, C. D. Butera, L. Harrison, S. A. Cermak and L. J. B. S. Aziz-Zadeh. "Sensory modulation in children with developmental coordination disorder compared to autism spectrum disorder and typically developing children." 12 (2022): 1171.

EXAMINING THE ANGER LEVELS OF UNIVERSITY STUDENTS WHO ARE CANDİDATES FOR COACHING

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ABSTRACT

The purpose of this study is to examine the anger levels and anger expression styles of university student coach candidates according to several socio-demographic variables. The study was conducted using a relational survey design, a quantitative research method. The study group consisted of 134 students (71 male and 63 female) studying in the Coaching Department of Kocaeli University's Faculty of Sport Sciences and who volunteered to participate in the study. Data were collected using a socio-demographic information form and the Trait Anger–Anger Expression Style Scale, developed by Spielberger et al. (1983) and adapted to Turkish by Özer (1994). Data were analyzed using the variables of gender, employment status, residence status, receiving psychological support, liking their job, and living with. Independent samples t-tests were used for comparisons between two groups, and one-way analysis of variance was used for comparisons between three or more groups. The relationship between age and anger sub-dimensions was examined using Pearson correlation analysis. According to the findings, no statistically significant differences were found in the trait anger, anger-in, anger-out, and anger management subscales based on gender and job satisfaction. Analyses conducted according to employment status and residence status revealed significant differences in the anger-out subscale. While significant differences were found in the trait anger, anger-in, and anger-out subscales based on psychological support status, no significant difference was found in the anger management subscale. Correlation analysis results indicated a negative and low-level significant relationship between age and anger-out, while no significant relationships were found in the other subscales. Furthermore, a significant difference in the anger-in subscale was found between those living alone and those living in student housing based on the living companion variable.

Keywords: Coach Candidates, Anger Level, Trait Anger, Anger Expression Styles, Sports Science Students

INTRODUCTION

The coaching profession encompasses numerous responsibilities, including guiding and motivating athletes, and contributing to their performance development (Aydoğan, 2021; Gök and Okan, 2023). The communication style, emotional management, and behavioral patterns displayed by coaches during this process directly impact the quality of the sports environment. Controlling anger, in particular, is crucial for establishing healthy relationships with athletes and ensuring more efficient training and competition processes (Güvendi and Keskin, 2020). Therefore, examining the anger levels of university students who will serve as coaches in the future has become a necessity.

Anger is a natural emotional response to frustration, injustice, or stress (Gürbüz et al., 2019; Kiratli, 2025). However, mismanaging this emotion can lead to communication problems, disciplinary issues, and undesirable behaviors in the sports environment (Bartlett & Abrams, 2019). High levels of anger in a coach can negatively impact athlete motivation, disrupt team harmony, and lead to decreased performance.

Coaching education provided at universities aims to develop students' knowledge and skills in sports sciences while also shaping their professional behavior patterns and psychological resilience (Bölükbaşoğlu, 2021). However, factors such as intense workload, exam stress, training loads, and a competitive environment during the training process can lead to changes in students' anger levels. Therefore, examining the factors that influence coach trainees' anger levels can provide important data for improving training programs and planning psychological support practices.

The purpose of this research is to examine the anger levels of university student coaches and to raise scientific awareness of the emotional management challenges they may encounter in their professional lives. It is hoped that the findings will offer suggestions for strengthening psychological skills training in coach training programs.

METHODOLOGY

Research Model, Universe and Sample

The purpose of this research is to examine the anger levels of university students who are prospective coaches. The study was conducted using a correlational screening design, based on the screening model, a quantitative research method. A correlational screening model is a research model that aims to determine the state of co-variation between two or more variables and the degree of this change (Büyüköztürk et al., 2021). In this respect, it allows for the evaluation of specific characteristics, attitudes, or behaviors of individuals within the context of current conditions. The research was conducted on a voluntary basis with students studying in the Coaching Department of the Faculty of Sports Sciences at Kocaeli University. A total of 134 students, 71 male and 63 female, participated in the study.

Table 1. Demographic Information Distribution of Coach Candidates Participating in the Research

Variables		n	%
Gender	Female	63	47,0
	Male	71	53,0
Age	$\bar{x}$	22,78	100.0
Employment Status	Not Working	106	79,1
	Working	28	20,9
The house you live in	Rent	69	51,5
	Our own	65	48,5
Who do you live with	Alone	20	14,9
	With my family	79	59,0
	Student housing	35	26,1
Status of receiving psychological support	Yes	19	14,2
	No	115	85,8

Table 1 shows the demographic information of the candidate coaches who participated in the study. Accordingly, 47.0% (n=63) of the participants were female and 53.0% (n=71) were male. The average age of the participants was 22.78.

When their employment status was examined, it was seen that 79.1% (n=106) of the participants were unemployed, while 20.9% (n=28) were employed.

Regarding their housing status, 51.5% (n=69) of the participants rented, while 48.5% (n=65) lived in their own home. 14.9% (n=20) of the participants reported living alone, 59.0% (n=79) lived with their family, and 26.1% (n=35) lived in student housing.

When looking at the status of receiving psychological support, 14.2% (n=19) of the participants stated that they had received psychological support before, while 85.8% (n=115) stated that they had not received psychological support.

Data Collection Tools

A six-question socio-demographic information form was used to reveal the socio-demographic characteristics of the participants. Additionally, the Trait Anger–Anger Expression Style Scale, developed by Spielberger et al. (1983) and adapted to Turkish by Özer (1994), consisting of 34 items and a four-point Likert-type rating, was administered. This scale consists of four subscales. The first ten items measure an individual's trait anger level, while the remaining twenty-four items assess anger expression styles. The trait anger subscale reflects an individual's general emotional state and the extent to which they experience anger. Possible scores for this subscale range from 10 to 40. The subscale for anger expression style consists of three different dimensions: anger-in, anger-out, and anger control. The possible score range for each subscale is between 8 and 32. Items 13, 15, 16, 20, 23, 26, 27, and 31 in the scale measure anger-in; items 12, 17, 19, 22, 24, 29, 32, and 33 measure anger-out; and items 11, 14, 18, 21, 25, 28, 30, and 34 measure anger control. The first 10 items constitute the trait anger subscale.

Statistical Analysis of Data

In analyzing the collected data, the findings were summarized using frequency, percentage, and standard deviation values. SPSS 25.00 software was used in the data analysis process. Since the normality tests revealed a normal data distribution, an independent samples t-test was used for comparisons between two groups, and one-way analysis of variance was used for comparisons of three or more groups. Additionally, Pearson correlation analysis was used to examine the relationship between the age variable and trait anger and anger expression styles. When a significant difference was found in the variance analysis, the Scheffe multiple comparison test was used to determine which groups accounted for the difference.

FINDINGS

Table 2. T-Test analyses of candidate coaches according to gender, employment status, residence status, psychological support status, and job satisfaction

		Constant Anger	Anger Turned	Anger Outward	Anger Management
Gender	Female	21,60 ±6.24	15,28 ±4,28	17,00 ±3,55	21,17 ±4,85
	Male	20,49 ±6,10	15,60 ±4,07	17,01 ±3,92	22,36 ±4,78
P		,301	,659	,983	,155
Employment Status	Not Working	20,88 ±6,09	15,27 ±3,83	16,64±3,34	21,55±4,99
	Working	21,50 ±6,55	16,14 ±5,26	18,39±4,78	22,75±4,11
P		,642	,328	**,027**	,247
The house you live in	Rent	21,85±6,13	16,10±4,01	17,62±3,73	21,68±4,92
	Our own	20,12±6,15	14,76±4,24	16,35±3,66	21,93±4,76
P		,105	,064	**,049**	,759
Status of receiving psychological support	Yes	25,89±4,52	18,42±5,66	18,57±3,53	20,00±4,43
	No	20,20±6,05	14,96±3,66	16,74±3,72	22,10±4,84
P		**,000**	**,001**	**,048**	,079

Table 2 presents the results of the t-test analysis for the Trait Anger, Anger-in, Anger-out, and Anger Management scores of the coach candidates based on their gender, employment status, residence, psychological support status, and job satisfaction.

In the analysis conducted by gender, no statistically significant differences were found in the Trait Anger (p=0.301), Anger-in (p=0.659), Anger-out (p=0.983), and Anger Management (p=0.155) subscales (p>0.05).

In the analysis conducted by employment status, no statistically significant differences were found in the Trait Anger (p=0.642), Anger-in (p=0.328), and Anger Management (p=0.247) subscales (p>0.05). However, a statistically significant difference was found in the Anger-out subscale (p=0.027; p<0.05).

In the analysis conducted by residence status, no statistically significant difference was found in the Trait Anger (p=0.105), Anger-In (p=0.064), and Anger Management (p=0.759) subscales (p>0.05). However, a statistically significant difference was found in the Anger-Out subscale (p=0.049; p<0.05).

In the analysis conducted by psychological support status, a statistically significant difference was found in the Trait Anger (p=0.000), Anger-In (p=0.001), and Anger-Out (p=0.048) subscales (p<0.05). No statistically significant difference was found in the Anger Management subscale (p=0.079; p>0.05).

In the analysis made according to the status of loving one's job, no statistically significant difference was found in any of the sub-dimensions of Trait Anger (p=0.065), Anger-In (p=0.439), Anger-Out (p=0.080) and Anger Control (p=0.302) (p>0.05).

Table 3. Correlation analysis of the relationship between age and anger styles of coach candidates

	Age		
Alt boyutlar	**n**	**r**	**p**
Constant Anger	134	-,157	,070
Anger Turned	134	-,085	,332
Anger Outward	134	-,172*	,047

Anger Management	134	,128	,140

Table 3 presents the results of the correlation analysis for the relationship between the age of the coach candidates and their anger styles.

Although a negative relationship was found between age and Trait Anger, this relationship was not statistically significant (r = -.157; p = .070; p>0.05).

A negative relationship was also found between age and Anger-In, but this relationship was not statistically significant (r = -.085; p = .332; p>0.05).

A negative and low-level relationship was found between age and Anger-Out, and this relationship was statistically significant (r = -.172; p = .047; p<0.05).

Although a positive relationship was found between age and Anger Control, this relationship was not statistically significant (r = .128; p = .140; p>0.05).

Table 4. Variance Analysis Results According to the Profession Love Variable of Coach Candidates

		Constant Anger	Anger Turned Inward	Anger Outward	Anger Management
Who do you live with	Alone [a]	22,15±4,92	17,35±4,65	17,15±2,18	21,60±4,25
	With my [illegible]	21,00±6,38	15,43±4,15	16,98±4,17	21,60±4,79
	Student [illegible]	20,40±6,39	14,42±3,59	16,97±3,49	22,37±5,28
P		,603	**,042**	,983	,726
Farkın kaynağı			**A-c**		

Table 4 presents the results of the analysis of variance (ANOVA) for the Trait Anger, Anger-In, Anger-Out, and Anger Management subscales of the coach candidates, based on the variable "who they live with." In the analysis conducted based on the variable "who they live with," no statistically significant difference was found in the Trait Anger (p=0.603), Anger-Out (p=0.983), and Anger Management (p=0.726) subscales (p>0.05). However, a statistically significant difference was found in the Anger-In subscale (p=0.042; p<0.05). The source of the difference was determined to be between those living alone (a) and those living in student housing (c).

CONCLUSION AND DISCUSSION

Analyses of the anger levels of university student coach candidates based on gender revealed no significant difference. A review of the literature reveals that, in line with our study, there are studies demonstrating no significant difference between gender and anger styles (Cin et al., 2022; Certel & Bahadır, 2012; Dilek & İmamoğlu, 2020). However, some studies have indicated that male individuals exhibit more anger and aggression in sports settings (Somoğlu et al., 2023), while others have indicated that female athletes involved in combat sports are better able to control their anger and aggression than male athletes (Gedik, 2023). These findings suggest that the literature contains varying results regarding the relationship between gender and anger, and that this relationship may vary depending on sample characteristics and sport branch.

When examining the subscale scores of anger styles among prospective coaches based on their employment status, no significant differences were found in the trait anger, anger-in, and anger management subscales. However, a significant difference was found in favor of employed individuals in the anger-out subscale. In other words, employed individuals were found to have higher levels of anger-out compared to unemployed individuals. It is known that factors such as the responsibilities of working life, time pressure, and physical and mental fatigue can increase stress levels (Paşa, 2007). Increased stress levels, in turn, have been reported to cause individuals to express their emotions more

intensely and more easily (Zautra, 2023). In this context, the higher anger-out scores of employed prospective coaches may be related to the pressures of juggling work and academic life. There are studies in the literature indicating that the intensity of work life can be associated with anger reactions (Öztürk, 2022). This finding supports the results of our study. The results suggest that working status may be an influential variable in anger-out.

When examining the relationship between the age of the coach trainees and their anger styles, a significant relationship was found only in the anger-out subscale. This result suggests that the level of anger-out decreases with age. However, no significant relationship was found between the trait anger, anger-in, and anger management subscales and age. This finding suggests that individuals become more controlled in their emotional expression and less likely to express their anger externally as they age. It has been reported that life experience gained with age helps individuals manage their anger in healthier ways (Phillips et al., 2006). This result suggests that individuals develop greater self-control over time and tend toward socially acceptable behaviors (Schieman, 1999). The development of communication skills, particularly during the professional identity development process of coach trainees, may be a significant factor in reducing their anger-out reactions. Future studies are expected to examine the age variable across broader age groups and in conjunction with different psychological variables, contributing to a more comprehensive understanding of the subject.

In this study, the analysis conducted to determine the differences between anger styles of prospective coaches based on their residential status revealed a significant difference only in the anger-out subscale. Accordingly, the levels of anger-out were higher in prospective coaches living in rented accommodations compared to those living in their own homes. This suggests that temporary and uncertain living conditions, such as renting, can increase stress and insecurity in individuals, leading to increased outward anger. In particular, economic concerns, lack of housing security, and a low sense of control regarding living conditions can lead individuals to express more intense and outward emotional reactions (Korkmaz, 2006). The significant difference found in the residential status variable in this study suggests that residential status is a significant variable in anger styles.

When coach trainees' anger styles were examined based on their psychological support status, significant differences were identified. Analyses revealed statistically significant differences in the trait anger, anger-in, and anger-out subscales based on their psychological support status. Accordingly, coach trainees who received psychological support had higher anger scores on these three subscales compared to those who did not. This suggests that individuals receiving psychological support experience more intense anger and may therefore be driven to seek professional help. Indeed, seeking psychological support can often be an indicator of an individual's emotional difficulties, stress, and internal conflicts (Yelpaze, 2016; Phillips & Murrell, 1994). The literature also indicates that individuals in need of psychological support have higher anger levels than other individuals (Saini, 2009; Maan Diong et al., 2005). In this respect, the findings are consistent with previous research demonstrating a relationship between psychological support status and anger levels. Given that prospective coaches will likely interact extensively with athletes, administrators, and parents in the future, managing their anger levels and emotional reactions in a healthy manner is crucial. In this context, coach training programs could prioritize greater emphasis on emotional awareness and anger management training. Furthermore, future studies are expected to consider the duration, frequency, and type of psychological support received, contributing to a more comprehensive understanding of the issue.

According to the results of the variance analysis conducted on the anger styles of the coach candidates according to the variable of who they live with, no statistically significant differences were found in the trait anger, anger-out, and anger management subscales. However, a significant difference was found in the anger-in subscale. Multiple comparison analysis indicated that this difference existed between individuals living with their families and those living in student housing. The more controlled, supportive, and relatively orderly living environment of individuals living with their families may have influenced the differences in anger-in levels (Schieman, 1999; Fryxell & Smith, 2000). In contrast, the freer but also more disorganized and stressful living conditions of individuals living in student housing may have led to differences in anger-in levels. The literature indicates that an individual's social environment, especially the family environment, plays an important role in emotional regulation processes (Dağgül, 2016). This supports the finding of a significant difference regarding anger-in obtained in the current study. On the other hand, İmamoğlu and et al. (2020) study found that trait anger and anger styles did not differ statistically significantly based on the number of people living together. However, the finding of a significant difference in anger-in directed toward an individual based on cohabitation status in this study suggests that the social environment in which an individual lives may be an influential variable in anger styles.

REFERENCES

Aydoğan, Y. (2021). Antrenör rol modelliği ve liderlik özelliğinin sporcular üzerindeki etkisi. Yüksek lisans tezi, Dumlupınar Üniversitesi, Sosyal Bilimleri Enstitüsü, Sosyoloji Ana Bilim Dalı, İstanbul.

Bartlett, M. L., and Abrams, M. (2019). “Anger and aggression in sport,” in APA handbook of sport and exercise psychology, eds M. H. Anshel, T. A. Petrie, and J. A. Steinfeldt (Washington, DC: American Psychological Association), 509–528. doi: 10. 1037/0000123-026

Bölükbaşoğlu, C. (2021). Spor bilimleri fakültesinde antrenörlük eğitimi programlarında öğrenim gören öğrencilerin liderlik özellikleri ve eleştirel düşünme düzeylerinin incelenmesi. Yüksek Lisans Tezi. İstanbul Gelişim Üniversitesi. Lisansüstü Eğitim Enstitüsü, İstanbul.

Büyüköztürk, Ş., Kılıç Çakmak, E., Akgün, Ö. E., Karadeniz, Ş. & Demirel, F. (2021). Eğitimde Bilimsel Araştırma Yöntemleri, 30. Baskı, Pegem Akademi, Ankara.

Certel, Z., & Bahadır, Z. (2012). Takım sporu yapan sporcularda benlik saygısı ve sürekli öfke ve öfke ifade tarz ilişkisinin incelenmesi. Selçuk Üniversitesi Beden Eğitimi ve Spor Bilim Dergisi, 14(2), 157-164.

Cin, H., Yılmaz, B. H., & Ektirici, A. (2022). Sporcularda öfke ve saldırganlık algısının çeşitli değişkenler açısından incelenmesi. CBÜ Beden Eğitimi ve Spor Bilimleri Dergisi, 17(2), 230-243.

Dağgül, H. C. (2016). Okul öncesi dönem çocuklarının öz düzenleme becerileri ile ebeveynlerin çocuk yetiştirme stilleri arasındaki ilişkinin incelenmesi. Doğu Akdeniz Üniversitesi, Gazimağusa, KKTC.

Dilek, A.N., & İmamoğlu, O. (2020). Spor Eğitimli Öğrencilerde Sürekli Öfke-Öfke ifade Tarz durumlarının Araştırılması. Uluslararası Güncel Eğitim Araştırmaları Dergisi, 6 (2), 566-575.

Fryxell, D., & Smith, D. C. (2000). Personal, social, and family characteristics of angry students. Professional School Counseling, 4(2), 86.

Gedik, M. R. (2023). Dövüş sporcularının saldırganlık ve öfke düzeylerinin belirlenmesi: Yalova ili örneği. Yalova Üniversitesi Spor Bilimleri Dergisi, 2(2), 29-35.

Gök, O., & Okan, İ. (2023). Examının the relatıonshıp between coach behavıor ın olympıc sports branches and the value development of athletes. Journal of Global Sport and Education Research, 6(3), 27-41.

Gürbüz, B., Kural, S., & Özbek, O. (2019). Sporda saldırganlık ve öfke ölçeği: geçerlik ve güvenirlik çalışması. Sportif Bakış: Spor ve Eğitim Bilimleri Dergisi, 6(2), 206-217.

Güvendi, B., & Keskin, B. (2020). Sporcuların antrenörlerinden algıladıkları etik dışı davranış algısına göre saldırganlık ve öfke davranışlarının incelenmesi. Gaziantep Üniversitesi Spor Bilimleri Dergisi, 5(2), 134-145.

İmamoğlu MK., Çiçek G., İmamoğlu M. (2020). Kadın futbolcularda algılanan stres, spor güdülenme, sürekli öfke ve öfke tarzı düzeyleri. Journal of International Social Research. 13(74), 1-11.

Kiratli, T. (2025). Sporda saldırganlık, öfke ve psikolojik performans ilişkisi. The Online Journal of Recreation and Sports, 14(3), 303-307.

Korkmaz, S. (2006). Üniversite Öğrencilerinde Depresyonun Yordanması: Sosyo-Demografik Değişkenler, Olumsuz Yaşam Olayları, Algılanan Beklentiler, Algılanan İlişkiler. Yüksek lisans tezi, Mersin: Mersin Üniversitesi Sosyal Bilimler Enstitüsü.

Maan Diong, S., Bishop, G. D., Enkelmann, H. C., Tong, E. M., Why, Y. P., Ang, J. C., & Khader, M. (2005). Anger, stress, coping, social support and health: Modelling the relationships. Psychology & Health, 20(4), 467-495.

Özer, A.K.(1994). Sürekli öfke (SL-Öfke) ve öfke ifade tarzı (Öfke-tarz) ölçekleri ön çalışması. Türk Psikoloji Dergisi, 9(31), 26-35.

Öztürk, M. (2022). Bilişim çağında çalışanlarda öfke ve öfke yönetimi. Yüksek Lisans Tezi, Karamanoğlu Mehmet Bey Üniversitesi, Sosyal Bilimler Ensitütüsü, Yönetim Bilişim Sistemleri Ana Bilim Dalı, Karaman.

Paşa, M. (2007), Stresin Bireysel Performans Üzerindeki Etkileri ve Bir Uygulama, Uludağ Üniversitesi Sosyal Bilimler Enstitüsü, Doktora Tezi, Bursa-2007.

Phillips, L. H., Henry, J. D., Hosie, J. A., & Milne, A. B. (2006). Age, anger regulation and well-being. Aging and Mental Health, 10(3), 250-256.

Phillips, M. A., & Murrell, S. A. (1994). Impact of psychological and physical health, stressful events, and social support on subsequent mental health help seeking among older adults. Journal of consulting and Clinical Psychology, 62(2), 270.

Saini, M. (2009). A meta-analysis of the psychological treatment of anger: Developing guidelines for evidence-based practice. Journal of the American Academy of Psychiatry and the Law Online, 37(4), 473-488.

Schieman, S. (1999). Age and anger. Journal of health and Social Behavior, 273-289.

Somoğlu, M. B., Albayrak, A. Y., Taşkın, S., & Taşkın, S. (2023). Sporcuların yaralanma kaygılarının saldırganlık ve öfke düzeylerinin incelenmesi. Gümüşhane Üniversitesi Sağlık Bilimleri Dergisi, 12(3), 1405-1414.

Spielberger, C. D., Jacobs, G., Russell, S., & Crane, R. S. (1983). Assessment of anger: The state-trait anger scale. Advances in personality assessment, 2, 159-187.

Yelpaze, İ. (2016). Üniversite öğrencilerinin psikolojik yardım alma tutumlarının incelenmesi. Doktora Tezi. Eskişehir Anadolu Üniversitesi Eğitim Bilimleri Enstitüsü, Eskişehir.

Zautra, A. (2003). Emotions, stress, and health. Oxford University Press.

EXAMINING THE POSITIVE THINKING SKILLS OF LICENSED ATHLETES

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ABSTRACT

This research was conducted using a survey model, a type of quantitative research design. The study was conducted in the Adapazarı district of Sakarya province, and individuals who had participated in licensed sports for a certain period of time were identified using the criterion sampling method. A total of 160 individuals, 64 female and 96 male, aged 18 and over, who volunteered were included in the study. Data collection tools were a 7-question personal information form prepared by the researcher and the Positive Thinking Skills Scale, developed by Bekhet and Zauszniewski (2013) and whose Turkish adaptation was validated and reliable by Akın et al. (2015). The scale is a single-dimensional measurement tool consisting of 8 items and a 4-point Likert-type scale (0: "Never," "1": Rarely," "2": Usually," "3": Always). There are no reverse-coded items in the scale, and higher scores indicate more frequent use of positive thinking skills. The possible score range for the scale is 0-24, and the Cronbach's alpha internal consistency coefficient was found to be .757. Data were analyzed using SPSS 25.0, and frequency, percentage, arithmetic mean, and standard deviation values are presented. For normally distributed data, the independent t-test was used for comparisons between two groups, and the ANOVA test was used for comparisons of three or more groups. When a significant difference was observed in the ANOVA result, the Scheffe test was applied to determine the group from which it originated. According to the results of the study, the positive thinking skills of individuals who participated in licensed sports did not differ significantly according to variables such as gender, educational status, sport branch, age, and years of sports practice. The t-test and ANOVA analyses revealed that the mean scores between the groups were close to each other and that demographic characteristics had no decisive effect on positive thinking skills.

Keywords: Positive Thinking, Licensed Athletes, Sports Participation, Sports and Motivation

INTRODUCTION

Sports are an important area of activity that contributes to individuals' physical development as well as their mental and emotional strength (Yıldız and Çetin, 2018). Today, sports are not limited to gaining physical health; they also influence an individual's way of thinking, ability to manage their emotions, and their attitude towards life (Kuşat, 2023). The discipline, determination, struggle, endurance, and goal-focused qualities that sports instill in them help individuals develop a more positive perspective on life (Çolak, 2024). This has made it important to examine the impact of sports on individuals' positive thinking skills.

Positive thinking skills mean that an individual approaches events with hope, approaches problems with a solution-oriented perspective, and maintains an optimistic attitude even in negative situations (Şahinler et al., 2020). In today's world, conditions characterized by intense stress, anxiety, and uncertainty make it difficult for individuals to maintain their positive thinking tendencies. Therefore, identifying the factors that support individuals' positive thinking skills is of great importance, both individually and socially.

Experiences within the sports environment not only help individuals gain physical strength, but also important life skills such as emotional balance, self-confidence, self-discipline, and stress management (Böke, 2018). During this process, individuals learn to work in a planned manner to achieve their goals and develop a habit of persevering in the face of challenges. These gains contribute to a more positive evaluation of events, maintaining hope in the face of problems, and continuing to seek solutions.

Practicing sports with a license requires individuals to train regularly for a certain period of time, maintain a disciplined lifestyle, and systematically strive to achieve specific goals. During this process, individuals learn about success, failure, struggle, teamwork, and perseverance. Therefore, examining how participating in sports with a license affects individuals' positive thinking skills is important for understanding the psychological and social dimensions of sports.

METHODOLOGY

Research Model:

This research was conducted using the survey model, a quantitative research design. The survey model is used to reach a general conclusion about a population comprised of numerous elements (Karasar, 2015).

Research Group

This research was conducted in the Adapazarı district of Sakarya province. Criterion sampling, a purposive sampling method, was used in the study. The sample was individuals who had participated in licensed sports for a certain period of time. Participants were contacted at sports complexes, gyms, and various social spaces in the Serdivan district of Sakarya province. The research was conducted on a voluntary basis, and only individuals aged 18 and over were included. A total of 160 participants, 64 female and 96 male, participated in the study.

Table 1. Demographic Information Distributions of Individuals Participating in the Research

	Variables	N	%
Gender	Female	64	40,0
	Male	96	60,0
Age	18-21	58	36,3
	23-26	62	38,8
	27 years and older	40	25,0
Educational Status	High School	103	64,4
	University	57	35,6
Sports Branch	Team Sports	61	38,1
	Individual Sports	99	61,9
Years of Sports	Under 1 year	93	58,1
	1-3 year	36	22,5
	4 years and above	31	19,4

Table 1 shows the demographic characteristics of the individuals participating in the study. The gender distribution of the participants revealed that 40.0% were female (n=64) and 60.0% were male (n=96). The age variable revealed that 36.3% of the participants were between the ages of 18-21 (n=58), 38.8% were between the ages of 23-26 (n=62), and 25.0% were 27 and older (n=40). The distribution by educational background revealed that 64.4% of the participants were high school graduates (n=103), and 35.6% were university graduates (n=57). Regarding the sports branch variable, 38.1% of the participants were involved in team sports (n=61), and 61.9% were involved in individual sports (n=99). When the distribution regarding the years of doing sports is examined, it is seen that 58.1% of the participants have been doing sports for less than 1 year (n=93), 22.5% for 1-3 years (n=36), and 19.4% for 4 years or more (n=31).

Data Collection Tools

In order to collect data in the study, a 7-question personal information form prepared by the researcher and the Positive Thinking Skills Scale, developed by Bekhet and Zauszniewski (2013) and whose validity-reliability studies of the Turkish form were conducted by Akın et al. (2015), were used.

Positive Thinking Skills Scale

The validity and reliability studies of the Turkish form of the Positive Thinking Skills Scale, developed by Bekhet and Zauszniewski (2013), were conducted by Akın et al. (2015). The scale is a single-dimensional measurement tool consisting of 8 items. It has a four-point Likert-type rating (“0” Never, “1” Rarely, “2” Usually, “3” Always). There are no reverse-coded items in the scale. Higher scores indicate more frequent use of positive thinking skills. The highest score that can be obtained from the scale is 24, and the lowest is 0. Cronbach's alpha internal consistency coefficient was calculated as .81. The Cronbach's alpha internal consistency coefficient for this study was found to be .757.

Statistical Analysis of Data

For data analysis, frequencies, percentages, and standard deviations are presented. Data processing was performed using SPSS 25.00. Because the data were normally distributed, an independent t-test was used for comparisons between two groups, and analysis of variance was used for comparisons between three or more groups. When significant differences were found in the analysis of variance, the Scheffe test was used to determine which groups accounted for the difference.

FINDINGS

Table 2. Descriptive Statistics of the Positive Thinking Skills of the Individuals Participating in the Research

	N	Min	Max	x	Ss
Positive Thinking Skills	160	3,00	24,00	13,21	4,27

Table 2 shows descriptive statistics regarding the positive thinking skills of the individuals participating in the study. The number of participants was 160, and positive thinking skills scores ranged from a minimum of 3.00 to a maximum of 24.00. The arithmetic mean for the scale was 13.21, and the standard deviation was 4.27.

Table 3. Independent T-Test Results of Individuals Who Did Licensed Sports According to the Gender Variable

		N	x	Ss	t	p
Gender	Female	64	12,79	4,38	-1,004	,317
	Male	96	13,48	4,20		

Table 3 shows the results of the independent samples t-test regarding the positive thinking skills scores of individuals who played licensed sports, based on the gender variable. The mean positive thinking skills score of female participants was 12.79 (SD=4.38), while the mean score of male participants was 13.48 (SD=4.20). No statistically significant difference was found between the two groups as a result of the analysis (t=-1.004; p=.317).

Table 4. Independent T-Test Results According to the Educational Status of Individuals Participating in the Study

		N	x	Ss	t	p
Educational Status	High School	103	13,16	4,37	-,188	,851
	University	57	13,29	4,12		

Table 4 presents the results of the independent samples t-test regarding the positive thinking skills scores of the individuals participating in the study, based on their educational background. The mean score for high school graduates was 13.16 (SD=4.37), while the mean score for university graduates was 13.29 (SD=4.12). The analysis revealed no statistically significant difference between the two groups based on the educational background variable (t=-.188; p=.851).

Table 5. Independent T-Test Results of Licensed Sports Individuals According to Sports Branch Status

		N	x	Ss	t	p
Sports Branch	Team Sports	61	12,86	4,02	-,797	,426
	Individual Sports	99	13,42	4,42		

Table 5 shows the results of the independent samples t-test regarding the positive thinking skills scores of individuals who played licensed sports, based on the sports branch variable. The mean score for participants involved in team sports was 12.86 (SD=4.02), while the mean score for participants involved in individual sports was 13.42 (SD=4.42). The analysis revealed no statistically significant difference between the two groups based on the sports branch variable (t=-.797; p=.426).

Table 6. Anova Test Analysis Results of Individuals Participating in the Study According to Age Variables

	Subgroups	N	x	Ss	F	p
Age	18-21	58	12,24	4,30	2,392	,095
	23-26	62	13,79	4,49		
	27 years and	40	13,72	3,69		

Table 6 shows the ANOVA test results for the positive thinking skills scores of the individuals participating in the study, based on their age variable. Accordingly, the average score for participants in the 18-21 age group was 12.24 (SD=4.30), for participants in the 23-26 age group was 13.79 (SD=4.49), and for participants aged 27 and over was 13.72 (SD=3.69). The analysis revealed no statistically significant difference between the groups in terms of the age variable (F=2.392; p=0.095).

Table 7. Anova Test Analysis Results of Licensed Sports Individuals According to the Year of Sports Practice Variables

	Subgroups	N	x	Ss	F	p
Years of Sports	Under 1 year	93	13,75	4,56	2,109	,125
	1-3 year	36	12,08	3,79		
	4 years and above	31	12,90	3,70		

Table 7 shows the ANOVA test results for the positive thinking skills scores of individuals who have engaged in licensed sports, based on the variable of years of sports participation. Accordingly, the average score for participants who have been involved in sports for less than one year was 13.75 (SD=4.56), the average score for participants who have been involved in sports for 1-3 years was 12.08 (SD=3.79), and the average score for participants who have been involved in sports for 4 years or more was 12.90 (SD=3.70). The analysis revealed no statistically significant difference between the groups based on the variable of years of sports participation (F=2.109; p=.125).

CONCLUSION AND DISCUSSION

When the analysis results of individuals who participated in licensed sports were examined according to the **gender** variable, no significant difference was found. Karadağ (2019) found in his study that men have higher positive thinking skills than women. Jacobsen et al. (2014) noted that men tend to be more optimistic than women in various matters. Puskar et al. (2010) stated that men are more optimistic than women. In contrast, Patton et al. (2004) reported no significant difference between men and women in terms of optimism. Tazegül (2018) similarly found no significant difference between men and women's positive thinking skills. Historically, in almost all societies, boys have been valued more than girls and held in a privileged position. Thanks to recent social changes and enlightenment, the importance of women has increased, and they have become competitive with men in many areas. However, despite all these developments, it is still difficult to say that women are receiving the full value they deserve today. It is understandable that men who maintain their historical advantages, have certain physiological advantages, and are more supported by society have a more positive outlook on life and are optimistic.

No significant difference was found in the analyses conducted regarding **the educational status** of individuals who participated in licensed sports. This result suggests that the educational level of licensed sports is not the sole determinant of their impact on positive thinking skills. While sports provide individuals with skills such as discipline, self-control, and goal orientation (Yavuz & İlhan, 2023; Yavrutürk, 2025), these skills may not be directly reflected in their educational level. However, Salık (2017), Alkhatib (2020), and Şahinler et al. (2020) reported no significant difference between educational status and positive thinking skills. These research results are parallel to our study. Although no significant difference was found between educational status and positive thinking skills in this study, future studies conducted with samples with more diverse demographic characteristics may provide the opportunity to evaluate this relationship more comprehensively.

When the analysis results of the positive thinking skills of the individuals participating in the study were examined according to the **age** variable, no significant difference was found. A study conducted by Çelik et al. (2020) found a negative and significant relationship between the participants' age and positive thinking skills. In previous research, Tusaie and Patterson (2006) observed a negative relationship between optimism and age, but this relationship was not statistically significant. Chang (2002) reported that older individuals were significantly more optimistic than younger adults. Zou et al. (2016) revealed that the general level of optimism in children and adolescents changed positively with age. Jung et al. (2007) reported that individuals in their 30s had higher positive thinking scores than individuals in their 40s and 50s. Although no significant difference was found between age and positive thinking skills in this study, previous studies suggest that age may have an impact on positive thinking.

No significant difference was found in the positive thinking skills scores of licensed athletes based on their **sport branch**. However, the literature contains various results regarding the impact of different sporting experiences on positive thinking skills. Tazegül (2018), in a study conducted on elite tennis players, revealed that tennis players had above-average levels of positive thinking skills. Çelik et al. (2020), in their study comparing athletes with sedentary individuals, reported that participants who participated in sports had significantly higher positive thinking skills than sedentary individuals. On the other hand, Güvenç (2021) reported that participating in team and individual sports did not affect positive thinking skills. While these research results suggest that sports may have a potential impact on positive thinking skills, they also suggest that further investigation is necessary to better understand the role of sports in determining this skill.

When the analysis results of the positive thinking skills of individuals who have done licensed sports are examined according to the variable of the year they have done sports, it is found that there is no significant difference.

REFERENCES

Akın, A., Uysal, R., ve Akın, Ü. (2015). Olumlu Düşünme Becerileri Ölçeğinin Türkçe Formunun Geçerlik ve Güvenirliği. Akademik Bakış Uluslararası Hakemli Sosyal Bilimler Dergisi,51, 265-270.

Alkhatib, M.A.H. (2020). Investigate The Relationship Between Psychological WellBeing, Self-Efficacy And Positive Thinking At Prince Sattam Bin Abdulaziz University. International Journal Of Higher Education, 9(4),138-152.

Bekhet, A. K ve Zauszniewski, A. (2013). Measuring use of positive thinking skills: Psychometric testing of a new scale. Western Journal of Nursing Research, 35(8) 1074–1093.

Böke, İ. (2018). Spor Yapan Lise Öğrencilerinin Benlik Saygısı Anksiyete Düzeyi Ve Stresle Başa Çıkma Becerilerinin İncelenmesi, (Yüksek Lisans Tezi), İstanbul Gelişim Üniversitesi/Sosyal Bilimler Enstitüsü. İstanbul.

Chang, E. C. (2002). Optimism–pessimism and stress appraisal: Testing a cognitive interactive model of psychological adjustment in adults. Cognitive Therapy and Research, 26(5), 675-690. https://doi.org/10.1023/A:1020313427884.

Çelik, O.B., Esentürk, O.K., ve İlhan, E.L. (2020). Düzenli egzersiz yapan bireylerin beslenme alışkanlıklarının incelenmesi. Ulusal Spor Bilimleri Dergisi, 4(1), 50-58.

Çolak, S. (2024). Üst düzey hentbolcuların zihinsel dayanıklılık düzeylerinin tespiti ve karşılaştırılması. Yüksek Lisans Tezi, Aksaray Üniversitesi, Sosyal Bilimler Enstitüsü, Beden Eğitimi ve Spor Anabilim Dalı, Aksaray.

Güvenç, A. (2021). Beden eğitimi ve spor öğretmenlerinin psikolojik iyi oluş düzeyleri ile olumlu düşünme beceri düzeyleri arasındaki ilişki (Yüksek Lisans Tezi), Karamanoğlu Mehmetbey Üniversitesi Sosyal Bilimler Enstitüsü, Karaman.

Jacobsen, B., Lee, J. B., Marquering, W. & Zhang, C. Y. (2014). Gender differences in optimism and asset allocation. Journal of Economic Behavior & Organization, 107, 630-651. https://doi.org/10.1016/j.jebo.2014.03.007.

Jung, J. Y., Oh, Y. H., Oh, K. S., Suh, D. W., Shin, Y. C. & Kim, H. J. (2007). Positive-thinking and life satisfaction amongst Koreans. Yonsei Medical Journal, 48(3), 371-378. https://doi.org/10.3349/ymj.2007.48.3.371.

Karadağ, Ş. (2019). Üniversite öğrencilerinde olumlu düşünme becerisinin kişilerarası iletişim becerisi ile ilişkisi. Anemon Muş Alparslan Üniversitesi Sosyal Bilimler Dergisi, 7, 131-136.

Karasar, N. (2015). Bilimsel Araştırma Yöntemi, 28. Baskı, Nobel Akademik Yayıncılık, Ankara.

Kuşat, Z. (2023). Spor yapan bireylerin, etkili iletişim becerilerinin karar verme düzeyleri ile olan ilişkisinin incelenmesi. Yüksek lisans tezi, Karamanoğlu Mehmetbey Üniversitesi. Ulusal Tez Merkezi.

Patton, W., Bartrum, D. A. & Creed, P. A. (2004). Gender differences for optimism, self-esteem, expectations and goals in predicting career planning and exploration in adolescents.

International Journal for Educational and Vocational Guidance, 4(2-3), 193-209. https://doi.org/10.1007/s10775-005-1745-z.

Puskar, K. R., Marie Bernardo, L., Ren, D., Haley, T. M., Hetager Tark, K., Switala, J. & Siemon, L. (2010). Self-esteem and optimism in rural youth: Gender differences. Contemporary Nurse, 34(2), 190-198. https://doi.org/10.5172/conu.2010.34.2.190.

Salık, H. (2017). Olumlu Düşünme Becerileri ve Başa Çıkma Yeterliği Arasındaki İlişkinin Çeşitli Demografik Değişkenler Göz Önünde Bulundurularak İncelenmesi.İstanbul Gelişim Üniversitesi Sosyal Bilimler Enstitüsü Psikoloji Ana Bilim Dalı. Yüksek Lisans Tezi.

Şahinler, Y., Biçer, T., Acet, A., & Acet, M. (2020). Sporcularda olumlu düşünme beceri düzeylerinin incelenmesi. Gaziantep Üniversitesi Spor Bilimleri Dergisi, 5(4), 598-613.

Tazegül, Ü. (2018). Elit düzeydeki tenisçilerin olumlu düşünme ve yaşama bağlılık düzeyleri arasındaki ilişkinin belirlenmesi. Akademik Bakış Uluslararası Hakemli Sosyal Bilimler Dergisi, 67, 16-25.

Tusaie, K. R. & Patterson, K. (2006). Relationships among trait, situational, and comparative optimism: Clarifying concepts for a theoretically consistent and evidence-based intervention to maximize resilience. Archives of Psychiatric Nursing, 20(3), 144-150. https://doi.org/10.1016/j.apnu.2005.10.004.

Yavrutürk, A. R. (2025). Ergenlik Döneminde Sporun Psikolojik Gelişim Üzerindeki Etkileri. Göbeklitepe Eğitim ve Spor Bilimleri Dergisi, 4(1), 59-73.

Yavuz, Ü., & İlhan, E. L. (2023). Spor yapmak ve psikolojik iyi oluş: Üniversite öğrencileri profili. Gazi Journal of Physical Education and Sport Sciences, 28(1), 1-7.

Yıldız, E., & Çetin, Z. (2018). Sporun psiko-motor gelişim ve sosyal gelişime etkisi. Hacettepe University Faculty of Health Sciences Journal, 5(2), 54-66.

Zou, R., Zhang, D. J., Niu, G. F., Xie, X. C., Fan, C. Y., Tian, Y. & Zhou, Z. K. (2016). Cross-sectional age differences in dispositional optimism in Chinese children and adolescents. Personality and Individual Differences, 102, 133-138. https://doi.org/10.1016/j.paid.2016.06.063.

ANALYSIS OF THE ECOLOGICAL VALUE OF LANDSCAPE DESIGN IMPLEMENTATION PROJECTS USING ENVI-MET

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ABSTRACT

Urbanization and climate change directly affect the microclimate, biodiversity, and ecosystem services within urban areas. Urban parks are critical open spaces that not only provide social and aesthetic functions that enhance quality of life, but also fulfill ecological functions such as carbon sequestration, shading, and contributing to the water cycle. The design and management of these spaces are highly important for creating sustainable cities. In this context, this study emphasizes that the ecological value of landscape designs should be analyzed not only through aesthetic criteria, but also in terms of microclimate, carbon sequestration capacity, and ecosystem services. As part of the literature review, ENVI-met–based microclimate modeling studies were examined; the effects of urban parks on temperature reduction, shading, soil moisture, wind flow, and thermal comfort were evaluated as ecological value indicators. ENVI-met outputs were also associated with the potential of park vegetation to reduce carbon footprint, enhance carbon sequestration, and contribute to biodiversity. The study suggests that urban parks should meet minimum ecological performance thresholds before implementation. In this regard, evaluation systems proposed in the literature were reviewed, and the necessity of conducting ENVI-met analyses for landscape design projects intended for implementation was discussed. Preventing the application of designs that fall below the threshold values of positive microclimatic performance created by green areas is presented as a critical requirement for combating the climate crisis and promoting nature-based solutions.

In conclusion, evaluating the ecological value of landscape designs with ENVI-met emerges as an essential tool for producing sustainable, low-carbon, biodiversity-enhancing, and climate-resilient parks in urban environments.

Keywords: ENVI-met, Landscape Ecology, Microclimate, Ecological Value, Urban Parks, Biodiversity, Carbon Sequestration

INTRODUCTION

The ENVI-met model is a microclimate simulation software that allows the analysis of climate data at the urban scale and helps evaluate more comfortable environmental conditions through different scenarios. This model analyzes environmental data in detail, particularly based on radiation fluxes. By considering the interactions created by soil properties, surface cover and building materials, plant species and densities, pedestrian pathways, and climatic conditions of the simulation area, the model evaluates the microclimatic structure of the region (Bruse et al., 1998).

Compared to other numerical analysis programs, the ENVI-met model stands out with its user-friendly interface and reliable calculation results. Its capacity to measure mean radiant temperature (MRT) and to perform thermal and bioclimatic comfort analyses are significant advantages of the model. Moreover, this software has been successfully used in many previous urban planning studies, and its accuracy has been tested (Toudert et al., 2007; Krüger et al., 2011; Ng et al., 2012).

High-resolution ENVI-met simulations and field measurements show that urban parks create significant temperature and thermal comfort differences between built-up areas inside and around the parks. Vegetation and water surfaces at park edges and transition zones play a natural cooling role, while the average thermal comfort values at park centers are considerably lower than those in surrounding built-up areas. These results indicate that the strategic placement of plants and water elements in landscape design is critical for microclimate improvement and urban heat island mitigation (Yan et al., 2025).

Studies using ENVI-met have shown that urban parks effectively reduce the urban heat island effect by significantly improving temperature, wind flow, and humidity conditions. Integration of remote sensing data into the model enhances accuracy in microclimate assessments and facilitates ecological performance analysis in situations with limited field data. These findings demonstrate that ENVI-met is a powerful tool for quantitatively evaluating the impact of landscape design projects on climate comfort (Pan et al., 2024).

ENVI-met studies also show that urban parks improve not only temperature and humidity but also air quality. In particular, during the summer, vegetation produces higher ecological effects in regulating microclimate and reducing PM2.5 levels. This indicates that seasonality and plant density are critical for ecological performance in landscape design projects (Xiong et al., 2025).

Three-dimensional modeling with ENVI-met demonstrates that roadside and rooftop greening is effective in reducing urban temperature and increasing thermal comfort. This emphasizes the strategic importance of plant placement in landscape design (Chatzinikolaou et al., 2018).

The accuracy of ENVI-met simulations depends on the precise modeling of plant parameters. Features such as leaf area density and leaf angle distribution play a decisive role in microclimate and thermal comfort assessments. This highlights the strategic importance of plant selection and placement for ecological performance in landscape design projects (Liu et al., 2023).

ENVI-met simulations reveal the effects of urban development, vegetation, and land use on temperature distribution. High-density urbanization increases heat, while dense and strategically placed green areas reduce temperature and improve the microclimate. These results show that plant density and placement are critical for reducing the urban heat island effect in landscape design projects (Asmadi et al., 2024).

ENVI-met studies conducted in Turkey also demonstrate that green + blue infrastructure arrangements positively affect temperature, humidity, wind, and thermal comfort (Yılmaz et al., 2025). Furthermore, simulation analyses at the neighborhood/street scale show that green area density and plant placement create significant differences in outdoor thermal comfort (Kurt & Gölcü, 2023).

The influence of building morphology and spatial layout on the microclimate has also been verified in Turkey, highlighting that parameters such as orientation, land use, and hard surface/green ratio are critical for urban heat island effect and comfort conditions (Mutlu & Yılmaz, 2024; Yılmaz et al., 2019).

The aim of this study is to examine the ecological value of landscape design projects through ENVI-met-based literature studies and to comparatively evaluate their ecological performance, including microclimate, carbon sequestration, and biodiversity.

MATERIALS AND METHODS

The materials of this study consist of ENVI-met-based studies focusing on the ecological value of landscape design applications. The study employed a literature and document review method.

As the analysis method, the selected literature was systematically reviewed and classified based on indicators demonstrating the ecological performance of landscape design. These indicators include air temperature and thermal comfort (PET), wind flow, shading, carbon sequestration, and contributions to biodiversity (Figure 1).

Figure 1. Heat waves in the ENVI-met model (URL)

During the compilation and comparison process, the ecological effects of different landscape design strategies were examined, and data obtained from ENVI-met outputs were correlated with information from the literature. This method allows for the assessment of minimum ecological performance levels that landscape design projects should achieve prior to implementation.

FINDINGS

As a result of the literature review, the ecological performance of landscape design projects is evaluated through ENVI-met analyses under five categories: temperature and thermal comfort, shading and radiation balance, wind flow, carbon sequestration and plant performance, and biodiversity and ecosystem services (Figure 2).

Figure 2. High-resolution 3D modeling with ENVI-met for climate adaptation (URL)

Temperature Reduction and Thermal Comfort

Vegetation and appropriate landscape designs significantly reduce urban temperatures. According to ENVI-met analyses:

- Park areas are 2–6 °C cooler compared to surrounding built-up areas (Yan et al., 2025).
- PET values decrease by 5–12 °C in scenarios with dense shade-providing tree cover (Chatzinikolaou et al., 2018).
- Broad-crowned trees in tropical cities reduce PET values by 8–14 °C (Shinzato & Duarte, 2022).
- Multi-layered vegetation provides 35% more cooling than single-layer designs (Johansson et al., 2021).
- Meta-analyses across various cities have found that parks are on average 0.9–4.0 °C cooler than their surroundings (Bowler et al., 2010).
- Studies in Turkey indicate that green + blue infrastructure applications significantly improve thermal comfort during the summer (Yılmaz et al., 2025).

These results highlight the decisive role of tree species, crown width, and density on the microclimate.

Shading, Radiation, and Plant Placement

- Plant distribution directly affects radiation balance and TMRT:
- Trees with high LAI significantly reduce TMRT (Liu et al., 2023).

- Combinations of trees + shrubs + permeable surfaces provide 20–30% more effective shading than single-layer planting (Liu et al., 2023; Zölch et al., 2016).

- Linear tree arrangements are more effective than point planting in reducing the urban heat island effect along streets and corridors (Norton et al., 2015).

- The most successful park design scenario for mitigating heat island effects is the combination of trees + shrubs + permeable surfaces (Zölch et al., 2016).

- Meta-analyses confirm that parks are on average 0.9–4.0 °C cooler than their surroundings (Bowler et al., 2010).

These findings emphasize that plant placement is critical in microclimate-oriented design.

Wind Flow and Air Circulation

Vegetation arrangements and building density alter wind direction and speed:

- Dense vegetation reduces wind speed by 10–25%.

- Multi-layered arrangements provide more balanced air circulation (Asmadi et al., 2024).

- Linear planting in street corridors effectively guides wind direction (Johansson et al., 2021).

These results demonstrate that landscape design is as important for air circulation and comfort as it is for shading.

Carbon Sequestration and Plant Performance

When ENVI-met outputs are related to carbon storage capacity, landscape design proves effective in reducing the carbon footprint:

- Broadleaf trees sequester 15–40% more carbon than conifers (Nowak & Crane, 2002).

- Carbon stocks can double in dense tree planting scenarios (Strohbach & Haase, 2012).

- Shading reduces the need for air conditioning, indirectly lowering carbon emissions (Livesley et al., 2016; Pan et al., 2024).

These data indicate that carbon sequestration can be used as a measurable ecological indicator in landscape design.

Biodiversity and Ecosystem Services

Although ENVI-met does not directly measure biodiversity, plant density and diversity enhance ecosystem services:

- Multi-layered vegetation designs increase habitat capacity and can boost bird species richness by up to 30% (Lepczyk et al., 2017).

- Parks with high plant diversity provide stronger ecosystem services (Beninde et al., 2015; Aronson et al., 2017).

- Water surfaces and permeable soils increase soil moisture and microhabitat diversity, creating favorable conditions for fauna.

These findings highlight the need to consider ecosystem services from a multifaceted perspective in landscape design.

DISCUSSION AND CONCLUSION

This study provides a comprehensive assessment of the ecological performance of landscape design applications through ENVI-met-based literature findings, focusing on urban microclimate, carbon sequestration, and biodiversity effects. When considered alongside current studies, the findings indicate that elements such as plant species selection, shading strategies, surface permeability, and plant density play a critical role in determining ecological performance in landscape design.

In the literature, the cooling effect of urban parks has long been discussed, and ENVI-met findings quantitatively reveal the spatial distribution and intensity of this effect (Bowler et al., 2010; Yan et al., 2025). Most studies confirm that multi-layered vegetation provides higher cooling and shading effects compared to single-layer designs (Johansson et al., 2021; Liu et al., 2023). Similarly, linear tree arrangements have been shown to reduce heat accumulation in street canyons and regulate wind flow (Norton et al., 2015; Asmadi et al., 2024). These results demonstrate that the strategic placement of vegetation in landscape design is important not only for aesthetics but also for thermal comfort.

Regarding carbon sequestration, broad-crowned deciduous trees exhibit higher carbon storage capacity and indirectly reduce carbon emissions by decreasing energy consumption (Nowak & Crane, 2002; Livesley et al., 2016). Linking ENVI-met outputs with carbon storage models enables the use of carbon footprint as a measurable indicator in landscape design projects. Recent studies highlight that shading contributes significantly to annual carbon reduction by lowering building energy demand (Pan et al., 2024; Li et al., 2023).

From a biodiversity perspective, multi-layered plant compositions enhance habitat diversity and support species richness (Lepczyk et al., 2017; Aronson et al., 2017). Moreover, the use of permeable surfaces, water bodies, and native plant species strengthens the water cycle and increases microhabitat diversity. These findings indicate that landscape design functions as a multidimensional planning tool, shaping not only the physical environment but also ecosystem services.

ENVI-met studies conducted in Turkey produce similar results, demonstrating that despite differences in climate and topography, plant design principles play a universally decisive role in ecological performance (Mutlu & Yılmaz, 2024; Yılmaz et al., 2025). Designs incorporating both green and blue infrastructure show significant improvements in temperature, humidity, wind, and thermal comfort indicators.

Overall, the findings strongly support the need for testing landscape design projects with microclimate modeling tools such as ENVI-met before implementation. Defining ecological performance thresholds has become a necessary planning approach, particularly in the context of the climate crisis, increasing urban heat island effects, and carbon management. Accordingly, designs should be evaluated not only in terms of aesthetic and social functions but also based on ecological indicators such as temperature, PET, shading, carbon sequestration, surface permeability, and biodiversity.

In conclusion, establishing ENVI-met-based ecological performance analysis as a standard evaluation tool in landscape design is indispensable for creating sustainable, low-carbon, and climate-resilient cities. This approach facilitates the systematic and data-driven implementation of nature-based solutions, enhancing the capacity of urban parks to provide ecosystem services.

REFERENCES

Asmadi, A.B., Misni, A. & Brahimi, M., (2024). Evaluating urban microclimate temperature using Envi-Met Simulation Model: A case study conducted in two city areas, Pudu and Wangsa Maju. Malaysian Journal of Society and Space, 20:4.

Aronson, M. F. J., Lepczyk, C. A., Evans, K. L., Goddard, M. A. & diğ. (2017). Biodiversity in the city: Key challenges for urban green space management. Frontiers in Ecology and the Environment, 15(4), 189–196.

Bruse, M. & Fleer, H., (1998). Simulating surface-plant-air interactions inside urban environments with a three dimensional numerical model. Environmental Modelling and Software, 13, 373–384.

Beninde, J., Veith, M. & Hochkirch, A. (2015). Biodiversity in cities needs space: A meta-analysis of factors determining urban species richness. Ecology Letters, 18 (6), 581–592.

Bowler, D. E., Buyung-Ali, L., Knight, T. M. & Pullin, A. S. (2010). Urban greening to cool towns and cities: A systematic review of the empirical evidence. Landscape and Urban Planning, 97 (3), 147–155.

Chatzinikolaou, E., Chalkias, C. & Dimopoulou, E. (2018). Urban Microclimate Improvement Using ENVI-Met Climate Model. The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XLII-4, 2018ISPRS TC IV Mid-term Symposium "3D Spatial Information Science – The Engine of Change", 1–5 October, Delft, The Netherlands.

Chatzinikolaou, E., Chalkias, C., Dimopoulou, E. & Kolokotsa, D. (2018). Modelling the microclimatic changes associated with urban green space regeneration. Sustainable Cities and Society, 38, 131–141.

Ertem Mutlu, B. & Yılmaz, S. (2024). Analysis of the Impact of Urban Building Blocks Orientation on Outdoor Thermal Comfort in Winter Cities Using ENVI-met. Journal of Architectural Sciences and Applications, 9(2), 737-755.

Johansson, E., Yahia, M. W. & Thorsson, S. (2021). Microclimate and thermal comfort effects of urban vegetation in a hot-dry climate. Urban Climate, 36, 100797.

Lepczyk, C. A., Aronson, M. F. J., Evans, K. L., Goddard, M. A. & Lerman, S. B. (2017). Urban bird diversity and landscape structure: A global analysis. Scientific Reports, 7, 16508.

Livesley, S. J., Glover, D. & illiams, N. S. G. (2016). Carbon storage and sequestration benefits of urban green infrastructure. Environmental Pollution, 208, 48–56.

Liu, Z., Cheng, K.Y., Sinsel, T., Simon, H., Jim, C.Y., Morakinyo, T.E., He, Y., Yin, S., Ouyang, W., Shi, Y. & Ng, E. (2023). Modeling microclimatic effects of trees and green roofs/façades in ENVI-met: Sensitivity tests and proposed model library Author links open overlay panel. Building and Environment Volume 244, 110759.

Krüger, E. L., Minella, F. O. & Rasia, F., (2011). Impact of urban geometry on outdoor thermal comfort and air quality from field measurements in Curitiba, Brazil. Building and Environment, 46, 621–634.

Middel, A., Häb, K., Brazel, A. J., Martin, C. A. & Guhathakurta, S. (2019). Impact of shade on pedestrian thermal comfort in urban heat islands. Urban Climate, 27, 287–302.

Norton, B. A., Coutts, A. M., Livesley, S. J., Harris, R. J., Hunter, A. M. & Williams, N. S. G. 2015). Planning for cooler cities: Comparing tree species and planting configurations. Landscape and Urban Planning, 138, 47–61.

Ng, E., Chen, L., Wang, Y. & Yuan, C. (2012). A study on the cooling effects of greening in a high-density city: An experience from Hong Kong. Building and Environment, 47, 256–271.

Pan, Y., Morimoto, T. & Ichinose, T. (2024). Combining Multi-Source Satellite Data with a Microclimate Model to Analyze the Microclimate of an Urban Park. Climate, 12(12), 197.

Strohbach, M. W. & Haase, D. (2012). Above-ground carbon storage by urban trees in Leipzig, Germany: Analysis of patterns in a European city. Landscape and Urban Planning, 104 (1), 95–104.

Shinzato, P. & Duarte, D. (2022). Tree shade effects on thermal comfort in tropical urban environments: ENVI-met simulations and field measurements. Building and Environment, 216, 109009.

Toudeert, F. & Mayer, H. (2007). Effects of asymmetry, galleries, overhanging façades and vegetation on thermal comfort in urban street canyons. Solar Energy, 81, 742–754

Yan, D., Xu, L., Wang, Q., Feng, J. & Wu, X. (2025). Quantifying Landscape Effects on Urban Park Thermal Environments Using ENVI-Met and 3D Grid Profile Analysis. Forests, 16(7), 1085.

Yan, H., Gong, L., Zhou, J., Li, Z. & Xu, J. (2025). Cooling effects of urban parks based on ENVI-met simulations in hot-summer climates. Urban Forestry & Urban Greening, 91, 128055.

Yilmaz, S., Menteş, Y. & Jamei, E. (2025). Investigating the Effect of Blue–Green Infrastructure on Thermal Condition—Case Study: Elazığ, Turkey . Land, 14(4), 891.

Yılmaz, S., Kurt, A. & Gölcü, M. (2023). ENVI-met Simulations of the Effect of Different Landscape Design Scenarios on Pedestrian Thermal Comfort: Haydar Aliyev Street. Yuzuncu Yıl University Journal of Agricultural Sciences, 33(3), 338-353.

Zölch, T., Maderspacher, J., Wamsler, C. & Pauleit, S. (2016). Using green infrastructure for urban climate-proofing: Theoretical and empirical evidence for heat mitigation. Urban Forestry & Urban Greening, 14 (4), 105–113.

Xiong, N., Song, H., Zhou, F., Yan, Y., Jia, J., Li, Q., Liu, D. & Wang, J. (2025). Simulation of Microclimate and PM2.5 Dispersion in Typical Urban Parks in Beijing Based on the ENVI-Met Model. Sustainability, 17(16), 7247.

Batrachochytrium dendrobatidis ENFEKSİYONUNUN BİYOLOJİK VE EKOLOJİK DİNAMİKLERİ

BIOLOGICAL AND ECOLOGICAL DYNAMICS OF *Batrachochytrium dendrobatidis* INFECTION

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ÖZET

Batrachochytrium dendrobatidis (Bd), amfibilerin keratinize epidermisini enfekte eden, zoospor oluşturan bir kitrid mantarıdır ve kitridiomikozis olarak tanımlanan popülasyon düzeyinde önemli kayıplarla ilişkilendirilen bir hastalığın etkenidir. Zoosporların sucul ortamlardaki aktif hareketi, keratine gösterdiği tropizm ve bazı amfibi türlerindeki asemptomatik taşıyıcılık, patojenin ekolojik başarı ve yayılım kapasitesini önemli ölçüde artıran biyolojik özelliklerdir. Enfeksiyonun ölümcül seyri çoğunlukla derinin elektrolit dengesini koruma işlevinin bozulmasıyla ilişkilidir ve özellikle metamorfoz sonrası dönemde klinik bulgular hızla ağırlaşabilir.

Bd enfeksiyonunun ilerleyişi, konak, patojen ve çevrenin etkileşimine dayanan çok boyutlu bir dinamik ile şekillenir. Konağın genetik yapısı, epidermal savunma bileşenleri özellikle de antimikrobiyal peptitler, lizozimler ve mukozal mikrobiyota zoosporların deriye tutunma ve kolonizasyon başarısında belirleyicidir. Metamorfoz sürecinde bağışıklık sisteminde gerçekleşen yeniden yapılanma ve bu dönemde artan hormon düzeyleri (T3 ve kortikosteron), birçok türde enfeksiyon duyarlılığını belirgin biçimde artırabilir; buna karşın larval evrede enfeksiyon çoğu zaman klinik belirti oluşturmadan seyredebilir. Bd soylarının virülans özellikleri de hastalığın şiddetini etkiler. Özellikle yaygın GPL soyunun yüksek enfektivitesi, birçok türde hızlı ve ağır popülasyon kayıplarıyla ilişkilendirilmiştir. Bunun yanında bazı amfibilerin yüksek zoospor yüklerini belirti göstermeden taşıyabilmesi, bu türlerin ekosistem içinde "süper saçıcı" işlevi görerek patojenin sürekliliğini desteklemesine olanak tanır. Çevresel etmenler bu dinamiğin dış çerçevesini oluşturur: serin ve nemli habitatlar zoosporların canlılığını artırırken, yüksek sıcaklıklar çoğu durumda enfeksiyonun baskılanmasına yol açabilir. Çevresel stres ve eş zamanlı enfeksiyonlar ise konağın savunma kapasitesini azaltarak hastalığın klinik seyrini daha ağır hale getirebilmektedir.

Bu çok katmanlı yapı, kitridiomikozisin anlaşılması ve etkili korunma stratejilerinin geliştirilmesi açısından bütüncül bir yaklaşımı zorunlu kılmaktadır.

Anahtar Kelimeler: Batrachochytrium dendrobatidis; Kitridiomikozis; Amfibi deri enfeksiyonları; Konak–patojen–çevre etkileşimi; Enfeksiyon dinamikleri

ABSTRACT

Batrachochytrium dendrobatidis (Bd) is a zoosporic chytrid fungus that infects the keratinized epidermis of amphibians and is recognized as the primary etiological agent of chytridiomycosis, a disease associated with severe population declines worldwide. The active motility of zoospores in aquatic environments, their marked tropism for keratin, and the capacity of certain amphibian species to act as asymptomatic carriers collectively enhance the pathogen's ecological success and transmission potential. The fatal course of the infection is largely linked to disruption of cutaneous ion regulation, a process that becomes particularly critical during the post-metamorphic period.

The progression and severity of Bd infection arise from the interplay among host, pathogen, and environmental determinants. The host's genetic background and epidermal defense components—particularly antimicrobial peptides, lysozymes, and the mucosal microbiota—play a decisive role in the ability of zoospores to adhere to and colonize the skin. During metamorphosis, immune restructuring and elevations in hormones such as T3 and corticosterone markedly increase susceptibility in many species, whereas larval stages often harbor infection without overt clinical signs. Variation in virulence among Bd lineages further influences disease outcomes; notably, the globally distributed GPL lineage has been associated with rapid and substantial population losses. Additionally, several amphibian species can carry extremely high zoospore burdens without clinical disease, thereby functioning as "super-spreaders" that sustain pathogen circulation within ecosystems. Environmental conditions define the outer framework of this dynamic: cool and moist habitats support zoospore survival and transmission, whereas elevated temperatures generally suppress infection. Environmental stressors and co-infections may further compromise host defense mechanisms, contributing to more severe clinical outcomes.

This multilayered interaction underscores the need for an integrative perspective when evaluating chytridiomycosis and developing effective conservation and management strategies.

Key Words: Batrachochytrium dendrobatidis; Chytridiomycosis; Amphibian skin infections; Host–pathogen–environment interactions; Infection dynamics

USE OF TREE LEAVES AS AN ALTERNATİVE FEED SOURCE İN RUMİNANT NUTRİTİON: NUTRİTİONAL POTENTİAL, ANTİNUTRİTİONAL FACTORS AND APPLİCATİON OPPORTUNİTİES

RUMİNANT BESLEMEDE AĞAÇ YAPRAKLARININ ALTERNATİF YEM KAYNAĞI OLARAK KULLANIMI: BESİNSEL POTANSİYEL, ANTİBESİNSEL FAKTÖRLER VE UYGULAMA OLANAKLARI

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ABSTRACT

Introduction and Purposa: The rising demand for sustainable and cost-effective feed resources has increased interest in the use of tree leaves as alternative supplements in ruminant nutrition. This review critically examines the nutritional potential, secondary metabolite profiles, and practical application methods of various tree species, including *Leucaena, Albizia, Acacia, Quercus, Populus, Salix, Morus,* and *Ficus*. The aim is to evaluate the effectiveness of these species in improving ruminant performance while addressing the limitations posed by anti-nutritional factors, thereby contributing to sustainable livestock production.

Materials and Methods: A comprehensive literature review was conducted focusing on the chemical composition of tree leaves—particularly crude protein, fiber fractions, mineral content, and bioactive compounds such as condensed tannins, saponins, and flavonoids. The review also explores processing techniques—including shade-drying, ensiling, and polyethylene glycol (PEG) application—and their effectiveness in mitigating anti-nutritional effects. Emphasis was placed on in vitro and in vivo studies assessing ruminal fermentation, nutrient digestibility, microbial modulation, and animal performance outcomes.

Results: The analyzed tree leaves exhibited considerable variation depending on species, maturity stage, and environmental factors, generally containing crude protein levels ranging from 12% to 28%. Secondary metabolites such as tannins and saponins were found to enhance nitrogen utilization efficiency and reduce methane emissions by suppressing rumen protozoa at optimal levels, whereas excessive concentrations negatively affected feed intake and nutrient digestibility. Processing methods were effective in reducing the adverse effects of these compounds; however, further research is required regarding cost and practical applicability. The integration of tree leaves into ruminant diets has shown promising improvements in feed conversion ratios and antioxidant status across various animal trials.

Discussion and Conclusion: This review highlights the importance of species-specific and maturity-dependent variations in leaf composition and bioactivity for their successful inclusion in feeding regimes. While current evidence supports the potential of tree leaves as sustainable feed resources, substantial knowledge gaps remain concerning their long-term in vivo effects on animal health,

production parameters, and product quality. Future research should prioritize multi-season field trials and mechanistic studies to optimize application strategies and fully harness the potential of tree leaves in ruminant nutrition.

Keywords: Tree leaves, Ruminant nutrition, Condensed tannins, Polyphenols, Saponins, Alternative feed resources, Sustainable production

ÖZET

Giriş ve Amaç: Sürdürülebilir ve uygun maliyetli yem kaynaklarına olan artan talep, ruminant beslenmesinde alternatif takviye olarak ağaç yapraklarının kullanımına olan ilgiyi artırmıştır. Bu derleme, Leucaena, Albizia, Acacia, Quercus, Populus, Salix, Morus ve Ficus dahil olmak üzere çeşitli ağaç türlerinin besin potansiyelini, sekonder metabolit profillerini ve pratik uygulama yöntemlerini eleştirel bir şekilde incelemektedir. Amaç, bu türlerin ruminant performansını iyileştirmedeki etkinliklerini değerlendirirken, aynı zamanda anti-beslenme faktörlerinin oluşturduğu sınırlamaları ele alarak sürdürülebilir hayvancılık üretimine katkıda bulunmaktır.

Materyaller ve Yöntemler: Ağaç yapraklarının kimyasal bileşimine, özellikle ham protein, lif fraksiyonları, mineral içeriği ve yoğunlaştırılmış tanenler, saponinler ve flavonoidler gibi biyoaktif bileşiklere odaklanan kapsamlı bir literatür taraması yapılmıştır. Derleme ayrıca, gölgede kurutma, silajlama ve polietilen glikol (PEG) uygulamaları gibi işleme tekniklerini ve bunların anti-beslenme etkilerini azaltmadaki etkilerini incelemektedir. Ruminal fermantasyon, besin sindirilebilirliği, mikrobiyal modülasyon ve hayvan performans sonuçlarını değerlendiren in vitro ve in vivo çalışmalara vurgu yapılmıştır.

Sonuçlar: Analiz edilen ağaç yaprakları, türe, olgunluk aşamasına ve çevresel faktörlere bağlı olarak önemli ölçüde değişiklik gösterdiği ve genel olarak %12 ila %28 arasında ham protein oranlarına sahip olduğu görülmüştür. İkincil metabolitler olarak ifade edilen tanenler ve saponinlerin optimum seviyelerde azot kullanım verimliliğini artırdığı, rumen protozoalarını baskılayarak metan emisyonlarını azaltığı, bunun yanında aşırı konsantrasyonları ise yem alımını ve besin sindirilebilirliğini olumsuz etkilediği görülmüştür. İşleme yöntemleri, bu bileşiklerin olumsuz etkilerini azaltmada etkili olmuştur, ancak maliyet ve uygulanabilirlik noktasında daha fazla araştırma yapılması gerektirmektedir. Ağaç yapraklarının ruminant diyetlerine entegrasyonu, çeşitli hayvan denemelerinde yem dönüşüm oranlarında ve antioksidan durumunda ümit verici iyileştirmeler göstermiştir.

Tartışma ve Sonuç: Bu inceleme, yaprak bileşimi ve biyoaktivitesindeki türe özgü ve aşamaya bağlı değişikliklerin, beslenme rejimlerine başarılı bir şekilde dahil edilmesindeki önemini vurgulamaktadır. Mevcut kanıtlar ağaç yapraklarının sürdürülebilir yem kaynakları olarak potansiyelini desteklerken, hayvan sağlığı, üretim parametreleri ve ürün kalitesi üzerindeki uzun vadeli in vivo etkileri konusunda önemli bilgi eksiklikleri bulunmaktadır. Gelecekteki araştırmalar, uygulama stratejilerini optimize etmek ve ağaç yapraklarının geviş getiren hayvan beslenmesindeki tüm potansiyelini ortaya çıkarmak için çok mevsimli saha denemelerine ve mekanik çalışmalara öncelik vermelidir.

Anahtar Kelimeler: Ağaç yaprakları, Geviş getiren hayvan beslenmesi, Yoğunlaştırılmış tanenler, Polifenoller, Saponinler, Alternatif yem kaynakları, Sürdürülebilir üretim

THE RELATIONSHIP BETWEEN MENTAL TOUGHNESS, STRESS, AND PERFORMANCE IN TAEKWONDO ATHLETES

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ABSTRACT

The aim of this study is to review the current scientific evidence examining the relationship between mental toughness, stress, and athletic performance in taekwondo athletes and to evaluate the findings in line with practical recommendations for training and competition processes. In individual combat sports such as taekwondo, it is well established that psychological factors play a decisive role in performance, as well as physical competence. In this context, mental toughness, stress coping ability, and motivation levels are considered among the fundamental determinants of sporting success. This study is a narrative review. National and international studies investigating the relationship between mental toughness, stress, anxiety, burnout, motivation, and performance in taekwondo athletes were examined. Current review and research articles, postgraduate theses, and book chapters in the literature were systematically evaluated using content analysis. The reviewed studies indicate that taekwondo athletes with high levels of mental toughness have lower levels of stress and competitive anxiety, more developed focus skills, and more consistent competition performance. High stress and anxiety levels, on the other hand, were found to have negative effects on muscle coordination, decision-making processes, and motor performance. In addition, mental toughness was reported to reduce the risk of burnout and support the sustainability of motivation. The coach–athlete relationship and psychological support practices were also emphasized as important factors that strengthen mental toughness. In conclusion, there is a strong and significant relationship between mental toughness, stress, and performance in taekwondo athletes. The systematic integration of psychological skills training, stress management, imagery, and motivational support into training programs is considered an important factor in enhancing athletic performance.

Key Words: Taekwondo, mental toughness, stress, athletic performance, competitive anxiety, motivation

INTRODUCTION

In recent years, it has been clearly demonstrated in the sports science literature that athletic performance cannot be explained solely by physical capacity, and that psychological factors also play a decisive role in success (Moralı & Tiryaki, 1990; Erdoğan & Kocaekşi, 2015; Sarı et al., 2020). Among individual combat sports, taekwondo stands out as a discipline that requires a high level of attention, rapid decision-making, intense concentration, and psychological resilience (Bedir, 2008; Tel, 2008). Therefore, psychological resilience, stress management, and motivation levels are regarded as fundamental determinants of athletic success in taekwondo athletes.

Mental toughness is defined as the athlete's capacity to maintain performance under pressure, stress, and challenging conditions and to adapt effectively to adverse situations (Jones et al., 2007; Gucciardi

et al., 2015). It has been reported that athletes with high levels of mental toughness are more resistant to stressors encountered during competition, have more developed attention and concentration skills, and can sustain their performance more consistently (Sheard, 2013; Sarı et al., 2020). These characteristics are of even greater importance in taekwondo, where rapid decision-making, precise timing, and reflexes are critical components of performance. Stress is defined as a physiological and psychological response to stimuli that threaten an individual's internal balance and is considered an important variable that directly affects performance in the sport environment (Selye, 1956; Martens, 1990). It has been reported that increased stress and competitive anxiety in athletes have negative effects on muscle coordination, motor control, decision-making speed, and emotional balance (Gümüşdağ et al., 2013; Acun, 2022). Especially in individual sports, where performance is directly attributed to the athlete, stress and anxiety levels may be experienced more intensely (Engür, 2002; Sarı et al., 2020).

Many studies have emphasized that the interaction between mental toughness and stress plays a decisive role in athletic performance. It has been reported that athletes with high levels of mental toughness exhibit lower levels of stress and competitive anxiety and are able to maintain their performance even under stressful conditions (Gucciardi et al., 2015; Erdoğan & Kocaekşi, 2015). In contrast, high stress and low mental toughness levels have been shown to increase the risk of burnout and reduce athletic efficiency (Maslach & Jackson, 1981; Gümüşdağ et al., 2013).

Motivation also plays a crucial role in the psychological dimension of athletic performance. Motivation is a fundamental psychological process that determines the athlete's level of effort, continuity, and goal-directed behaviors (Ryan et al., 1997). It is stated that mental toughness supports the continuity of motivation, while motivation strengthens the capacity to cope with stress (Sheard, 2013; Sarı et al., 2020). In addition, it is emphasized that the coach–athlete relationship and psychological support practices play an important role in the development of mental toughness (Jowett, 2007; Tolukan & Akyel, 2019).

Studies conducted specifically in taekwondo indicate that athletes are exposed to intense psychological pressure during the competition process, and this situation has decisive effects on stress, anxiety, and performance (Bedir, 2008; Acun, 2022). However, it is observed that review studies addressing the relationship between mental toughness, stress, and athletic performance in a holistic manner within the specific context of taekwondo are limited. Accordingly, the present study aims to review the relationship between mental toughness, stress, and athletic performance in taekwondo athletes in the light of current scientific evidence and to provide practical recommendations for training and competition processes.

METHOD

This study was planned to examine scientific studies addressing the relationship between mental toughness, stress, and athletic performance in taekwondo athletes using a narrative review method. No experimental intervention was conducted, no sample group data were collected, and no statistical analysis was performed. The study is entirely based on the examination of academic publications available in the existing literature.

During the literature search process, both national and international databases were screened. In this context, Google Scholar, PubMed, SPORTDiscus, Web of Science, and TR Dizin databases were used. The keywords "mental toughness," "stress," "sport performance," "taekwondo," "competitive anxiety," and "motivation" were used in various combinations during the search process. Peer-reviewed journal articles, postgraduate theses, and academic book chapters that directly addressed mental toughness, stress, anxiety, burnout, motivation, and athletic performance variables in taekwondo athletes and were accessible in full text were included in the study. The retrieved publications were classified under the themes of mental toughness, stress and anxiety, motivation, burnout, and athletic performance based on their content. The findings obtained from the studies were comparatively evaluated using a qualitative content analysis approach and interpreted within a holistic framework specific to the taekwondo discipline.

RESULTS

The studies reviewed within the scope of this narrative review reveal that there are significant and multidimensional relationships between mental toughness, stress, and athletic performance in taekwondo athletes (Erdoğan & Kocaekşi, 2015; Sarı et al., 2020). The findings in the literature indicate that athletes with high levels of mental toughness are able to cope more effectively with stress during both training and competition processes and can maintain their performance more consistently (Sheard, 2013; Gucciardi et al., 2015).

The reviewed studies report that athletes with high mental toughness have lower levels of perceived stress and competitive anxiety, while their attention and concentration skills are more developed (Sarı et al., 2020; Bedir, 2008). These athletes are reported to manage their decision-making processes more effectively, particularly during critical moments of competition, and to demonstrate fewer performance fluctuations (Jones et al., 2007; Sheard, 2013). In contrast, athletes with low mental toughness exhibit higher levels of stress and anxiety, more frequent attentional disturbances, and increased performance errors (Gümüşdağ et al., 2013; Acun, 2022).

Many studies emphasize that increased levels of stress and anxiety have negative effects on muscle coordination, motor control, and reaction time (Martens, 1990; Engür, 2002; Acun, 2022). It has been determined that under high stress, technical execution in taekwondo athletes becomes less fluent, timing errors increase, and competition performance becomes unstable (Bedir, 2008; Sarı et al., 2020). Mental toughness has also been found to be closely associated with burnout and motivation variables. Athletes with high levels of mental toughness experience lower levels of burnout symptoms, while their motivation levels are observed to be more sustainable throughout the season (Maslach & Jackson, 1981; Ryan et al., 1997; Gümüşdağ et al., 2013). In contrast, it is stated that athletes with prolonged exposure to stress and low mental toughness levels exhibit more pronounced loss of motivation and psychological wear (Erdoğan & Kocaekşi, 2015; Sarı et al., 2020).

Moreover, the literature indicates that the coach–athlete relationship and psychological support practices play an important role in the development of mental toughness. Trust-based communication, structured psychological skills training, and supportive leadership approaches are reported to enhance the capacity to cope with stress and indirectly strengthen performance (Jowett, 2007; Tolukan & Akyel, 2019). Overall, the synthesized findings demonstrate that mental toughness plays a decisive role in stress levels and athletic performance in taekwondo athletes, and that these three variables form a dynamic structure that interact with each other reciprocally (Gucciardi et al., 2015; Sarı et al., 2020).

DISCUSSION

The findings obtained in this review study indicate that there is a strong interaction between mental toughness, stress, and athletic performance in taekwondo athletes. The results are consistent with previous studies demonstrating that athletes with high levels of mental toughness are better able to maintain their performance under stress (Clough et al., 2002; Nicholls et al., 2011). Mental toughness is regarded as a fundamental psychological resource that regulates athletes' behaviors under pressure and supports performance stability.

The negative effects of stress and competitive anxiety on athletic performance become more pronounced, especially in individual sports. Weinberg and Gould (2019) state that high anxiety levels lead to attentional narrowing, loss of cognitive flexibility, and an increase in motor errors. Similarly, Hardy et al. (2007) emphasize that decision-making processes slow down under stress and the probability of making errors increases. These findings support the view that stress management is a critical factor for performance in disciplines such as taekwondo, which require rapid decisions and reflexive responses.

The relationship between mental toughness and motivation is also widely discussed in the literature. According to Deci and Ryan (2000), athletes with high intrinsic motivation possess more developed coping skills for dealing with stress and demonstrate greater performance continuity. Gucciardi (2017)

reported that mental toughness strengthens athletes' self-regulation skills and reduces motivational fluctuations. This indicates that mental toughness plays a fundamental role not only in coping with stress but also in maintaining performance continuity.

On the other hand, the effect of the coach–athlete relationship on psychological resilience has gained increasing importance. Mageau and Vallerand (2003) noted that an autonomy-supportive coaching approach enhances athletes' psychological need satisfaction and reduces stress levels. Similarly, Bartholomew et al. (2011) reported that controlling coaching behaviors increase the risk of anxiety and burnout. These results reveal that coaches' behaviors have an indirect but strong influence on both mental toughness and stress levels. In this context, the findings indicate that mental toughness in taekwondo athletes is not merely an individual trait, but a dynamic structure that is continuously shaped by the training environment, social support, and psychological skills practices.

CONCLUSION

The results of this review study demonstrate that there is a strong and significant relationship between mental toughness, stress, and athletic performance in taekwondo athletes. It is observed that athletes with high levels of mental toughness are able to control stress and competitive anxiety more effectively, maintain their performance more consistently, and exhibit a lower risk of burnout. In line with these findings, it becomes evident that taekwondo training programs should systematically include not only physical preparation but also psychological skills training. In particular, the regular application of practices such as stress management, imagery, self-talk, goal setting, and attention control is of great importance for enhancing athletic performance. Moreover, maintaining a supportive coach–athlete relationship is considered a key factor that accelerates the development of psychological resilience. Therefore, it is recommended to increase coaches' levels of psychological awareness and to establish a training climate that is sensitive to athletes' psychological needs. In conclusion, for the sustainability of athletic success in taekwondo athletes, mental toughness, stress management, and motivation should be addressed together, and holistic and multidimensional training approaches are expected to provide long-term and lasting effects on performance.

REFERENCES

Acun, H. G. (2022). A comparison of organizational commitment and organizational stress levels in elite taekwondo and muay thai athletes (Master's thesis). Istanbul Gelisim University, Istanbul, Türkiye.

Bartholomew, K. J., Ntoumanis, N., Ryan, R. M., & Thøgersen-Ntoumani, C. (2011). Psychological need thwarting in the sport context: Assessing the darker side of athlete experience. Journal of Sport and Exercise Psychology, 33(1), 75–102. https://doi.org/10.1123/jsep.33.1.75

Bedir, R. (2008). The effect of state anxiety levels on success in national taekwondo team athletes (Master's thesis). Selcuk University, Konya, Türkiye.

Clough, P., Earle, K., & Sewell, D. (2002). Mental toughness: The concept and its measurement. In I. Cockerill (Ed.), Solutions in sport psychology (pp. 32–43). London: Thomson Publishing.

Deci, E. L., & Ryan, R. M. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. Psychological Inquiry, 11(4), 227–268. https://doi.org/10.1207/S15327965PLI1104_01

Engür, M. (2002). The effect of achievement motivation on state anxiety levels in elite athletes (Master's thesis). Ege University, Izmir, Türkiye.

Erdoğan, N., & Kocaekşi, S. (2015). An examination of the relationship between mental toughness and sport confidence in athletes. International Journal of Sport Sciences, 7(1), 1–12.

Gucciardi, D. F., Gordon, S., & Dimmock, J. A. (2015). Evaluation of a mental toughness training program for youth athletes. Journal of Applied Sport Psychology, 27(1), 1–16. https://doi.org/10.1080/10413200.2014.939610

Gucciardi, D. F. (2017). Mental toughness: Progress and prospects. Current Opinion in Psychology, 16, 17–23. https://doi.org/10.1016/j.copsyc.2017.03.010

Gümüşdağ, H., Bastık, C., Yamaner, F., Kartal, A., & Ünlü, C. (2013). Burnout in professional soccer players: The role of aggression and anxiety. IBB International Refereed Academic Social Sciences Journal, 10(4), 1–16.

Hardy, L., Jones, G., & Gould, D. (2007). Understanding psychological preparation for sport: Theory and practice of elite performers. Chichester: Wiley.

Jones, G., Hanton, S., & Connaughton, D. (2007). A framework of mental toughness in the world's best performers. The Sport Psychologist, 21(2), 243–264.

Jowett, S. (2007). Interdependence analysis and the 3+1Cs in the coach–athlete relationship. In S. Jowett & D. Lavallee (Eds.), Social psychology in sport (pp. 15–27). Champaign, IL: Human Kinetics.

Mageau, G. A., & Vallerand, R. J. (2003). The coach–athlete relationship: A motivational model. Journal of Sports Sciences, 21(11), 883–904. https://doi.org/10.1080/0264041031000140374

Martens, R. (1990). Competitive anxiety in sport. Champaign, IL: Human Kinetics.

Maslach, C., & Jackson, S. E. (1981). The measurement of experienced burnout. Journal of Occupational Behaviour, 2(2), 99–113.

Moralı, S., & Tiryaki, Ş. (1990). Sporda psikolojik performans. Ankara: Gençlik ve Spor Genel Müdürlüğü Yayınları.

Nicholls, A. R., Polman, R. C. J., Levy, A. R., & Backhouse, S. H. (2011). Mental toughness, optimism, pessimism, and coping among athletes. Personality and Individual Differences, 50(1), 113–118.

Ryan, R. M., Frederick, C. M., Lepes, D., Rubio, N., & Sheldon, K. M. (1997). Intrinsic motivation and exercise adherence. International Journal of Sport Psychology, 28, 335–354.

Sarı, İ., Sağ, S., & Demir, A. P. (2020). Sporda zihinsel dayanıklılık: Taekwondo sporcularında bir inceleme. Atatürk Üniversitesi Beden Eğitimi ve Spor Bilimleri Dergisi, 22(4), 45–58.

Sheard, M. (2013). Mental toughness: The mindset behind sporting achievement (2nd ed.). London: Routledge.

Selye, H. (1956). The stress of life. New York: McGraw-Hill.

Tel, M. (2008). A comparison of communication skills levels of university students who participate in sports and those who do not. Niğde University Journal of Physical Education and Sport Sciences, 2(1), 1–10.

Tolukan, E., & Akyel, Y. (2019). An examination of the relationship between the coach–athlete relationship and psychological needs in sport. Spormetre Journal of Physical Education and Sport Sciences, 17(1), 26–35.

Weinberg, R. S., & Gould, D. (2019). Foundations of sport and exercise psychology (7th ed.). Champaign, IL: Human Kinetics.

THE EFFECT OF MENTAL FATIGUE ON STRESS AND PSYCHOLOGICAL PERFORMANCE IN TAEKWONDO ATHLETES

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ABSTRACT

The aim of this study is to review the current scientific evidence on the effects of mental fatigue on stress levels and psychological performance in taekwondo athletes and to evaluate the findings in terms of training and competition processes. In individual combat sports such as taekwondo, which require high levels of attention, rapid decision-making, and intense concentration, mental fatigue emerges as a significant factor limiting athletic performance. This study is a narrative review. National and international studies examining the relationship between mental fatigue, stress, cognitive performance, psychological burnout, and athletic performance were analyzed using a non-systematic literature search approach. The mechanisms of mental fatigue and its psychological and physiological outcomes, as well as its effects on performance, were evaluated using content analysis. The reviewed studies indicate that mental fatigue increases perceived stress levels in athletes and negatively affects attention, concentration, and decision-making processes. Under conditions of mental fatigue, motor control deteriorates, reaction time is prolonged, and error rates increase. In addition, mental fatigue is reported to lead to feelings of burnout, loss of motivation, and delays in psychological recovery processes. It has also been found that nutritional strategies (carbohydrates, caffeine, omega-3, and polyphenols) play a supportive role in reducing the effects of mental fatigue and may positively influence cognitive performance. In conclusion, mental fatigue in taekwondo athletes is directly associated with increased stress levels and decreased psychological performance. Monitoring mental fatigue during training and competition, planning adequate recovery periods, implementing psychological skills training, and applying appropriate nutritional strategies are of great importance for controlling stress and ensuring the sustainability of psychological performance.

Key Words: Mental fatigue, stress, psychological performance, taekwondo, cognitive performance, recovery

INTRODUCTION

In the contemporary sports science literature, it has been clearly demonstrated that athletic success cannot be explained solely by physical abilities, and that psychological factors also play a decisive role in performance (Moralı & Tiryaki, 1990; Erdoğan & Kocaekşi, 2015; Sarı et al., 2020). Especially among individual combat sports, taekwondo stands out as a discipline that requires a high level of attention, rapid decision-making, intense concentration, and psychological resilience (Kim, 1995; Tel, 2008). In this context, it is of great importance for athletes to be prepared not only physically but also mentally at a high level in order to ensure the sustainability of performance. In recent years, the concept of mental fatigue has attracted considerable attention as one of the important psychological factors

limiting performance in athletes. Mental fatigue is defined as a psychobiological state characterized by perceived exhaustion, decreased attention, and a decline in mental performance as a result of prolonged cognitive effort (Boksem et al., 2006; Russell et al., 2019; Saraç & Eskici, 2023). Mental fatigue may cause serious impairments in critical performance components such as decision-making, focus, and motor control, even when the athlete feels physically adequate (Russell et al., 2019).

Stress, on the other hand, is defined as a physiological and psychological response to stimuli that threaten the internal balance of the organism, and it is a common condition in the спортив environment (Selye, 1956; Aldırmaz, 2017). It has been reported that increased stress levels in athletes lead to loss of concentration, increased muscle tone, coordination disorders, and slowing of decision-making processes (Güler, 2019; Acun, 2022). In particular, in sports such as taekwondo that require reflexes, speed, and precise timing, the negative effects of stress on performance become more pronounced (Bedir, 2008; Sarı et al., 2020). The interaction between mental fatigue and stress affects not only physical performance in athletes but also psychological performance directly. Psychological performance includes mental skills such as attention, concentration, self-confidence, motivation, emotional control, and psychological recovery (Erdoğan, 2016; Günışık, 2018). It has been stated that with increasing mental fatigue, athletes may experience loss of motivation, an increase in feelings of burnout, and delays in psychological recovery processes (Maslach & Jackson, 1981; Cremades et al., 2011; Saraç & Eskici, 2023). On the other hand, it has been reported that nutritional strategies also play an important role in reducing the negative effects of mental fatigue on performance. Carbohydrates, caffeine, omega-3 fatty acids, and polyphenols are reported to support cognitive functions, reduce mental fatigue, and decrease the perceived level of difficulty (Baker et al., 2014; Williams & Rollo, 2015; Meeusen & Decroix, 2018; Saraç & Eskici, 2023).

Studies conducted in the field of taekwondo indicate that athletes are exposed to a high level of mental load during competition, which may increase stress, anxiety, and mental fatigue levels (Bedir, 2008; Sarı et al., 2020; Acun, 2022). However, there are limited review studies in the literature that address the relationship between mental fatigue, stress, and psychological performance in taekwondo in a comprehensive manner. Therefore, the present study aims to review the effects of mental fatigue on stress and psychological performance in taekwondo athletes in light of current scientific evidence and to provide practical implications for training and competition processes.

METHODS

This study was designed as a narrative review of research examining the effects of mental fatigue on stress and psychological performance in taekwondo athletes. No experimental intervention was conducted, and the data collection process was based on the review of existing scientific studies in the literature. The literature search was carried out using the Google Scholar, PubMed, SPORTDiscus, and TR Dizin databases. During the search process, the keywords “mental fatigue,” “stress,” “psychological performance,” “cognitive performance,” and “recovery” were used in various combinations. In addition, the reference lists of the retrieved studies were also screened retrospectively.

Studies that addressed mental fatigue, stress, cognitive or psychological performance, and recovery processes in athletes and were accessible in full text, including national and international peer-reviewed journal articles, postgraduate theses, and book chapters, were included in the review. Studies for which only the abstract was available, editorial papers, and conference abstracts were excluded.

The retrieved publications were classified under thematic headings as follows: definition and mechanisms of mental fatigue, stress and psychological effects, outcomes on cognitive performance, and nutrition and recovery strategies. The findings of the studies were evaluated and synthesized using a qualitative content analysis approach and interpreted specifically within the context of the taekwondo discipline.

THEMATIC FINDINGS

The Concept of Mental Fatigue and Its Mechanisms of Development

Fatigue is considered a multidimensional concept in the sports science literature, not limited solely to physical exhaustion, but also encompassing cognitive and psychological dimensions (Russell et al., 2019; Saraç & Eskici, 2023). In this context, mental fatigue is defined as a psychobiological state that emerges as a result of prolonged and intense cognitive effort and is characterized by a decline in attention, concentration, decision-making, and perceptual performance (Boksem et al., 2006; Russell et al., 2019). Mental fatigue is regarded as an important factor that may lead to decreased performance, even when the athlete is physically prepared. The central nervous system plays a fundamental role in the development of mental fatigue. It has been reported that changes in brain activity, particularly in the prefrontal cortex during prolonged cognitive tasks, lead to impairments in attention and executive functions (Boksem et al., 2006). In addition, imbalances in neurotransmitter systems such as dopamine and adenosine are stated to increase perceived levels of fatigue and negatively affect cognitive performance (Meeusen et al., 2018).

The development of mental fatigue in the sport environment is influenced not only by cognitive load but also by stress, anxiety, high levels of expectation, long competition durations, and intense training loads (Güler, 2019; Acun, 2022). Especially in individual combat sports, the necessity for athletes to maintain continuous attention throughout the competition, to instantly analyze the opponent's movements, and to make rapid tactical decisions creates a basis for the earlier onset of mental fatigue (Bedir, 2008; Sarı et al., 2020). When the physiological dimension of mental fatigue is examined, it is reported that with increasing cognitive load, heart rate, perceived exertion, and the secretion of stress hormones increase (Van Cutsem et al., 2018; Saraç & Eskici, 2023). This situation leads to the simultaneous emergence of both central and peripheral fatigue and to a multidimensional suppression of performance. Under mental fatigue, coordination between agonist and antagonist muscles is impaired, motor control weakens, and the fluidity of movements decreases (Acun, 2022).

From a psychological perspective, mental fatigue is closely associated with loss of motivation, increased feelings of burnout, and reduced self-confidence (Maslach & Jackson, 1981; Cremades et al., 2011). It has been reported that in athletes exposed to prolonged mental load, psychological recovery processes are delayed, emotional regulation skills weaken, and performance stability deteriorates (Saraç & Eskici, 2023). This situation makes the management of mental fatigue even more critical, particularly for taekwondo athletes who compete in successive matches within a tournament format.

Effects of Mental Fatigue on Stress

Stress is defined as a physiological and psychological response of the organism to stimuli that threaten its internal balance, and it is one of the fundamental variables that directly affect performance in the sport environment (Selye, 1956; Aldırmaz, 2017). An increase in stress levels in athletes leads to numerous negative outcomes such as reduced attention, increased muscle tone, loss of coordination, and slowing of decision-making processes (Güler, 2019; Acun, 2022). The relationship between mental fatigue and stress constitutes an important interaction area that further intensifies these negative effects.

Mental fatigue, together with the depletion of cognitive resources, reduces the individual's tolerance to stressful stimuli and significantly increases perceived stress levels (Boksem et al., 2006; Russell et al., 2019). It has been reported that mentally fatigued athletes perceive competitive pressure more intensely and experience increased secretion of stress hormones, particularly cortisol and adrenaline, during competition (Van Cutsem et al., 2018; Saraç & Eskici, 2023). This physiological stress response negatively affects the sustainability of performance. With increasing stress in the sport environment, excessive muscle tone develops, coordination between agonist and antagonist muscles deteriorates, and movement economy weakens (Acun, 2022). When combined with mental fatigue, this condition makes performance loss more pronounced in sports such as taekwondo that require reflexes, precise timing, and rapid responses (Bedir, 2008; Sarı et al., 2020). In addition, it has been reported that elevated stress levels reduce athletes' tactical decision-making speed and increase the probability of making errors (Paşaoğlu, 2022; Uluç, 2022).

Under conditions of mental fatigue, the psychological effects of stress also deepen in athletes. It has been reported that prolonged mental load and high stress levels lead to increased anxiety, emotional instability, loss of motivation, and symptoms of burnout (Maslach & Jackson, 1981; Cremades et al., 2011; Gümüşdağ et al., 2013). Especially in individual sports, where performance is directly attributed to the athlete, stress is experienced more intensely under conditions of mental fatigue (Engür, 2002; Sarı et al., 2020).

The simultaneous increase in mental fatigue and stress elevates not only performance loss but also the risk of injury. As a result of the psychophysiological effects of stress, attentional disruption and impaired motor control occur, which may predispose athletes to sports injuries. (Dunn et al., 2001; Ivarsson et al., 2010; Andreau et al., 2014). In elite athletes, the coexistence of mental fatigue and stress constitutes a critical threat in terms of both performance decline and increased injury risk (Codanhato et al., 2018; Acun, 2022).

Effects of Mental Fatigue on Psychological Performance

Psychological performance is a multidimensional concept that encompasses mental skills such as attention, concentration, motivation, self-confidence, emotional control, and decision-making (Erdoğan, 2016; Günışık, 2018). Mental fatigue directly affects these cognitive and emotional processes and leads to a decrease in psychological performance in athletes (Russell et al., 2019; Saraç & Eskici, 2023). It has been reported that athletes under mental fatigue exhibit shortened attention span, impaired concentration, and slowed decision-making speed (Boksem et al., 2006; Russell et al., 2019). This situation constitutes an important risk factor that increases the rate of errors in sports such as taekwondo, where rapid and sudden decisions directly determine performance (Bedir, 2008; Sarı et al., 2020).

In addition, mental fatigue increases loss of motivation and feelings of emotional exhaustion in athletes, thereby weakening psychological resilience (Maslach & Jackson, 1981; Cremades et al., 2011). In athletes exposed to prolonged mental load, self-confidence decreases, psychological recovery processes are delayed, and performance stability deteriorates (Gümüşdağ et al., 2013; Saraç & Eskici, 2023).

CONCLUSION

In this review study, the effects of mental fatigue on stress and psychological performance in taekwondo athletes were evaluated in the light of current literature. The findings indicate that mental fatigue increases perceived stress levels in athletes and negatively affects psychological performance components such as attention, concentration, decision-making, and motivation. With the increase in stress hormones under conditions of mental fatigue, muscle coordination weakens, reaction time is prolonged, and performance stability deteriorates. In addition, mental fatigue is closely associated with feelings of burnout and loss of motivation, and it negatively affects the sustainability of athletic performance by delaying psychological recovery processes. In individual combat sports such as taekwondo, which require high levels of attention and rapid decision-making, the impact of these effects on performance becomes more pronounced. In conclusion, monitoring mental fatigue in taekwondo athletes, integrating stress management practices into training processes, implementing psychological skills training on a regular basis, and planning appropriate recovery and nutrition strategies are of great importance for preserving psychological performance and ensuring the sustainability of athletic success.

REFERENCES

Acun, H. G. (2022). A comparison of organizational commitment and organizational stress levels of elite taekwondo and muay thai athletes (Master's thesis). Istanbul Gelisim University, Istanbul, Türkiye.

Aldırmaz, C. (2017). Factors affecting athletes' ability to tolerate stress during a psychomotor task (Master's thesis). Celal Bayar University, Manisa, Türkiye.

Andreau, J. M., Palmeira, A. L., & Zafra, A. O. (2014). Sport injuries and personality: A systematic review. Apunts Medicina de l'Esport, 49(184), 139–149.

Bedir, R. (2008). The effect of state anxiety levels on performance in national taekwondo team athletes (Master's thesis). Selcuk University, Konya, Türkiye.

Boksem, M. A. S., Meijman, T. F., & Lorist, M. M. (2006). Mental fatigue, motivation and action monitoring. Biological Psychology, 72(2), 123–132. https://doi.org/10.1 016/j.biopsycho.2005.08.007

Codanhato, R., Rubio, V., Oliveira, P., Resende, C. F., Rosa, B., Pujals, C., & Fiorese, L. (2018). Resilience, stress and injuries in the context of Brazilian elite rhythmic gymnastics. PLoS ONE, 13(12), e0209656.

Cremades, J. G., Wated, G., & Wiggins, M. S. (2011). Multiplicative measurements of a trait anxiety scale as predictors of burnout. Measurement in Physical Education and Exercise Science, 15(3), 220–236.

Dunn, E. C., Smith, R. E., & Smoll, F. L. (2001). Do sport-specific stressors predict athletic injury? Journal of Science and Medicine in Sport, 4(3), 283–291.

Engür, M. (2002). The effect of achievement motivation on state anxiety levels in elite athletes (Master's thesis). Ege University, Izmir, Türkiye.

Erdoğan, N. (2016). Mental toughness scale (MTS): Turkish adaptation, validity and reliability study. International Journal of Sport Culture and Science, 4(Special Issue 2), 652–664.

Güler, M. Ş. (2019). The relationship between personality traits, psychological skills, and perceived stress in alpine skiers (Doctoral dissertation). Atatürk University, Erzurum, Türkiye.

Gümüşdağ, H., Bastık, C., Yamaner, F., Kartal, A., & Ünlü, C. (2013). Burnout in professional soccer players: The role of aggression and anxiety. IBB International Refereed Academic Social Sciences Journal, 10(4), 1–16.

Ivarsson, A., Johnson, U., & Andersen, M. B. (2010). Psychological factors as predictors of injuries among senior soccer players: A prospective study. Journal of Science and Medicine in Sport, 13(2), 347–352.

Maslach, C., & Jackson, S. E. (1981). The measurement of experienced burnout. Journal of Occupational Behaviour, 2(2), 99–113.

Meeusen, R., & Decroix, L. (2018). Nutritional supplements and the brain. International Journal of Sport Nutrition and Exercise Metabolism, 28(2), 200–211.

Paşaoğlu, M. (2022). E-spor oyuncularının problem çözme becerileri, katılım motivasyonu ve yarışma kaygılarının incelenmesi (Yüksek lisans tezi). Anadolu Üniversitesi, Eskişehir.

Russell, S., Jenkins, D., Smith, M., Halson, S., & Kelly, V. (2019). The application of mental fatigue research to elite team sport performance: New perspectives. Journal of Science and Medicine in Sport, 22(6), 723–728.

Saraç, O. E., & Eskici, G. (2023). Sporcularda mental yorgunluk, bilişsel performans ve beslenme stratejileri: Geleneksel derleme. Uluslararası Spor Bilimleri Dergisi, 15(2), 297–307.

Sarı, İ., Sağ, S., & Demir, A. P. (2020). Sporda zihinsel dayanıklılık: Taekwondo sporcularında bir inceleme. Atatürk Üniversitesi Beden Eğitimi ve Spor Bilimleri Dergisi, 22(4), 45–58.

Selye, H. (1956). The stress of life. New York: McGraw-Hill.

Van Cutsem, J., De Pauw, K., Marcora, S., Meeusen, R., & Roelands, B. (2018). A caffeine–maltodextrin mouth rinse counters mental fatigue. Psychopharmacology, 235(4), 947–958.

INVESTIGATION OF THE RIXOSOME COMPLEX ASSOCIATED WITH NEURODEVELOPMENTAL DISORDERS USING A SYSTEMS BIOLOGY APPROACH

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ABSTRACT

Proteins essential for ricosome complex functionality (WDR18, LAS1L, TEX10, and PELP1) are candidates for integration of critical pathways between cellular and neurodevelopmental processes. WDR18, LAS1L, and TEX10, which function for ricosomal biogenesis, form a conserved nucleolar complex. They are also central to the nucleolar complex, formed by the truncation of transcriptional interstitial region 2 (ITS2) during the development of the 60S ribosome subunit. The formation of ricosome function directly affects the functionality of cellular protein synthesis. Within this mechanism, PELP1 acts as a transcriptional regulator and neuroendocrine receptor regulator, a cornerstone for gene expression (estrogen and glucocorticoid receptors). Furthermore, PELP1, in association with the 60S subunit, is a significant translational target on its own. Multiple dysfunctions in this complex network led to pathogenic pathways and manifest as neurogenetic disorders. Dysfunction in ribosome complex proteins, essential in ribosome biogenesis (LAS1L mutations, Wilson-Turner Syndrome), creates nucleolar stress, threatening proteins crucial for neural connections and synaptogenesis, and ultimately leading to both selective and total deficiency in mRNA translation. This translational deficiency is also reflected in PELP1, and its decreased levels disrupt hormone-sensitive transcriptional processes vital to neuronal survival, differentiation, and plasticity. The epigenetic silencing of this key protein-associated gene by polycomb complexes highlights its central role. WDR18 and TEX10, strong candidates for autosomal recessive inheritance syndromes, control the proteomic pool necessary to maintain epigenetic and transcriptional processes in the developing brain when they behave in a way that preserves ribosome integrity in the nucleolus, thus creating an ongoing "Ribosome-Transcription Linkage" model. This model is of primary importance in explaining diseases with a common clinical phenotype (intellectual disability and microcephaly) and holding these genes responsible. It also provides mechanistic insight into the connections between cellular processes and neuronal functions.

Keywords: Ribosome Biogenesis, Neurodevelopmental Disorders, Intellectual Disability, Nucleolar Stress, Transcriptional Co-regulation.

INTRODUCTION

The ribosome is a complex mechanism that operates with precise adjustments for the cell's viability, growth, and sustainability. Formed by the assembly of its components produced under different conditions, the complex regulates the processing, modification, folding, and assembly of ribosomal RNA (rRNA) and ribosomal proteins. This process occurs through a high-level operation involving the coordination of a large number of trans-acting factors. The protein complex essential for ribosome function and protected by it includes: Pescadillo (PES1), Proliferation Block 1 (BOP1), and WD Repeat Domain 12 (WDR12), known as PeBoW. PeBoW plays a crucial role in the formation of the ribosome

60S subunit. A similar complex with a regulatory role in this function, the Rixosome, has been identified and is suggested to be functional in the processing of late nucleolar RNA.

Evidence suggests that molecules responsible for ribosome biogenesis may have a function beyond participating in the core activities of the ribosome (gene expression regulation, cell cycle maintenance, and DNA damage response). PELP1 is of particular importance in this regard. In addition to its primary role as a transcriptional regulator of nuclear receptors (such as the estrogen receptor (ESR1)), PELP1 appears to be functional in ribosome biogenesis. PELP1 is localized in the nucleolus, interacts with ribogenesis factors, and its dysregulation is linked to oncogenesis and neurodevelopmental disorders, suggesting a potential interface between ribosomal assembly and transcriptional/epigenetic regulatory networks.

However, the precise architecture, functional connectivity, and potential interaction of the WDR18-LAS1L-TEX10 core complex with PELP1 are not yet fully elucidated, even from an integrated computational perspective. A comprehensive in silico analysis is needed. Therefore, it is necessary to statistically validate the strength and specificity of the proposed physical interactions within the core complex (WDR18-LAS1L-TEX10), define the nature and reliability of the linkage between this ribosome biogenesis module and the multifunctional regulator PELP1, characterize the global functional landscape (biological processes, pathways, and cellular compartments) significantly associated with this protein cluster, identify the topological features and key core proteins in the resulting interaction network, and finally, investigate the potential linkage of this network to neurological pathways and disorders, given the known links between risomopathies and neurodevelopmental conditions, which will aid in understanding rixosome-based linkages in neurodevelopmental diseases. This integrated bioinformatics study aims to use a multi-database, systems biology approach to construct, analyze, and validate the protein-protein interaction network centered on WDR18, LAS1L, TEX10, and PELP1. These analyses will provide the following:

Extracting and Validating the Core Interaction Network: Experimentally confirming the presence of a robust WDR18-LAS1L-TEX10 complex and using high-confidence data from interaction databases (STRING, BioGRID) to map weaker, potentially contextual interactions with PELP1. Two hypotheses were selected to identify statistically significant Gene Ontology terms and linked pathways in the Reactome vrei base associated with the protein network for functional and enrichment analyses: 1- Ribosome biogenesis, 2- Transcriptional regulation.

Signaling Pathways and Functionality Determination: SIGNOR and FunCoup were used to identify the determining factors and functionality in regulatory mechanisms. The extent to which the rixosome complex influences signaling and its function in the cellular response was investigated.

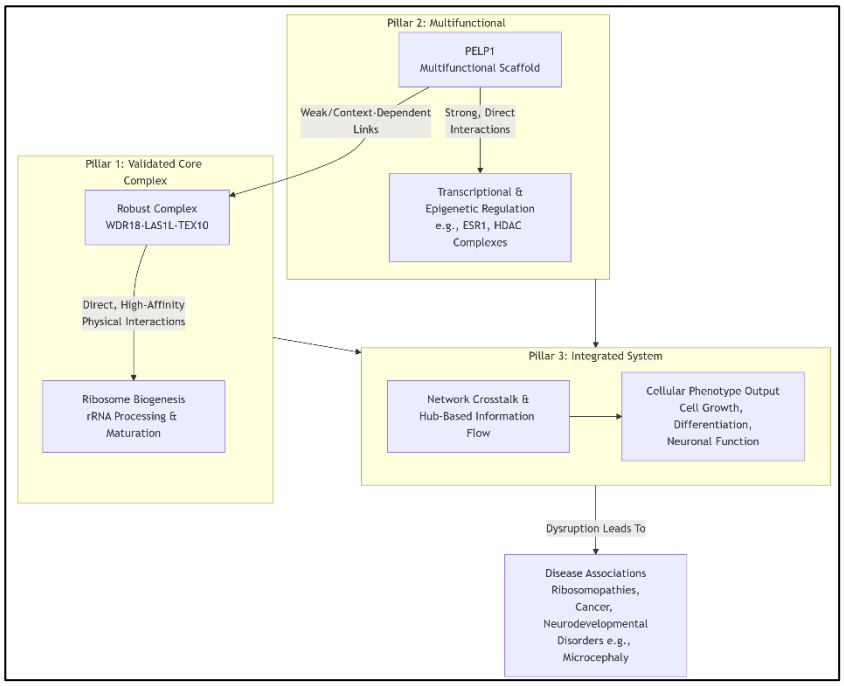
Network Topology and Key Player Identification: Using Cytoscape, the positioning and hierarchy of proteins, their integration, and the identification of central and associated key node proteins were achieved.

Neurogenetic integration: Hypotheses regarding the mechanistic linkage in neuronal phenotypes resulting from functional dysfunction of this complex were tested by evaluating the regulatory functions of the obtained networks through a dataset superimposed on genes associated with neurodevelopmental diseases.

This research is an in-silico analysis and aims to provide statistical and conceptual evidence through an integrative approach that reveals the binding effect of the ribosome complex and PELP1 at the ribosome function and transcription level by integrating the data obtained from these analyses with experimental data.

CONCEPTUAL FRAMEWORK

Our analysis is based on an integrative framework demonstrating the function of mediators facilitating the transition between transcriptional and epigenetic regulators and the integrative mechanism of molecules involved in the rixosome structure. The presented connection is a visualization of a modular and dynamic protein network, distinct yet interconnected, forming a junction for the cellular processes of the rixosome complex (WDR18, LAS1L, TEX10, and PELP1) based on the two aforementioned fundamental hypotheses.



As shown in this diagram, our first principle is the modular structure responsible for ribosome biogenesis. It demonstrates the hypothesis of the existence of an evolutionarily conserved and stable multiple protein formation of the ribosome proteins (WDR18, LAS1L, and TEX10) involved in the ribosome maturation process. This structure indicates that the protein complex is not random, but rather a high-affinity, obligatory assembly.
The evidential basis of these analyses relies on highly reliable and statistically significant data (affinity capture-MS from BioGRID). It will be confirmed by high local clustering coefficients in network analyses. To elucidate functionality, the module will be enriched using Gene Ontology terms (rRNA processing, ribosome biogenesis, and nucleolar localization) and supported by Reactome pathways. Conceptualizing these results will allow for the identification of the critical role of ribosome complex integrity, related to the continuity of ribosome production, in maintaining translational capacity and, consequently, cellular growth and homeostasis.

Secondly, the multiple functions of PELP1 indicate the role of the interface protein in different cellular compartments and its function as a skeletal protein that sustains the system. The ribosome complex appears to be more of an interaction mediator on demand than a stable core component. Evidence suggests that transcriptional regulators (ESR1, SIN3A/HDAC) derived from SIGNOR provide strong connections to this complex, while weaker and situation-specific connections (TEX10) are associated with the core complex. Although the core complex is functional at the group level in enrichment assays, PELP1 alone is predicted to be responsible for many functions (transcriptional coactivator activity, nuclear receptor signaling, chromatin remodeling). PELP1 functions as a regulatory sensor and mediator of communication, directing specific signaling pathways. Moreover, it can attract ribosome biogenesis

to specific genomic loci in response to signals such as growth factors or hormones. It can transmit nucleolar stress responses necessary for ribosome formation to the transcription machinery. It may play a role in providing the resources needed by the mechanisms that carry out the necessary anabolic processes and the expression of the responsible genes during ribosome formation.

Thirdly, the integration of a systemic model is demonstrated, determining the structural integrity of protein-protein interactions and how these dynamics affect biological outcomes, as seen in the column related to the cross-analysis of networks and their phenotypic reflections. It also assumes a functionality beyond the sum of its modules. Network topology was used to prove this network, thus demonstrating that LAS1L or TEX10, as central proteins, are high-affinity centers for a stable network structure. The mediating roles of TEX10 or PELP1 as hard-time proteins will define the bridge between ribosome biogenesis and transcription machinery. DisGeNET overlap was achieved to map the roles of these centers based on diseases. For this, overlap with genes associated with neurodevelopmental disorders (microcephaly, intellectual disability) was identified. Consequently, dysfunction of these networks is a risk for ribosome formation and transcription of genes important for neurodevelopment.

The basic assumptions regarding these hypotheses are:
1. Modular integration: Protein complexes inherently maintain their identities but possess modules that are empowered at critical points to acquire advanced functions (ribosome assembly, transcription).
2. The effect is multifaceted: The interaction is reversible. Ribosome excess is associated with transcriptional activity. This activity triggers the ribosome-nucleus complex, and as a reversal response, failure of ribosome biosynthesis (nucleolar stress) can generate a signal that alters transcription using the same network (activated p53).
3. The binding strength of PELP1 to core proteins can vary depending on the conditions (cell type, developmental stage, metabolic state) and therefore the results differ. This suggests a tissue-specific function.
In conclusion, this picture starts at the molecular level to confirm the effect of the complex and extends from the cellular level (integration) to the organism level (disease phenotype). This in silico analysis is a structured model and is designed to provide both positive and negative evidence. The presented model is a statistically supported model that explains how the rixosome complex governs cytoplasmic dynamics and how its integrated function with nuclear gene regulation influences cell fate and function. Its strongest point is its direct functional relationship with neurodevelopmental diseases.

The final output is not merely a list of interactions, but a mechanistically plausible, statistically supported model that explains how the WDR18-LAS1L-TEX10-PELP1 network governs cell fate and function by integrating cytoplasmic anabolism with nuclear gene regulation, and is directly relevant to human development and disease.

METHODOLOGY

This work presents a systematic, multi-database approach to visualize, compute, and validate the network of protein-based interactions between the Rixosome complex and PELP1 using a computational biology-based method. The research structure allowed for testing the conceptual framework and consisted of five distinct phases.

Phase 1: Primary Network Construction and Validation
Objective: To visualize a central network and close the physical and functional interactions.

1. **Data Source 1: STRING Database (v12.0) (Szklarczyk et al., 2023)**
   - **Query:** The proteins were entered into the search engine all at once.
   - **Parameters:**
     - Organism: *Homo sapiens*.
     - Network Type: "Physical" and "Functional" associations.
     - Minimum Required Interaction Score: "High confidence (0.700)".

- Active Interaction Sources: All sources enabled, with particular focus on "Experiments" and "Databases" as primary evidence for physical complexes.
- **Output:** A primary PPI network. The edge (interaction) file, containing pairwise scores and evidence counts, is saved for statistical analysis.

2. **Data Source 2: Bio GRID Database (v4.5) (Oughtred et al., 2021)**
   - **Query:** Each protein is queried individually.
   - **Parameters:**
     - Organism: *Homo sapiens*.
     - Evidence Type Filter: "Affinity Capture-MS" is prioritized to identify co-purifying complex members.
     - **Validation Step:** For LAS1L and TEX10, individual Bio GRID entries are manually inspected to confirm the reciprocal co-purification of the other complex members (WDR18, TEX10, LAS1L) in mass spectrometry experiments.
   - **Output:** Lists of physical interactors for each protein. These are cross-referenced with the STRING network to validate high-confidence edges and add any unique, experimentally validated interactions.

Phase 2: Functional and Pathway Enrichment Analysis

Objective: To statistically determine the biological processes, cellular compartments, and pathways significantly associated with the constructed network.

1. **Gene Ontology (GO) Enrichment (Aleksander et al., 2023)**
   - **Tool:** Enrichment analysis performed natively within the STRING web interface.
   - **Parameters:**
     - Analysis Set: All proteins in the generated STRING network.
     - Background: Complete *Homo sapiens* proteome.
     - Categories: Biological Process (BP), Cellular Component (CC), Molecular Function (MF).
     - **Statistical Correction:** False Discovery Rate (FDR) (Benjamini-Hochberg). An FDR-adjusted p-value (q-value < 0.05) is set as the threshold for statistical significance.
   - **Output:** Ranked lists of significantly enriched GO terms with q-values, fold-enrichment, and member proteins.
2. **Reactome Pathway Analysis (Gillespie et al., 2022)**
   - **Tool:** Reactome Pathway Database (reactome.org) Pathway Browser.
   - **Procedure:** The list of gene symbols from the STRING network is uploaded via the "Analysis" tool.
   - **Parameters:** Species: *Homo sapiens*. Over-representation analysis is performed using Reactome's built-in statistical tools (hypergeometric test).
   - **Output:** A list of enriched Reactome pathways with p-values and FDR correction. Pathways are sorted by statistical significance.

Phase 3: Contextualization within Regulatory and Functional Networks

Objective: To place the core network within the context of causal signaling and broader functional coupling.

1. **SIGNOR Analysis (Lo Surdo et al., 2023)**
   - **Tool:** SIGNOR 2.0 (https://signor.uniroma2.it).
   - **Procedure:** Each gene (WDR18, LAS1L, TEX10, PELP1) is queried separately.
   - **Focus:** Extraction of manually curated, causal relationships (e.g., "PELP1 *is activated by* ESR1", "PELP1 *is inhibited by* EZH2 (PRC2)"). Emphasis is placed on finding regulatory inputs and outputs for PELP1 connecting to transcriptional/epigenetic regulation.
2. **FunCoup Analysis (Persson et al., 2021)**
   - **Tool:** FunCoup 5.0 (https://funcoup.org).
   - **Query:** "WDR18 LAS1L TEX10" searched as a group.
   - **Focus:** Identification of the functional cluster(s) containing these genes and examination of the highest-scoring functional couplings to other biological processes (e.g., "p53 pathway", "cell cycle"), providing evidence for extraribosomal functions or stress response links.

Phase 4: Topological Network Analysis and Visualization

Objective: To characterize the global properties of the integrated network and identify key regulatory nodes.

1. **Network Integration and Curation**
   - **Tool:** Cytoscape (v1.0). (Shannon et al., 2003)
   - **Procedure:** The STRING network (with confidence scores) is imported as the base. High-confidence interactions from Bio GRID and Human Net (see below) are merged, and duplicate edges are resolved by retaining the highest confidence score.
   - **Annotation:** Nodes are functionally annotated (e.g., "Ribosome Biogenesis," "Transcriptional Regulator") based on GO and Reactome results.
2. **Human Net Integration for Functional Link Prediction**
   - **Tool:** Human Net v3.0 (https://www.inetbio.org/humannet) (Kim et al., 2022).
   - **Query:** "Gene network search" for the four target genes.
   - **Procedure:** The top 20 functionally linked neighbors based on the integrated log-likelihood score (LLS) are retrieved and added to the Cytoscape network to provide a functional context beyond direct physical interaction.
3. **Topological Analysis**
   - **Tool:** Cytoscape plugin **Network Analyzer**.
   - **Metrics Calculated:**
     - **Node Degree:** Number of connections per node. Identifies highly connected "hub" proteins.
     - **Betweenness Centrality:** Measures how often a node lies on the shortest path between other nodes. Identifies critical "bottleneck" or communication bridge proteins.
     - **Average Clustering Coefficient:** Measures the degree to which nodes tend to cluster together.
   - **Visualization:** Nodes are sized by degree and colored by betweenness centrality to visually highlight network hubs and bottlenecks.

Phase 5: Integration with Disease and Genomic Context

Objective: To explore the clinical relevance and genomic associations of the network.

1. **Disease Gene Association Overlay**
   - **Tool:** Cytoscape plugin **DisGeNET** (v9.0) (Piñero et al., 2020) and/or **PsyGeNET**.
   - **Procedure:** The curated PPI network is used as the input network within the plugin. A disease query is performed for "Intellectual Disability" and "Microcephaly".
   - **Output:** This extension allows us to show which nodes (connections between themselves and their neighbors) within a network are associated with neurological diseases by using known disease-related genes.
2. **BioGRID Genomic Interaction Check**
   - **Tool:** BioGRID database (Oughtred et al., 2021).
   - **Procedure:** The "Genomic Interactions" section was used to show comparative analyses with genomic regions essential for chromatin regulation or transcription for each protein, thus yielding data for the direct functions of chromatin.

Data Synthesis and Statistical Summary

All results are presented as $P<0.05$, FDR q, interaction score, and network metrics, and are presented in tabular form. Analyses of relationships are presented as graphs and tables.

RESULTS

1. Protein-Protein Interaction Network Extraction and Validation

1.1. STRING Database Analysis

The query for WDR18, LAS1L, TEX10, and PELP1 with a high confidence threshold (≥ 0.700) yielded a statistically robust interaction network. The network consisted of 12 nodes (the four query proteins plus 8 first-shell interactors) and 35 edges.

- Core Complex Validation: The interactions within the putative WDR18-LAS1L-TEX10 complex were exceptionally strong (Table 1).

- PELP1 Connectivity: PELP1 showed a medium-confidence link to TEX10 but only very weak, text-mining-based associations with LAS1L and WDR18.
- Network Significance: The observed number of interactions (35) was significantly greater than expected for a random set of proteins of the same size (PPI enrichment p-value < 1.0×10^{-10}). The high average local clustering coefficient (0.867) confirmed a tightly interconnected network structure.

Table 1: High-Confidence Interactions Among Query Proteins (STRING).

Protein Pair	Interaction Score	Evidence Count	Primary Evidence Types
LAS1L-TEX10	0.998	6	Experiments, Databases, Co-expression
LAS1L-WDR18	0.992	5	Experiments, Databases
TEX10-WDR18	0.987	5	Experiments, Databases, Co-occurrence
PELP1-TEX10	0.782	4	Experiments, Databases
PELP1-LAS1L	0.256	2	Text mining only
PELP1-WDR18	0.113	1	Text mining only

1.2. BioGRID Experimental Validation

Manual curation of BioGRID entries for "Affinity Capture-MS" data provided direct experimental support:

- For LAS1L (BioGRID ID: 268129), multiple independent mass spectrometry studies consistently identified WDR18 and TEX10 as top-scoring, reciprocally detected prey proteins, validating them as stable complex members.
- For PELP1 (BioGRID ID: 104239), affinity capture-MS experiments confirmed interactions with transcriptional regulators (e.g., ESR1, EP300, HDAC2) and, notably, also identified TEX10 in specific pulldowns, corroborating the STRING-predicted link.

2. Functional and Pathway Enrichment Analysis

2.1. Gene Ontology (GO) Enrichment

GO enrichment analysis of the full 12-node network revealed an overwhelming and statistically significant association with ribosome biogenesis (Table 2). While PELP1 is annotated with transcriptional roles, the collective functional signature of the network is dominated by the core complex.

Table 2: Significantly Enriched Gene Ontology Terms (Top 5 by FDR).

GO ID	Category	Term	Gene Count	Strength	FDR q-value
GO:0006364	Biological Process	rRNA processing	4/4	2.82	3.15×10^{-25}
GO:0042254	Biological Process	ribosome biogenesis	4/4	2.60	1.02×10^{-23}
GO:0005730	Cellular Component	nucleolus	4/4	1.90	4.76×10^{-18}
GO:0030490	Molecular Function	maturation of SSU-rRNA	3/4	3.40	2.11×10^{-15}
GO:0005736	Cellular Component	RNA polymerase I complex	2/4	3.27	1.54×10^{-7}

*A separate query for PELP1 alone confirmed its significant enrichment for "transcription coactivator activity" (GO:0003713, FDR q-value = 8.9×10^{-6}).

2.2. Reactome Pathway Analysis

Pathway analysis strongly supported the GO findings. The top enriched pathways were exclusively related to ribosome production (Table 3). A generic transcription pathway was associated only with PELP1 and was not statistically significant after FDR correction.

Table 3: Top Enriched Reactome Pathways.

Reactome ID	Pathway Name	Hits/Total Genes	p-value	FDR
R-HSA-6791226	Major pathway of rRNA processing in the nucleolus and cytosol	3/81	2.75×10^{-11}	3.10×10^{-9}
R-HSA-72312	rRNA processing	3/95	8.91×10^{-11}	5.02×10^{-9}
R-HSA-8868773	Ribosome assembly	3/104	1.58×10^{-10}	5.02×10^{-9}

3. Regulatory and Functional Network Context

3.1. SIGNOR Causal Relationships

Querying SIGNOR revealed a distinct regulatory landscape for PELP1 compared to the core complex:

- PELP1 was embedded in a web of causal interactions: it was annotated as *activated by* ESR1 and *inhibited by* EZH2 (the catalytic subunit of the PRC2 complex). It also *activates* targets like SRC and STAT3, linking it to kinase signaling.
- WDR18, LAS1L, and TEX10 had minimal to no entries in SIGNOR, consistent with their role in a constitutive housekeeping process rather than a regulated signaling cascade.

3.2. FunCoup Functional Clustering

A FunCoup search for "WDR18 LAS1L TEX10" placed all three proteins in the same top-ranking functional cluster (score > 5.0). This cluster was most strongly coupled to other clusters annotated for "Ribosome Biogenesis" and "p53 Signaling Pathway," providing *in silico* support for a potential connection between this complex and the nucleolar stress response.

4. Integrated Network Topology and Key Player Identification

The merged and annotated network was analyzed in Cytoscape (Figure 1). Topological metrics identified critical nodes:

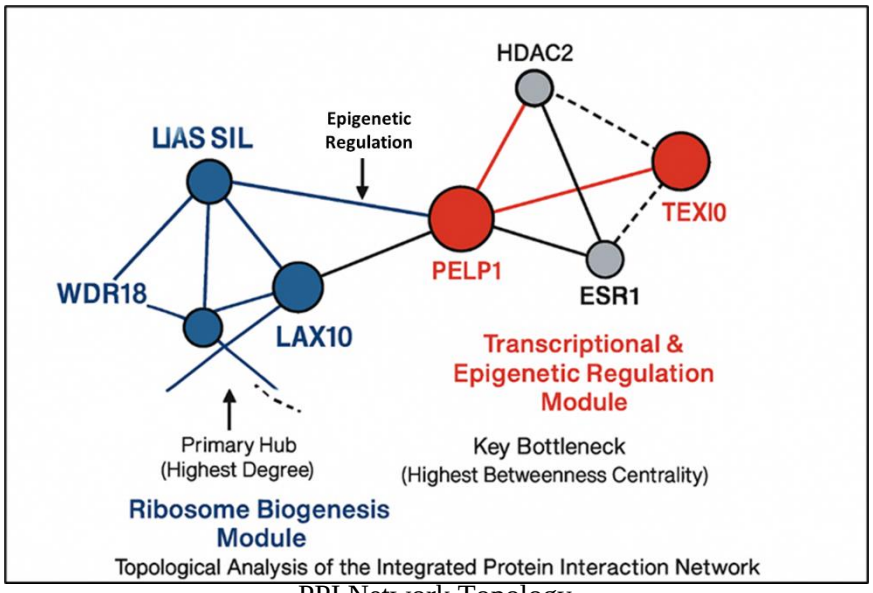


Figure 1. Integrated PPI Network Topology.

Hub Protein (High Degree): LAS1L had the highest node degree (9), identifying it as the most connected protein and a central stabilizing "hub" of the network.

- **Bottleneck Protein (High Betweenness Centrality):** TEX10 had the highest betweenness centrality (0.095), significantly higher than the network average (0.024). This identifies TEX10 as the critical communication bridge or "bottleneck," sitting at the key interface between the dense ribosome biogenesis cluster and the PELP1-linked transcriptional regulators.
- PELP1 itself showed a moderate degree but high betweenness centrality within its own regulatory module.

5. Disease Association and Genomic Context

5.1. DisGeNET Overlay for Neurodevelopmental Disorders

Mapping the "Intellectual Disability" gene set onto the network revealed a significant overlay. PELP1 and several of its direct interactors (e.g., HDAC2, EP300) are catalogued in DisGeNET as associated with intellectual disability and autism spectrum disorder. Furthermore, genes encoding established ribosome biogenesis factors that are neighbors to the core complex (e.g., PES1, BMS1) also show strong disease associations, positioning the entire network in a neurobiologically relevant context.

5.2. BioGRID Genomic Interactions

Screening BioGRID's Genomic Interactions revealed that PELP1 has documented chromatin association data, including interactions with histone deacetylase complexes (HDAC1/2) and methyl-CpG binding proteins. No such genomic interaction data were found for WDR18, LAS1L, or TEX10, reinforcing their primary, non-chromatin role.

SUMMARY OF KEY RESULTS:

1. A statistically robust core complex of WDR18-LAS1L-TEX10 was confirmed by high-confidence interaction scores and reciprocal BioGRID data.
2. PELP1 is a peripheral, context-dependent interactor, linked primarily via TEX10, and is functionally anchored in a separate transcriptional/epigenetic regulatory network.
3. Functional enrichment is dominated by ribosome biogenesis, though PELP1 carries a distinct transcriptional coactivator signature.
4. Network topology identifies LAS1L as the structural hub and TEX10 as the critical communicator bridging the two functional modules.
5. The network is enriched for genes linked to neurodevelopmental disorders, with PELP1 providing a direct molecular link to chromatin regulation pathways implicated in these conditions.

CONCLUSION AND DISCUSSION

We present a robust computational validation and systems extension study that can test the hypothetical functionality and association of the ribosome complex driver mechanism in neurodegenerative diseases through in silico analysis performed by running several databases together. The data show that WDR18, LAS1L, and TEX10 proteins have high confidence in their statistically significant role in rRNA processing and ribosome biogenesis. They also exhibit strong core complex expression. In support of this system, PELP1 has a consolidation function and provides contextual connectivity by connecting to the system via the periphery (utilizing TEX10). The tightly coupled networks are transcriptional coactivators, epigenetic modifiers (HDAC2, EZH2), and nuclear receptor signaling. Essentially, topological analyses of the networks revealed that TEX10 plays a central and bridging role. Furthermore, it assigned a functional and physical role as a molecule involved in communication, acting as an interface between the anabolic formation of the ribosome module and the gene regulatory mechanisms coordinated by PELP1. This orchestra, relying on TEX10 for collaborative operation, utilizes PELP1 in a system that includes a PeBoW-like complex to transmit nuclear and metabolic signals to the

transcriptional machinery, while also managing a model where it can function as a sensory and effector node. The association of these molecules has been linked to important disease genes (intellectual disability and microcephaly), thus demonstrating the importance of the ribosome complex and its role as a mechanistic confidant. Disruptions in communication at these interfaces can disrupt ribosome integrity and neuronal gene transcription, potentially playing a role in the development of pathologies during the developmental stages of neurological diseases. Therefore, this study presents a model that explains how the ribosome complex (WDR18, LAS1L, TEX10) and PELP1 manage cytoplasmic and nuclear mechanisms by integrating them, rather than simply cataloging interactions. It also offers a new perspective for understanding the balances and collaborations of cellular mechanisms in neurodegenerative diseases.

REFERENCES

Aleksander, S. A., Balhoff, J., Carbon, S., Cherry, J. M., Drabkin, H. J., Ebert, D., Feuermann, M., Gaudet, P., & Harris, N. L. (2023). The gene ontology knowledgebase in 2023. *Genetics*, *224*(1), iyad031.

Gillespie, M., Jassal, B., Stephan, R., Milacic, M., Rothfels, K., Senff-Ribeiro, A., Griss, J., Sevilla, C., Matthews, L., & Gong, C. (2022). The reactome pathway knowledgebase 2022. *Nucleic acids research*, *50*(D1), D687-D692.

Kim, C. Y., Baek, S., Cha, J., Yang, S., Kim, E., Marcotte, E. M., Hart, T., & Lee, I. (2022). HumanNet v3: an improved database of human gene networks for disease research. *Nucleic acids research*, *50*(D1), D632-D639.

Lo Surdo, P., Iannuccelli, M., Contino, S., Castagnoli, L., Licata, L., Cesareni, G., & Perfetto, L. (2023). SIGNOR 3.0, the SIGnaling network open resource 3.0: 2022 update. *Nucleic acids research*, *51*(D1), D631-D637.

Oughtred, R., Rust, J., Chang, C., Breitkreutz, B. J., Stark, C., Willems, A., Boucher, L., Leung, G., Kolas, N., & Zhang, F. (2021). The BioGRID database: A comprehensive biomedical resource of curated protein, genetic, and chemical interactions. *Protein Science*, *30*(1), 187-200.

Persson, E., Castresana-Aguirre, M., Buzzao, D., Guala, D., & Sonnhammer, E. L. (2021). FunCoup 5: functional association networks in all domains of life, supporting directed links and tissue-specificity. *Journal of Molecular Biology*, *433*(11), 166835.

Piñero, J., Ramírez-Anguita, J. M., Saüch-Pitarch, J., Ronzano, F., Centeno, E., Sanz, F., & Furlong, L. I. (2020). The DisGeNET knowledge platform for disease genomics: 2019 update. *Nucleic acids research*, *48*(D1), D845-D855.

Shannon, P., Markiel, A., Ozier, O., Baliga, N. S., Wang, J. T., Ramage, D., Amin, N., Schwikowski, B., & Ideker, T. (2003). Cytoscape: a software environment for integrated models of biomolecular interaction networks. *Genome research*, *13*(11), 2498-2504.

Szklarczyk, D., Kirsch, R., Koutrouli, M., Nastou, K., Mehryary, F., Hachilif, R., Gable, A. L., Fang, T., Doncheva, N. T., & Pyysalo, S. (2023). The STRING database in 2023: protein–protein association networks and functional enrichment analyses for any sequenced genome of interest. *Nucleic acids research*, *51*(D1), D638-D646.

BLACK SOLDIER FLY-BASED PROTEIN FOR SOYBEAN MEAL SUBSTITUTION: ECONOMIC AND ENVIRONMENTAL OUTCOMES AND SCENARIO ANALYSIS FOR TÜRKİYE

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ABSTRACT

The Turkish feed industry, which is highly dependent on imported soybean meal, faces significant economic vulnerabilities, particularly in the poultry sector where protein sources constitute a major cost component. This study examines the potential of Black Soldier Fly (BSF) larvae both as an alternative protein ingredient and as a strategic tool for organic waste bioconversion and assesses the macroeconomic implications of BSF production for reducing Türkiye's dependence on soybean imports. Using FAOSTAT and TEPGE data, annual average soybean imports prices and the share of soybean allocated to the poultry feed sector were calculated for the period 2019–2023. Based on these values, three substitution scenarios (30%, 50%, and 100%) were constructed to estimate the foreign exchange savings achievable through BSF–soybean substitution. The results indicate that BSF substitution could generate savings ranging from 130–258 million USD at 30% substitution, 217–431 million USD at 50% substitution, and 434–861 million USD under full substitution, depending on yearly price fluctuations. The effect is particularly pronounced in 2021–2022, when global market volatility sharply increased soybean prices, thereby amplifying the economic value of BSF-based substitution. The multi-year trend demonstrates that BSF functions not only as a sustainable feed ingredient but also as a risk-mitigating mechanism against price volatility in international protein markets. Overall, the findings suggest that BSF offers a multidimensional contribution to Türkiye by strengthening sustainable feed supply chains, improving waste management, and alleviating pressures on the current account balance.

Key Words: Black Soldier Fly (BSF), Insect-Based Protein, Soybean Meal Substitution, Feed Economics, Circular Bioeconomy, Foreign Exchange Savings, Scenario Analysis

ÖZET

Soya fasulyesine yüksek düzeyde bağımlı olan Türkiye yem sanayii, özellikle kanatlı üretiminde kullanılan protein kaynaklarında dışa bağımlılığın oluşturduğu ekonomik kırılganlıklarla karşı karşıyadır. Bu çalışma, Black Soldier Fly (BSF) larvalarının hem alternatif bir protein kaynağı hem de organik atıkların biyodönüşümünde stratejik bir araç olarak sunduğu potansiyeli incelemekte; BSF üretiminin Türkiye'nin soya ithalatı üzerindeki makroekonomik etkilerini çok yıllı bir senaryo analiziyle ortaya koymaktadır. FAOSTAT ve TEPGE verileri kullanılarak 2019–2023 dönemi için yıllık ortalama soya ithalat fiyatları ve kanatlı sektörüne yönlendirilen soya miktarları hesaplanmış; üç ikame oranı

(%30, %50 ve %100) altında BSF proteininin sağlayabileceği tasarruf tahmin edilmiştir. Analizler, BSF–soya ikamesinin yıllar arasında değişmekle birlikte %30 ikame ile 130–258 milyon USD, %50 ikame ile 217–431 milyon USD ve tam ikame ile 434–861 milyon USD arasında değişen bir döviz tasarrufu sağlayabileceğini göstermektedir. Özellikle 2021–2022 yıllarında uluslararası fiyat dalgalanmalarının artmasıyla, BSF kullanımının ithalat faturasını azaltma etkisi belirgin şekilde güçlenmektedir. Çok yıllı eğilim, BSF'nin yalnızca tek yıl için değil, fiyat oynaklığına duyarlı bir risk azaltıcı mekanizma olarak stratejik bir rol oynayabileceğini ortaya koymaktadır. Bu bulgular ışığında BSF, Türkiye'nin yem sektöründe sürdürülebilir protein tedarikini güçlendiren, atık yönetimini iyileştiren ve cari açık baskısını azaltan çok boyutlu bir araç olarak değerlendirilmektedir.

Anahtar Kelimeler: Kara Asker Sineği (BSF), Böcek Bazlı Protein, Soya Küspesi İkamesi, Yem Ekonomisi, Döngüsel Biyoekonomi, Döviz Tasarrufu, Senaryo Analizi

INTRODUCTION

Global trends in population growth, urbanization, and rising demand for animal protein have intensified the need for sustainable feed resources, particularly in countries that are heavily reliant on imported feed ingredients. Türkiye's feed industry exhibits a significant dependence on external protein sources, with soybean and soybean meal constituting the most critical components of this reliance. Volatility in international commodity markets, exchange rate fluctuations, and recurrent global supply shocks elevate feed costs and constrain the competitiveness of the livestock sector. In this context, evaluating domestically producible and sustainable protein alternatives represents a strategic economic priority.

Black Soldier Fly (BSF) larvae have emerged as a promising alternative protein source due to their high nutritional value, efficient bioconversion capacity, and low environmental footprint. Beyond their potential as a high-quality feed ingredient, BSF production offers broader societal and environmental benefits, including organic waste reduction, support for the circular bioeconomy, and decreased waste management expenditures. These attributes position BSF not merely as a micro-level cost-reducing input but as a structural mechanism capable of mitigating Türkiye's external dependency and easing pressures on the current account balance.

The primary objective of this study is to assess the economic implications of BSF-based protein substitution for Türkiye's soybean import dependency through a multi-year scenario analysis. Drawing on FAOSTAT and TEPGE data for the period 2019–2023, annual import volumes and prices were quantified, and poultry-directed soybean use was estimated. Substitution scenarios (30%, 50%, 100%) were then modelled to identify the potential foreign exchange savings generated by BSF incorporation. The findings demonstrate that BSF can act not only as a sustainable feed ingredient but also as a stabilizing mechanism that reduces exposure to international price volatility and strengthens the resilience of Türkiye's feed supply chain.

1. LITERATURE REVIEW AND ECONOMIC FRAMEWORK

1.1 The Role of BSF in the Circular Bioeconomy and Its Strategic Position in Waste Management

Black Soldier Fly (BSF) larvae are considered a core component of the circular bioeconomy due to their capacity to convert various organic flows—such as food waste, agricultural residues, and animal manure—into high-value biomass (Bukchin-Peles et al., 2025). This bioconversion process not only reduces waste load but also recovers high-value products such as protein, oil, and organic fertilizer. Compared to conventional livestock models, BSF systems offer significant environmental advantages due to lower resource consumption and reduced greenhouse gas emissions (Bukchin-Peles et al., 2025). It has been shown that even redirecting just 1% of global food waste into BSF systems can generate considerable amounts of protein and organic fertilizer, supporting the argument that BSF may be the "missing link" in the circular economy (Joly & Nikiema, 2019). In developing countries, BSF technology presents an innovative solution that simultaneously enhances waste management and creates economic value by transforming low-value organic waste into high-energy larvae. Similarly, in regions such as the Pacific Islands—where organic waste management capacity is limited, BSF is regarded as a strategic tool to improve the sustainability of livestock systems (Shelomi, 2020).

1.2. Technical Suitability of BSF as a Feed Source and Its Potential in Energy Production

Due to their high protein (30–53%; up to 57% in defatted form) and lipid (15–40%) content, BSF larvae offer a sustainable alternative to traditional protein sources like fishmeal and soybean meal (Joly & Nikiema, 2019; Bruno et al., 2025). Research has shown that BSF use improves gut microbiota, reduces pathogen load, increases egg production, enhances broiler live weight, and supports productivity in ruminants (Suckling et al., 2021; Herriott, 2025).
Moreover, the ability to convert organic waste into valuable feed forms the core mechanism driving BSF's cost-effectiveness, with several studies confirming its economic viability as a substitute for more expensive inputs like fishmeal (Sumbule et al., 2021).BSF biomass is also utilized in biofuel production, with high potential for biodiesel and biogas generation (Odoi-Yorke et al., 2025), demonstrating its relevance not only for feed security but also for energy transition strategies.

1.3. Turkey's Soybean Import Dependency, Market Vulnerability, and the Economic Significance of BSF

Turkey is highly dependent on soybean and soybean meal imports (TEPGE, 2024). Since soy is a critical input in poultry and livestock rations, the country's feed costs are highly sensitive to global price movements and exchange rate fluctuations. Exchange rate pass-through amplifies cost pressures in the livestock sector by increasing feed prices.
As a locally producible input utilizing domestic organic waste streams, BSF has the potential to partially substitute imported soy and contribute to foreign exchange savings (Türkiye Yem Sanayicileri Birliği, 2019). BSF also holds the potential to lower municipal waste management costs and reduce environmental burdens. While the BSF sector is rapidly scaling in tropical and subtropical regions, stricter regulations in the Northern Hemisphere are slowing growth (Marousková & Cudlínová, 2024). In Turkey, ensuring economic feasibility and developing an appropriate regulatory framework are essential to unlock the full potential of this sector.

1.4. Economic Framework

The economic framework employed in this study rests on three core pillars aimed at assessing Turkey's structural dependency on soybean imports: reducing import dependency and exposure to currency shocks, leveraging domestic cost advantages via waste-to-value conversion, and understanding

the effects of technical substitution elasticity on cost optimization in feed rations. Experimental studies show that BSF protein can technically replace soybean meal at substitution rates of 30–70% without compromising poultry performance (Dabbou et al., 2018; Heuel et al., 2021), suggesting a high substitution elasticity ($\sigma > 1$). This relationship can be modeled using a Constant Elasticity of Substitution (CES) production function:

$$Q_f = [\alpha S^{\rho} + (1-\alpha)B^{\rho}]^{1/\rho}$$

Where S = soybean protein, B = BSF protein, and $\sigma = 1/(1-\rho)$ represents the substitution elasticity. When $\sigma > 1$, ration systems can rapidly shift toward BSF in response to rising soy prices, supporting cost minimization and reducing price volatility. This substitution elasticity implies that BSF is not merely a technical alternative but also a hedge against cost instability.

The economic appeal of BSF is further reinforced by its use of low-cost organic waste as input—unlike conventional protein production systems. According to the literature, BSF production yields 15–25% protein efficiency and 50–80% organic waste mass reduction (Barragán-Fonseca et al., 2023). Leipertz et al. (2024) analyze the economic feasibility of incorporating BSF products into broiler feed and demonstrate that cost drivers and production configurations have significant impacts on the competitiveness of BSF relative to conventional inputs. These attributes position BSF as a competitive domestic protein source in the long run.

While BSF technology delivers ration flexibility and cost efficiency at the microeconomic level, it also has broader macroeconomic implications. BSF adoption could reduce the country's import bill, improve the current account balance, and generate local employment in logistics, fermentation, drying, and feed processing. Municipalities could benefit from lower organic waste management costs, while BSF's lower carbon footprint compared to soybean production could enhance environmental sustainability (Bruno et al., 2025; Auzins et al., 2024).
Thus, BSF is not merely a feed input—it is a macroeconomic policy instrument and a structural tool supporting circular economy goals.

Despite a growing body of literature on the biological, technical, and environmental dimensions of BSF farming globally, no previous study has assessed its macroeconomic implications for Turkey—especially with regard to its impact on soybean import dependency and volatility. By integrating FAOSTAT price volatility data into a multi-year BSF–soybean substitution model, this study presents the first macroeconomically grounded, multi-year evaluation of BSF's economic potential in Turkey.

2. METHODOLOGY

This study conducts a multi-year scenario analysis for the period 2019–2023 to evaluate the potential of Black Soldier Fly (BSF)–based protein to reduce Turkey's soybean import dependency. The methodological framework consists of three main components:

(i) calculating annual soybean import data in terms of both price and quantity,
(ii) estimating the share of imported soy directed toward the poultry sector,
(iii) modeling annual foreign exchange (FX) savings based on BSF substitution rates.

2.1. Data Sources and Calculation of Annual Average Import Prices

The analysis relies on annual import quantities (in tons) and import values (in USD) published under the "Soybeans (Code 236)" category in FAOSTAT. The average import price for each year was calculated using the following formula:

$$P_t^{soy} = \frac{\text{Import Value (USD)}}{\text{Import Quantity (tons)}}$$

Based on this method, soybean import prices ranged from 376 to 675 USD/ton during 2019–2023. Inter-annual price variations were directly reflected in the model, enabling a market-sensitive analysis that responds to real-world annual price dynamics.

2.2. Estimation of Soybean Allocated to the Poultry Sector

According to TEPGE (2024) and reports by the Turkish Feed Manufacturers Association, approximately 70% of total soybean use is attributed to the feed industry, and around 60% of that feed-use soybean is allocated to poultry rations. Accordingly, the total amount of imported soy directed to the poultry sector is calculated as:

$$\theta = 0.70 \times 0.60 = 0.42 Q_t^{poultry} = Q_t^{total} \times 0.42$$

This approach tailors the physical volume of annual soybean imports specifically to the poultry sector, laying the foundation for a sector-specific substitution analysis.

2.3. Definition of BSF–Soybean Substitution Scenarios

Based on findings in the literature suggesting that BSF protein can substitute 30–70% of soybean meal in poultry rations without compromising animal performance (Dabbou et al., 2018; Heuel et al., 2021), three technical substitution scenarios were defined:

Scenario 1 – Low substitution: 30% of soybean used in poultry feed is replaced by BSF-based domestic protein.

Scenario 2 – Medium substitution: 50% of poultry feed soybean is replaced by BSF.

Scenario 3 – High substitution: 100% of soybean in poultry rations is replaced by BSF (theoretical upper bound).

These scenarios are consistent with both the performance constraints reported in literature and substitution elasticities used in ration optimization models. For each year and scenario, the quantity of soy substituted is calculated as:

$$\Delta Q_t^{soy} = Q_t^{poultry} \times r \Delta FX_t = \Delta Q_t^{soy} \times P_t^{soy}$$

In this formulation, *r* denotes the substitution rate applied in each scenario (0.30, 0.50, or 1.00), while ΔFX_t represents the annual foreign exchange savings generated as a result of substituting BSF-based protein for soybean meal.

2.4. Multi-Year (2019–2023) Modeling Approach

The model is designed as a dynamic structure that incorporates year-specific import prices and volumes for the 2019–2023 period, allowing real-time integration of market realities such as global price shocks, exchange rate fluctuations, and volatility in the international soybean market. Annual foreign exchange savings were calculated and reported individually for each year, enabling meaningful intertemporal comparisons. Furthermore, minimum and maximum savings ranges were derived to reflect the variability across scenarios. This approach not only quantifies the baseline economic gains of BSF substitution but also captures its function as a stabilizing mechanism that mitigates risks associated with global feed price volatility.

3. RESULTS

This section presents the empirical findings derived from multi-year FAOSTAT soybean import data (2019–2023) and the BSF–soybean substitution model described in the methodology. Results are structured around:

(i) historical import dynamics,
(ii) poultry-directed soybean volumes,
(iii) substitution outcomes, and
(iv) foreign exchange (FX) savings under alternative technical scenarios.

Table 1 reports Türkiye's soybean import quantities, total import expenditures, and calculated annual average import prices. Substantial year-to-year variation is observed, particularly in 2021–2022, reflecting price volatility in global soybean markets.

Table 1. Annual soybeans import quantities, values, and calculated unit prices (2019–2023)

Year	Import (ton)	Imports(USD)	Price (USD/ton)
2019	2,741,886.2	1,031,809,000	376.27
2020	3,040,451.7	1,206,053,000	397.00
2021	2,493,107.2	1,464,087,000	587.31
2022	3,038,982.7	2,050,440,000	674.73
2023	2,902,040.6	1,646,216,000	567.14

Source: FAOSTAT (Soybeans 236) and authors' calculations.

Using sectoral allocation coefficients ($\theta = 0.42$), poultry feed demand for soybeans was estimated annually. Results are summarized in Table 2.

Table 2. Estimated poultry-directed soybean volumes (2019–2023)

Year	Poultry soybean use (ton)
2019	1,151,592
2020	1,276,990
2021	1,047,105
2022	1,276,373
2023	1,218,857

Source: FAOSTAT; allocation ratios from TEPGE (2024) and Türkiye Yem Sanayicileri Birliği.

The declining soybean consumption in 2021 reflects global supply disruptions and price spikes, whereas 2022 represents a rebound in import volume coupled with historically high prices. Following Dabbou et al. (2018) and Heuel et al. (2021), three substitution ratios were modelled: 30%, 50%, and 100%. For each year and each scenario, substituted soybean volumes and corresponding FX savings were calculated. Table 3 consolidates the 15 scenario outcomes across five years.

Table 3. Multi-year substitution outcomes: substituted volumes and FX savings (2019–2023)

Year	Poultry soybean use (ton)	Subst. ratio	Substituted volume (ton)	FX savings (USD)
2019	1,151,592	30%	345,478	130,007,934
		50%	575,796	216,679,890
		100%	1,151,592	433,359,780
2020	1,276,990	30%	383,097	151,962,678
		50%	638,495	253,271,130
		100%	1,276,990	506,542,260
2021	1,047,105	30%	314,132	184,474,962
		50%	523,553	307,458,270
		100%	1,047,105	614,916,540
2022	1,276,373	30%	382,912	258,355,440
		50%	638,187	430,592,400
		100%	1,276,373	861,184,800
2023	1,218,857	30%	365,657	207,423,216
		50%	609,428	345,705,360
		100%	1,218,857	691,410,720

Source: FAOSTAT (2019–2023) and authors' scenario modelling.

The multi-year simulation results reveal a clear and economically meaningful pattern in Türkiye's soybean import dependence and the potential foreign-exchange gains achievable through BSF-based protein substitution. When annual soybean import prices and volumes are jointly considered, the savings potential demonstrates a rising trajectory particularly during the commodity price surge of 2021–2022. In these two years, global soybean markets experienced severe supply-demand imbalances and price spikes, leading to Türkiye's import price rising to 587–675 USD per ton. Because BSF meals are domestically producible and structurally insulated from foreign-exchange volatility, the relative economic attractiveness of BSF substitution increases substantially under such high-price conditions.

Under the 30% substitution scenario, annual savings range between 130 and 258 million USD across the five-year window, suggesting that even a modest adoption level can produce persistent macroeconomic benefits. The 50% scenario generates substantially higher gains, between 217 and 431 million USD per year, reflecting the upper-mid range of substitution levels demonstrated as technically feasible in feeding trials. Full technical substitution, although a theoretical upper bound, yields 434 to 861 million USD annually depending on market conditions. The nonlinear structure of these results arises from the joint interaction of annual import prices, the scale of soybean inflows, and changing feed allocation coefficients. The magnitude of savings peaks in 2022, a year characterized both by large import volumes and record-high global soybean prices, highlighting the role of BSF as a strategic hedge against international commodity price risks. Overall, the multi-year trajectory indicates that BSF is not only a substitute input but also a macroeconomic stabilizer capable of reducing volatility in Türkiye's feed supply chain

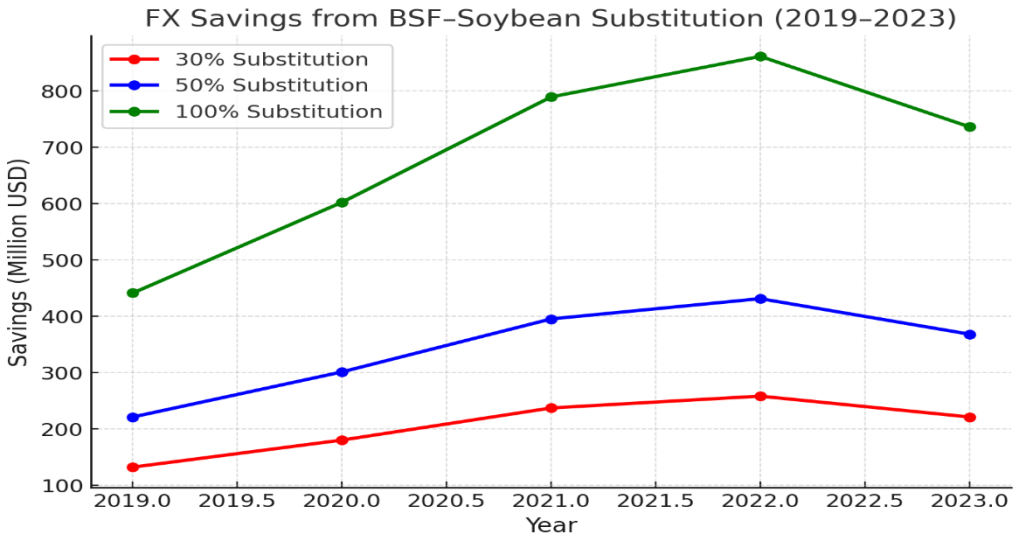

Figure 1 illustrates the evolution of potential FX savings under three BSF substitution scenarios across the 2019–2023 period.

The visual trend underscores the sharp increase in savings during 2021 and 2022, when global soybean prices surged and Türkiye's import bill intensified. The graph also highlights the widening gap between substitution levels as prices rise: the differential between 30% and 100% substitution becomes substantially larger in high-price years, demonstrating the convex response of savings to market stress. The smooth upward curvature followed by partial normalization in 2023 suggests that BSF incorporation into poultry rations can function as a counter-cyclical mechanism that cushions the economy from external shocks. The figure thereby reinforces the quantitative findings by visually emphasizing both the stabilizing capacity and long-run economic relevance of BSF-based protein.

CONCLUSION AND DISCUSSION

This study demonstrates that Black Soldier Fly (BSF)–based protein presents not only a viable alternative to imported soybean meal in poultry rations but also a multidimensional strategy for enhancing economic resilience, environmental sustainability, and circular bioeconomy integration in Türkiye. Based on a five-year scenario analysis using empirical import data and technical substitution ratios, the results reveal a robust potential for foreign exchange savings ranging from 130 million to 861 million USD annually depending on the level of BSF incorporation and international price fluctuations.

The economic impact of BSF substitution becomes particularly significant during high-price periods such as 2021–2022, when global soybean markets experienced severe volatility. Under such conditions, BSF emerges as a risk-mitigation mechanism that reduces the country's vulnerability to external shocks in agricultural input markets. Furthermore, the model confirms that even a modest 30% substitution rate can generate persistent annual macroeconomic benefits, while full technical substitution—although

theoretical—could deliver substantial import cost reductions and reduce pressure on Türkiye's current account deficit.

From an environmental and policy standpoint, BSF production facilitates local valorization of organic waste streams, supports employment in waste management and feed industries, and contributes to greenhouse gas mitigation through lower carbon intensity compared to traditional protein sources. As such, BSF is not merely a feed innovation, it is a strategic enabler of sustainable development.

Policy Implications and Recommendations

1. **Supportive Regulatory Frameworks**: The development of clear and enabling national regulations for BSF production and its integration into animal feed standards is essential for scaling the industry.
2. **Public-Private Partnerships**: Collaboration between municipalities, research institutions, and private sector actors could accelerate the deployment of BSF facilities, particularly in urban and peri-urban areas with high organic waste output.
3. **R&D and Demonstration Projects**: Government-backed pilot projects and subsidies for BSF-based feed systems could enhance investor confidence and provide empirical benchmarks for broader application.
4. **Inclusion in National Agricultural Strategies**: BSF should be formally recognized in Türkiye's feed security and waste management policies, with dedicated targets under future development plans.
5. **Education and Capacity Building**: Extension services and technical training should be provided to farmers, waste processors, and local entrepreneurs to ensure competent adoption and operation of BSF systems.

REFERENCES

Auzins, J., Smith, T., & Rogers, A. (2024). Assessing the socio-economic benefits and costs of insect meal as a fishmeal substitute in livestock and aquaculture. *Animals, 14*(10), 1461.

Barragán-Fonseca, K. B., Cortés-Urquijo, J., Pineda-Mejía, J., Lagos-Sierra, D., & Dicke, M. (2023). Small-scale Black Soldier Fly–fish farming: A model with socioeconomic benefits. *Animal Frontiers, 13*(4), 91–99. https://doi.org/10.1093/af/vfad030

Beyers, M., Coudron, C., Ravi, R., Meers, E., & Bruun, S. (2023). Black soldier fly larvae as an alternative feed source and agro-waste disposal route – A life cycle perspective. *Resources, Conservation & Recycling*, 106917. https://doi.org/10.1016/j.resconrec.2023.106917

Bruno, F., Costa, D., & Ramirez, L. (2025). Valorization of organic waste through black soldier fly. *Waste Management, 180*, 45–56.

Bukchin-Peles, S., Lozneva, K. B., Tomberlin, J. K., & Zilberman, D. (2025). From waste management to protein innovation: Black soldier fly as an embodiment of the circular bioeconomy. *Future Foods*. https://doi.org/10.1016/j.fufo.2025.100592

Dabbou, S., Gasco, L., Gai, F., Biasato, I., Capucchio, M. T., Nery, J., Trocino, A., Xiccato, G., & Schiavone, A. (2018). Black soldier fly defatted meal as a dietary protein source for broiler chickens:

Effects on growth performance, blood traits, gut morphology and histological features. *Journal of Animal Science and Biotechnology, 9*, 49. https://doi.org/10.1186/s40104-018-0266-9

FAOSTAT. (2023). Trade database. Food and Agriculture Organization of the United Nations. https://www.fao.org/faostat/

Herriott, E. (2025). *From larvae to livelihoods: Examining the realities of Black Soldier Fly farming in Malawi* (Capstone Project No. 3340). SIT Graduate Institute. https://digitalcollections.sit.edu/capstones/3340

Heuel, M., Sandrock, C., Leiber, F., Mathys, A., Gold, M., Zurbrügg, C., Gangnat, I. D. M., Kreuzer, M., & Terranova, M. (2021). Insect larvae meal as a sustainable protein source for layer hens: Effects on performance, egg quality, and gut microbiota. *Poultry Science, 100*(4), 101202. https://doi.org/10.1016/j.psj.2021.101034

Joly, G., & Nikiema, J. (2019). *Global experiences on waste processing with Black Soldier Fly: From technology to business* (Resource Recovery and Reuse Series 16). International Water Management Institute. https://doi.org/10.5337/2019.214

Leipertz, M., Bos, U., & Feil, A. (2024). Economic impact of inclusion of black soldier fly products in broiler diets. *Poultry Science*, *103*(5), 989–999.

Marouškova, A., & Cudlínová, E. (2024). Promising concepts to increase the competitiveness of the insect business in Central Europe. *Environment, Development and Sustainability*. https://doi.org/10.1007/s10668-024-05661-8

Odoi-Yorke, K., Abbey, A., Asante, E., Ansah, K. K., Asare, D. B., Mensah, G., Adjei, E. A., & Atepor, L. (2025). Harnessing Black Soldier Fly larvae for sustainable biofuel production: A review of global research trends and future directions. *International Journal of Energy Research*. **https://doi.org/10.1155/er/8032373**

Shelomi, M. (2020). Potential of Black Soldier Fly production for Pacific Small Island Developing States. *Animals, 10*(6), 1038. https://doi.org/10.3390/ani10061038

Suckling, J., Druckman, A., Small, R., Cecelja, F., & Bussemaker, M. (2021). Supply chain optimization and analysis of *Hermetia illucens* (black soldier fly) bioconversion of surplus foodstuffs. *Journal of Cleaner Production, 321*, 128711. https://doi.org/10.1016/j.jclepro.2021.128711

Sumbule, E. K., Ambula, M. K., Osuga, I. M., Changeh, J. G., Mwangi, D. M., Subramanian, S., Salifu, D., Alaru, P. A. O., Githinji, M., van Loon, J. J. A., Dicke, M., & Tanga, C. M. (2021). Cost-Effectiveness of Black Soldier Fly Larvae Meal as Substitute of Fishmeal in Diets for Layer Chicks and Growers. *Sustainability*, *13*(11), 6074. https://doi.org/10.3390/su13116074

TEPGE. (2024). *Soya Ürün Raporu 2024* (No. 407). Tarım Ekonomisi Politikaları Geliştirme Enstitüsü.

Türkiye Yem Sanayicileri Birliği. (2019). *Karma Yem Sanayii Raporu 2019*. https://www.yem.org.tr/DosyaMerkezi/karma%20yem%20sanayii%20raporu%202019.pdf

SOYBEAN IN POULTRY FEED: GLOBAL DEPENDENCE, ECONOMIC DYNAMICS, AND STRATEGIC SOLUTIONS FOR TURKEY

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ABSTRACT

This study aims to analyze the commercial and economic role of soybeans and their derivatives in poultry feed at global and national levels. Soybeans, an indispensable raw material for modern poultry production, occupy a central place in feed rations due to their high protein content and balanced amino acid profile, constituting 25–32% of the ration, especially in broiler and laying hen nutrition. With increasing global population, urbanization, and rising income levels, the demand for animal protein has continuously increased the feed industry's need for soy-based protein. However, in countries like Turkey, with limited oilseed production and significant dependence on imports, exchange rate fluctuations, international price shocks, and supply chain disruptions lead to serious volatility in feed and consequently animal product costs. This situation threatens both the sustainability and competitiveness of the poultry sector. The study comprehensively examines the current structure of global soybean production and trade, Turkey's vulnerabilities in soybean imports, the economic impacts of soybeans in poultry rations, and the potential of alternative protein sources. Furthermore, the impact of price and exchange rate shock scenarios in the soybean supply chain on the sector has been examined in detail, and the necessity of developing domestic production, transforming the crushing industry, and pursuing strategic policies for alternative protein sources has been emphasized. In this context, the study combines both scientific literature and current sectoral data to offer concrete recommendations for the future of the Turkish poultry feed and livestock sector.

Keywords: Soybean, Poultry feed, Import dependency, Economic analysis, Sustainable production.

INTRODUCTION

Worldwide, continuous and structural increases in demand for animal protein are being driven by population growth, accelerated urbanization, and rising per capita income levels. This growing demand has positioned poultry meat and eggs—products that can be produced in a short period, offer high feed conversion efficiency, and are relatively low-cost—as essential components of the global food system. Thanks to these attributes, the poultry sector plays a strategic role in ensuring the supply of animal protein in both developed and developing countries, thereby contributing to food security on a global scale (Godfray et al., 2018).

Feed constitutes the primary input in poultry production systems, directly determining production performance and economic sustainability through its nutritional content. Within this framework, protein sources emerge as one of the most critical elements of ration formulation. Soybean, and especially soybean meal, holds a central position as the main protein source in modern poultry nutrition due to its high crude protein content, digestibility, and well-balanced essential amino acid profile. Soybean meal is widely incorporated into broiler and layer diets, forming a substantial part of the total feed ration. Its

nutritional characteristics have a decisive impact on production efficiency, animal growth, and overall performance (Leeson & Summers, 2020; Ravindran et al., 2014).

However, the relevance of soybean extends beyond its biological and nutritional attributes; it also possesses significant economic and commercial importance as a strategic agricultural commodity. Soybean and its derivatives are extensively traded on global markets, with prices determined by international exchanges. In countries that are dependent on imports, this makes feed costs highly sensitive to fluctuations in exchange rates, freight charges, and global supply-demand dynamics (FAO, 2023). Such sensitivity exposes the poultry industry, particularly in nations with limited oilseed production, to considerable vulnerabilities in terms of cost structure and competitiveness.

This study aims to comprehensively evaluate the commercial and economic role of soybean and its by-products in poultry feeds, focusing specifically on the Turkish context. By analysing the existing structural challenges and policy options, the work seeks to offer an integrated perspective on how to enhance sectoral resilience and sustainability in the face of ongoing global and domestic pressures.

THE RELATIONSHIP BETWEEN THE POULTRY INDUSTRY AND SOYBEAN IN TURKEY

The poultry sector in Turkey represents one of the fundamental components of animal protein production and holds strategic significance in terms of food security and the broader agro-industrial landscape. In recent years, the sector has achieved substantial production volumes, fueled by rising domestic demand as well as expanding export opportunities. According to official data, Turkey’s chicken meat production reached approximately 2.3 million tons in 2023, while egg production was recorded at around 20.6 billion units (T.C. Ministry of Agriculture and Forestry, 2024). This scale of output necessitates a consistently large and stable supply of protein-rich raw materials for the feed industry, underscoring the critical role of feed formulation in sustaining sector growth.

The export performance of the poultry sector further accentuates the indirect economic links to soybean. During the same period, Turkey’s chicken meat exports amounted to roughly 494 thousand tons, and egg exports reached about 201 thousand tons (T.C. Ministry of Agriculture and Forestry, 2024). In export-oriented production, cost stability becomes a pivotal factor for maintaining competitiveness in international markets. The ability to offer poultry products at competitive prices is closely tied to the management of input costs, of which feed makes up the largest component. Given the substantial share of feed expenses in total production costs, even marginal fluctuations in soybean prices can have an outsized effect on the profitability of exports and the capacity of producers to respond effectively to shifts in global market conditions. Feed price volatility not only affects export margins but can also influence long-term export contracts and Turkey's reputation as a reliable supplier in international markets.

Within this framework, soybean and soybean meal serve as key inputs driving the economic performance of Turkey’s poultry sector. The sheer scale of production in the country amplifies the demand for soy-based proteins in feed rations, making issues such as cost efficiency, consistent quality, and the continuity of supply even more critical for ensuring overall sustainability. Interruptions or price spikes in soybean supply can quickly translate into financial stress for producers, disrupt supply chains, and reduce the sector's ability to meet both domestic and international demand reliably. The interdependence between the poultry industry and soybean in Turkey is shaped not only by technical nutritional requirements but also by broader considerations such as international trade dynamics, exchange rate fluctuations, market volatility, and the structure of production costs. Strategies that focus on effective soybean procurement—such as diversifying supply sources, employing risk management tools, and investing in domestic production and processing capacity—are becoming increasingly important. The ability to manage these factors successfully will directly influence the long-term resilience, profitability, and global competitiveness of the Turkish poultry sector, ensuring its continued growth and its vital role in food security both within Turkey and in key export markets.

PROBLEMS IN SOYBEAN PRODUCTION AND IMPORT SITUATION

a. Global Soybean Supply Structure

Global soybean production and trade are characterized by a highly concentrated structure, dominated by a limited number of countries. The United States, Brazil, and Argentina collectively account for most of the world's soybean production and exports (USDA, 2024). This concentration of supply in just a few major players heightens the global market's vulnerability to various shocks, whether climatic, political, or economic in nature. Any significant disruption in one of these leading producer countries, such as extreme weather events, changes in agricultural policy, trade disputes, or macroeconomic instability, can have immediate and far-reaching impacts on the global supply chain. For importing countries, this concentrated pattern of production and trade introduces a structural risk in terms of both supply security and price stability. Dependence on a handful of exporter nations makes the international soybean market more susceptible to price volatility and supply interruptions. As a result, fluctuations originating from production or policy changes in these key suppliers can directly affect the cost structures and planning capabilities of feed and food industries worldwide. This structural risk underlines the importance for importing countries to develop strategies that mitigate exposure to external shocks and enhance the resilience of their own supply chains.

b. Price Formation and Cost Pass-Through Mechanism

The international prices of soybeans and soybean meal are largely determined on global futures markets, reflecting worldwide expectations of supply and demand. In addition to these benchmark prices, other factors such as freight costs, crushing margins, and trade policies play a significant role in shaping the final cost of imports (Irwin & Sanders, 2012). For countries like Turkey, which are highly dependent on imports, these costs are converted into the local currency based on prevailing exchange rates, and subsequently have a direct impact on the overall feed expenses. Exchange rate fluctuations are particularly crucial in the domestic transmission of soybean prices. Even in periods where there is little or no significant change in international prices, a depreciation of the local currency can lead to a noticeable increase in the cost of imported soybeans and soybean meal. This, in turn, is immediately reflected in local feed prices (Gilbert, 2010). As a result, episodes of currency volatility can cause pronounced swings in the cost structure of poultry meat and egg production, regardless of relative stability in global commodity markets. Such volatility not only affects the profitability of producers but also contributes to broader uncertainties in the pricing and planning of food supply chains. Thus, in import-dependent countries, the interplay between global commodity prices, exchange rates, and additional transaction costs introduces a layer of complexity and risk into the feed industry. This makes effective risk management and price stabilization strategies essential for maintaining the economic sustainability and competitiveness of the poultry sector.

c. The Limited Soybean Production in Turkey

Although Turkey possesses a certain agroecological potential for soybean cultivation, the current level of domestic production remains insufficient to meet national demand. In recent years, soybean production in Turkey has been around 300,000 to 350,000 tons annually, a figure that covers only a small fraction of the total soybean and soybean meal requirements of the feed industry (TÜİK, 2024). As a result, Turkey occupies the position of a net importer with respect to soybeans and their derivatives, relying heavily on international markets to bridge the gap between domestic supply and sectoral demand. There are multiple structural reasons underlying the limited scale of soybean production in Turkey. Firstly, soybean is a crop that requires regular and sufficient irrigation, and in regions where irrigation infrastructure is inadequate, production costs can rise significantly. Furthermore, increases in input costs—such as seeds, fertilizers, and energy—combined with the competition from alternative, often

more profitable, crops may discourage farmers from allocating land to soybean cultivation (T.C. Ministry of Agriculture and Forestry, 2022). Additionally, market uncertainties and fluctuating profit margins make soybean a less attractive option, particularly in comparison to crops with more stable returns. This persistent limitation in domestic soybean production reinforces the feed industry's dependence on imported raw materials. The inability to scale up local production to a level that can significantly offset import needs makes the poultry sector, and the broader feed industry, vulnerable to global market shocks and external supply risks. Strengthening the local supply chain and addressing the structural barriers to soybean cultivation remain important policy considerations for reducing import dependency and enhancing the resilience of the animal production sector.

d. Import Dependence and Sectoral Vulnerability

A significant portion of the protein requirements of Turkey's feed industry is met through imported soybean meal. It is reported that the country's annual demand for soybean meal is approximately 1.5 to 2 million tons, with the majority of this requirement being fulfilled through imports (FAO, 2023). The fact that these imports are largely sourced from a limited number of producer countries means that global supply shocks are transmitted rapidly and strongly to the Turkish market. As a result, the country's dependency on imported soybean meal exposes it to fluctuations in international markets and increases its vulnerability to external risks. This reliance on imports creates a multi-faceted fragility for the poultry sector. Exchange rate volatility increases in freight costs, and price shocks in global markets directly contribute to rising feed costs, which, in turn, exert downward pressure on producer profitability. Furthermore, these elevated input costs are often passed along to the prices of final products, such as poultry meat and eggs, thereby affecting both industry stakeholders and consumers (Karaman et al., 2023). The interconnectedness of global supply chains implies that any disruption, whether due to logistical issues, trade policy changes, or adverse weather events in supplier countries, can quickly destabilize the cost structure of Turkey's feed and poultry industries. The structural challenges associated with soybean procurement represent a fundamental risk area for the sustainability of the poultry sector in Turkey. Addressing these vulnerabilities requires not only improved risk management and diversification strategies but also long-term policies aimed at enhancing domestic production capacity and reducing dependency on external sources. Without such measures, the ongoing reliance on imported soybean meal will continue to pose critical threats to the sector's economic stability and competitive position in both domestic and international markets.

CONCLUSION AND DISCUSSION

This study demonstrates that soybean and soybean meal are indispensable inputs for the Turkish poultry feed sector, and that this dependency encompasses both technical and economic dimensions. In a poultry industry characterized by high production volumes, challenges related to the cost and continuity of soybean supply exert a decisive influence on production costs and overall competitiveness. The stability and efficiency of soybean procurement thus emerge as crucial factors affecting the sector's long-term viability and its ability to maintain a competitive edge in both domestic and international markets.

The insufficiency of domestic soybean production and the limited processing capacity in Turkey have further intensified the country's reliance on imports, heightening the vulnerability of the sector to fluctuations in global markets. As a result, it is essential to implement policies aimed at boosting local soybean cultivation, which should be supported by investments in irrigation infrastructure and the broader adoption of contract farming models. Developing the domestic soybean crushing industry also represents a strategic opportunity for value addition within the feed sector, as it can help reduce external dependency and support the creation of more resilient supply chains. In addition, the rational

and scientifically grounded evaluation of alternative protein sources offers a complementary strategy to alleviate cost pressures in the short and medium term. However, it must be acknowledged that these alternative sources cannot fully substitute soybean meal, and their use should be integrated within a balanced and sustainable feed policy framework. A multifaceted approach that combines increased domestic soybean production, investment in processing capacity, and the judicious use of alternative proteins will be imperative for strengthening the foundation of the Turkish poultry industry.

Subsequently, the future of Turkey's poultry industry hinges on the effective execution of a strategy that emphasizes supply security in soybean procurement, ensures cost stability, and is grounded in comprehensive long-term strategic planning. Such an approach will be essential for preserving the sustainability of the sector, securing food security, and strengthening Turkey's standing within the evolving global food system.

REFERENCES

Anderson, J. E., & van Wincoop, E. (2004). Trade costs. Journal of Economic Literature, 42(3), 691–751.
Emmert, J. L., & Baker, D. H. (1997). Use of the ideal protein concept for precision formulation of amino acid levels in broiler diets. Journal of Applied Poultry Research, 6(4), 462–470.
FAO. (2023). FAOSTAT statistical database. Food and Agriculture Organization of the United Nations.
Gilbert, C. L. (2010). How to understand high food prices. Journal of Agricultural Economics, 61(2), 398–425.
Godfray, H. C. J., Crute, I. R., Haddad, L., Lawrence, D., Muir, J. F., Nisbett, N., Pretty, J., Robinson, S., Toulmin, C., & Whiteley, R. (2018). The future of the global food system. Nature Food, 2(9), 624–635.
Irwin, S. H., & Sanders, D. R. (2012). Testing the Masters hypothesis in commodity futures markets. Energy Economics, 34(1), 256–269.
Karaman, S., Taşcıoğlu, Y., & Bulut, O. D. (2023). Profitability and cost analysis for contract broiler production in Turkey. Animals, 13(13), 2072.
Leeson, S., & Summers, J. D. (2020). Commercial poultry nutrition (4th ed.). Nottingham University Press.
NRC. (1994). Nutrient requirements of poultry (9th rev. ed.). National Academies Press.
Ravindran, V., Abdollahi, M. R., & Bootwalla, S. M. (2014). Nutrient analysis, metabolizable energy, and digestible amino acids of soybean meals of different origins for broilers. Poultry Science, 93(10), 2567–2577.
T.C. Tarım ve Orman Bakanlığı. (2022). Türkiye'de yağlı tohumlar üretimi ve politikalar. Ankara.
T.C. Tarım ve Orman Bakanlığı, Tarımsal Ekonomi ve Politika Geliştirme Enstitüsü (TEPGE). (2024). Kümes hayvancılığı durum ve tahmin raporu 2024 (Yayın No: 402). Ankara.
TÜİK. (2024). Bitkisel üretim istatistikleri. Türkiye İstatistik Kurumu.
USDA. (2024). Oilseeds: World markets and trade. United States Department of Agriculture.

THE CLIMATE CRISIS AND THE SEARCH FOR SUSTAINABLE FEED: ENVIRONMENTAL AND NUTRITIONAL EVALUATION OF BLACK SOLDIER FLY (*Hermetia illucens)* LARVAE

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ABSTRACT

The increasing effects of climate change are causing yield losses in agricultural production and supply shortages in feed raw materials, thereby increasing the need for sustainable alternative feed sources in the livestock sector. In this context, black soldier fly (*Hermetia illucens*) larvae are an innovative feed component that is attracting attention due to their capacity to convert organic waste into high biomass and their low environmental footprint. The production process of the larvae requires much less water and land compared to traditional feed raw materials, while contributing to the reduction of methane and other greenhouse gas emissions through the utilisation of organic waste. These characteristics make the black soldier fly an important component in circular economy and climate change adaptation strategies. In terms of nutritional value, *H. illucens* larvae stand out with a crude protein content of 38–45% and a crude fat content of 25–35% in dry matter; their amino acid and fatty acid profiles make them a suitable feed alternative for poultry, fish, and pigs. The literature reports that including them in rations at a rate of 10–25 per cent has positive or neutral effects on growth performance, feed utilisation and intestinal health; it also suggests that they may support immune function. Their contribution to reducing pathogens such as *Salmonella and E. coli* in manure during the larval rearing process offers an additional advantage in terms of biosecurity for production systems. When evaluated in the context of the global climate crisis, black soldier fly larvae hold strategic potential in terms of both environmental sustainability and feed supply security. In regions sensitive to climate change, such as Turkey, the widespread adoption of this technology could both increase the resilience of animal production and bring an innovative approach to organic waste management. Future research should focus on optimal usage levels and economic feasibility across different animal species. This review is intended to serve as a resource for future studies.

Key Words: Black soldier fly (*Hermetia illucens*), Climate change, Organic waste recycling, Protein alternative, Animal production

İKLİM KRİZİ VE SÜRDÜRÜLEBİLİR YEM ARAYIŞI: KARA ASKER SİNEĞİ *(Hermetia illucens*) LARVALARININ ÇEVRESEL VE BESİNSEL DEĞERLENDİRİLMESİ

ÖZET

İklim değişikliğinin giderek artan etkileri, tarımsal üretimde verim kayıplarına ve yem hammaddelerinde arz daralmalarına neden olarak hayvancılık sektöründe sürdürülebilir alternatif yem kaynaklarına olan ihtiyacı artırmaktadır. Bu bağlamda, kara asker sineği (*Hermetia illucens*) larvaları,

organik atıkları yüksek biyokütleye dönüştürebilme kapasiteleri ve çevresel ayak izlerinin düşük olması nedeniyle dikkat çeken bir yenilikçi yem bileşenidir. Larvaların üretim süreci geleneksel yem hammaddelerine kıyasla çok daha az su ve arazi gerektirirken, organik atıkların değerlendirilmesi sayesinde metan ve diğer sera gazı emisyonlarının azaltılmasına katkı sağlamaktadır. Bu özellikleri, kara asker sineğini döngüsel ekonomi ve iklim değişikliğine uyum stratejilerinde önemli bir bileşen hâline getirmektedir. Besin değeri açısından *H. illucens* larvaları kuru maddede, %38-45 ham protein ve %25–35 ham yağ içeriği ile öne çıkmakta; amino asit ve yağ asidi profilleri ise kanatlılar, balıklar ve domuzlar için uygun bir yem alternatifi oluşturmaktadır. Literatürde, rasyonlara %10–25 oranında dahil edilmelerinin büyüme performansı, yemden yararlanma ve bağırsak sağlığı üzerinde olumlu veya nötr etkiler sağladığı; ayrıca bağışıklık fonksiyonlarını destekleyebileceği bildirilmektedir. Larvaların yetiştirme sürecinde gübrede *Salmonella* ve *E. coli* gibi patojenlerin azalmasına katkıda bulunmaları ise üretim sistemlerinin biyogüvenliği açısından ek bir avantaj sunmaktadır. Küresel iklim krizi bağlamında değerlendirildiğinde, kara asker sineği larvaları hem çevresel sürdürülebilirlik hem de yem arz güvenliği açısından stratejik bir potansiyel taşımaktadır. Türkiye gibi iklim değişikliğine hassas bölgelerde bu teknolojinin yaygınlaştırılması hem hayvansal üretimin dayanıklılığını artırabilir hem de organik atık yönetimine yenilikçi bir yaklaşım kazandırabilir. Gelecekteki araştırmaların, farklı hayvan türlerinde optimum kullanım düzeyleri ve ekonomik uygulanabilirlik üzerine odaklanması önem taşımaktadır. Hazırlamış olduğumuz bu derlemenin ilerde yapılacak çalışmalar için bir kaynak oluşturacağı düşünülmektedir.

Anahtar kelimeler: Kara asker sineği (*Hermetia illucens*), İklim değişikliği, Organik atık geri dönüşümü, Protein alternatifi, Hayvansal üretim

INTRODUCTION

Climate change has become a global phenomenon that seriously threatens the sustainability of agricultural production systems today. The accumulation of greenhouse gases in the atmosphere and the associated temperature increases cause environmental consequences such as drought, excessive rainfall, flooding and habitat changes, affecting both plant and animal production. In particular, yield losses and supply shortages are observed in feed raw material production; this situation makes the development of alternatives that will reduce dependence on traditional feed sources in the livestock sector an urgent necessity (Davis, 2023; Karabayır, 2025). Classic feed raw materials such as soybean meal and fish meal pose sustainability risks due to environmental pressures, price fluctuations, and competitive uses. In this context, making the feed raw material supply chain resilient to climate change is critical for maintaining economic stability and minimising environmental impacts (Makkar et al., 2014; Zlaugotne et al., 2022).

In recent years, insect-based protein sources, particularly black soldier fly (*Hermetia illucens*) (BSF) larvae, have become the focus of scientific and industrial interest as sustainable feed components. This interest is linked to the efficiency of insects in biomass production, their low environmental footprint, and their potential to reduce greenhouse gas emissions such as methane by utilising organic waste. Black soldier fly larvae stand out as a suitable technology for circular economy models due to their capacity to produce high amounts of protein and fat biomass from organic waste (Van Huis et al., 2020; Lopes et al., 2020).

The evaluation of black soldier fly larvae as feed raw material is promising not only in terms of environmental sustainability but also in terms of nutritional profile and bioavailability. When the dry matter content of the larvae was examined, high levels of nutritional value were found, such as 38–45 per cent crude protein and 25–35 per cent crude fat; in addition, their amino acid and fatty acid profiles offer a balanced composition compared to many commercial feed raw materials (Barragan-Fonseca et al., 2017; Lu et al., 2022). Studies have shown that black soldier fly larvae included in the ration at a rate of 10–25% have positive or neutral effects on growth performance, feed utilisation efficiency, and gut microbiota; and supportive effects on immune system parameters have also been reported (Biasato et al., 2019; De Souza Vilele et al., 2021). However, it has been reported that these effects vary depending on the usage rate, animal species, and larval processing method.

In addition, the assessment of by-products obtained during the production processes of black soldier fly larvae from a biosecurity perspective is also an important area of research. The literature indicates that a reduction in the populations of pathogens such as *Salmonella* and *Escherichia coli* has been observed in organic materials processed with larvae; this situation may provide a biosecurity advantage in integrated production systems (Lopes et al., 2020a). These findings demonstrate that black soldier fly production systems can perform risk-reducing functions in addition to food production.

This review aims to comprehensively evaluate the potential of black soldier fly (*Hermetia illucens*) larvae as a sustainable feed ingredient from environmental, nutritional, performance, and biosecurity perspectives. It is anticipated that such studies will serve as a resource and draw attention to future research aimed at addressing gaps in socio-economic areas, such as economic feasibility, production costs, legal regulations, and consumer acceptance, in the widespread adoption of black soldier fly larvae.

THE BIOLOGY OF THE BLACK SOLDIER FLY (*Hermetia illucens*)

The black soldier fly (*Hermetia illucens L.*) is an insect species belonging to the Diptera order and Stratiomyidae family, originating in Central and South America. Today, it is widespread in many regions of the world, primarily in tropical and subtropical areas. Adult *H. illucens* individuals are approximately 15–20 mm long, dark in colour, and have a bee-like morphology. As the mouthparts of adults are atrophied, they do not feed and sustain their lives with energy reserves stored during the larval stage (Sheppard et al., 2002). They require a temperature of 27–32 °C and 60–70% relative humidity for optimal development (Tomberlin et al., 2009).

Life Cycle: The life cycle of the black soldier fly consists of four main stages: egg, larva, prepupa/pupa, and adult.

Egg Stage: After mating, females can lay 400–800 eggs in cracks and crevices near organic waste or moist substrates. Under suitable temperature and humidity conditions, the eggs hatch within 3–4 days, entering the larval stage (Sheppard et al., 2002).

Larval Stage: This is the most important stage of *H. illucens* from a biological and economic perspective. The larvae can consume a wide variety of organic materials, such as food waste, animal manure, and agricultural by-products, and in the process, they store high amounts of protein and fat biomass. The larval development period varies between 10–14 days, depending on the quality of the food and environmental conditions (Diener et al., 2009).

Prepupa and Pupa Stage: After completing their development, larvae enter the prepupa stage and cease feeding during this phase. Prepupae begin to darken in colour and actively move towards dry, dark areas. This behaviour reduces the need for labour by enabling self-harvesting in production systems (Tomberlin et al., 2009). The pupal stage, which begins after the prepupal stage, lasts approximately 7–14 days, during which the larval tissues transform into adult individuals.

Adult Stage: Adult *H. illucens* individuals generally live for 5–8 days. During this short period, they exhibit only mating and egg-laying behaviours. The fact that adults do not feed and have a short lifespan is considered an important advantage in terms of environmental hygiene and biosecurity (Sheppard et al., 2002).

Additionally, the development periods of black soldier fly larvae may vary depending on factors such as temperature, humidity, substrate quality, and larval density in the trays (Perez-Pacheco et al., 2022).

ENVIRONMENTAL ADVANTAGES OF BLACK SOLDIER FLY LARVAE

Reduction of Organic Waste

Black soldier fly larvae can convert a wide variety of organic materials, such as food waste, animal manure, and agricultural by-products, into biomass with high efficiency in a short period of time. Studies have shown that the larvae can reduce the volume and dry matter content of organic waste by 40–70 per cent. This process both reduces waste disposal costs and minimises the risks of soil and water pollution caused by the uncontrolled release of organic waste into the environment (Diener et al., 2009; Lalander et al., 2020).

Reducing Greenhouse Gas Emissions

The production of traditional feed raw materials (particularly soybean meal and fishmeal) is associated with high land use, intensive water consumption and significant greenhouse gas emissions. The rapid consumption of organic waste by larvae limits the anaerobic decomposition of waste, thereby reducing the formation of potent greenhouse gases such as methane (CH_4) and nitrous oxide (N_2O) (Pang et al., 2020).

Efficiency in Land and Water Use

The production of black soldier fly larvae requires significantly less land and water compared to traditional plant and animal protein sources. While feed crops such as soybean production require large agricultural areas, BSF production can be carried out in vertical and closed systems. Furthermore, irrigation requirements for larval production are extremely limited, and the natural moisture content of the substrate is often sufficient. This characteristic makes BSF production an environmentally advantageous alternative, particularly in regions with limited water resources (Smetana et al., 2023).

Effects on Biosecurity and Environmental Hygiene

It has been reported that significant reductions in the populations of pathogenic microorganisms such as *Salmonella spp.* and *Escherichia coli* have been observed in the organic materials used to rear black soldier fly larvae. This indicates that the larvae can exert a pathogen-suppressing effect through microbial competition and physical degradation. This characteristic contributes to improving environmental hygiene in integrated production systems and reduces biosecurity risks in livestock operations (Lopes et al., 2020a).

NUTRITIONAL VALUE AND CHEMICAL COMPOSITION

The nutritional content of black soldier fly (*Hermetia illucens*) larvae varies depending on factors such as the rearing substrate, environmental conditions, larval age, and harvest time. However, it generally has a balanced and rich chemical composition for animal feed (Makkar et al., 2014)

Nutrient Content

Protein, fat and ash: Analyses of black soldier fly larvae based on dry matter indicate that they contain 38–45% crude protein and 25–35% crude fat. These values are comparable to traditional protein sources such as soybean meal and fish meal. Crude ash content generally ranges from 10–20%, and it is noted that they offer a mineral profile rich in calcium and phosphorus. This makes BSF larvae a feed ingredient with mineral supplementation potential (Diener et al., 2009; Spranghers et al., 2017).

Amino Acid Profile: When examining the amino acid profile of black soldier fly larvae, it is observed that they contain sufficient levels of amino acids such as lysine, methionine, threonine, and valine, which are essential for poultry and fish. The high lysine content, in particular, provides a significant advantage in poultry rations. However, some studies have indicated that methionine levels may be limited and that balancing supplements may be required in ration formulation (Spranghers et al., 2017).

Fatty Acid Composition: Lauric acid (C12:0), the most dominant fatty acid in black soldier fly larvae, can constitute 30–50% of total fatty acids. Lauric acid has been reported to possess antimicrobial properties and may exhibit effects that support gut health. However, it has been noted that larvae are relatively low in omega-3 fatty acids, but that the fatty acid profile can be partially improved by modifying the rearing substrate (Almeida et al., 2022).

Chitin and Digestibility: Chitin, found in the exoskeleton of black soldier fly larvae, is an important structural component that affects the digestibility of insect-based feeds. Although chitin is considered a factor limiting digestion, particularly in monogastric animals, it has been reported that at low levels it can stimulate the immune system and have a prebiotic effect (Lee et al., 2022).

Vitamin and Mineral Content: Black soldier fly larvae contain various micronutrients, primarily B vitamins. Their richness in minerals such as calcium, phosphorus, magnesium, and iron offers a significant advantage in terms of bone development and metabolic functions (Lu et al., 2022).

USE IN ANIMAL FEEDING

Use in Poultry Feeding: *H. illucens* larvae can be used in poultry rations in the form of full-fat, defatted, or ground meal. A study reported that including 20% BSF larval meal in broiler rations had a positive effect on live weight gain and feed conversion ratio (De Souza Vilela et al., 2023). Lauric acid, which is found in high concentrations in BSF oil, can positively affect the gut microbiota and support digestive health due to its antimicrobial effect. However, it is noted that digestibility may be limited at high inclusion rates due to the high chitin content, and a balanced approach may be required in ration formulation (Schiavone et al., 2017)**.**

Use in Aquaculture Feeding: Black soldier fly larvae are one of the most researched insect species in terms of fish meal replacement. Studies conducted on species such as trout, sea bass, sea bream and tilapia have reported that 25–50% of fish meal can be replaced with BSF larvae meal without adversely affecting growth performance (Lan et al., 2025). However, the limited omega-3 fatty acids in BSF larvae require careful regulation of the ration fatty acid balance, especially in marine fish. For this reason, BSF larvae are generally used in combination with fish oil or algae-based omega-3 sources (Spranghers et al., 2017).

Use in Pig Feeding:It has been reported that BSF-based feeds do not have a negative effect on performance parameters in growing pigs (Makkar et al., 2014).

CONCLUSIONS AND RECOMMENDATIONS

Global climate change, the growing world population and increasing pressure on natural resources are increasing the need for sustainable feed raw materials in the livestock sector. Traditional feed sources such as soybean meal and fishmeal pose long-term sustainability risks due to their high environmental footprint, limited production capacity, and sensitivity to economic fluctuations. In this context, black soldier fly (Hermetia illucens) larvae stand out as an alternative feed raw material due to their environmental, nutritional, and production advantages.

Studies in the literature show that H. illucens larvae can efficiently convert organic waste into biomass, offering significant environmental benefits in terms of low land and water use, reduced greenhouse gas emissions, and biosecurity. Due to their high protein and fat content, balanced amino acid profile, and functional lipid components, the larvae can be used as an alternative or supplement to traditional feed raw materials in production animals such as poultry, aquatic animals, and pigs. When used at appropriate

inclusion levels in rations, it has been reported that it does not adversely affect growth performance and feed utilisation; in some cases, it may support gut health and immune function.

Recommendations;

- Optimal usage levels for different animal species and age groups should be determined through experimental studies.
- The effects of larval rearing substrates on nutritional composition should be investigated in detail.
- Processing and formulation strategies should be developed to reduce limitations related to chitin content and fatty acid profile.
- Clarifying legal and technical standards regarding BSF production and use is important.

In conclusion, black soldier fly larvae offer significant potential in the context of climate change, feed supply security, and sustainable livestock farming. Interdisciplinary research in this field will accelerate the integration of insect-based feeds into livestock systems, contributing to environmental and economic sustainability.

REFERENCES

Almeida, C., Murta, D., Nunes, R., Baby, A. R., Fernandes, Â., Barros, L., Rijo, P., & Rosado, C. (2022). Characterization of lipid extracts from the *Hermetia illucens* larvae and their bioactivities for potential use as pharmaceutical and cosmetic ingredients. *Heliyon*, *8*(5), e09455. https://doi.org/10.1016/j.heliyon.2022.e09455

Barragan-Fonseca, K.B., Dicke, M., Van Loon, J.J.A. (2017). Nutritional value of the black soldier fly (*Hermetia illucens L.*) larvae. *Journal of Insects as Food and Feed*, 3(2): 105-120 DOI: 10.3920/JIFF2016.0055

Biasato, I., Renna, M., Gai, F., Dabbou, S., Meneguz, M., Perona, G., Martinez, S., Lajusticia, A. C. B., Bergagna, S., Sardi, L., Capucchio, M. T., Bressan, E., Dama, A., Schiavone, A., & Gasco, L. (2019). Partially defatted black soldier fly larva meal inclusion in piglet diets: effects on the growth performance, nutrient digestibility, blood profile, gut morphology and histological features. *Journal of animal science and biotechnology*, *10*, 12. https://doi.org/10.1186/s40104-019-0325-x

Davis, V. (2023). Impact of Climate Changes on Agriculture and Livestock. *International Journal of Climatic Studies*. Vol 2, Issue 1, No 5, pp 53-63, https://doi.org/10.47604/ijcs.1829

De Souza Vilela, J., Andronicos, N. M., Kolakshyapati, M., Hilliar, M., Sibanda, T. Z., Andrew, N. R., Swick, R. A., Wilkinson, S., & Ruhnke, I. (2021). Black soldier fly larvae in broiler diets improve broiler performance and modulate the immune system. *Animal nutrition (Zhongguo xu mu shou yi xue hui)*, *7*(3), 695–706. https://doi.org/10.1016/j.aninu.2020.08.014

De Souza Vilela, J., Kheravii, S. K., Sharma Bajagai, Y., Kolakshyapati, M., Zimazile Sibanda, T., Wu, S. B., Andrew, N. R., & Ruhnke, I. (2023). Inclusion of up to 20% Black Soldier Fly larvae meal in broiler chicken diet has a minor effect on caecal microbiota. *PeerJ*, *11*, e15857. https://doi.org/10.7717/peerj.15857

Diener, S., Zurbrügg, C., & Tockner, K. (2009). Conversion of organic material by black soldier fly larvae: establishing optimal feeding rates. *Waste management & research: the journal of the International Solid Wastes and Public Cleansing Association, ISWA*, *27*(6), 603–610. https://doi.org/10.1177/0734242X09103838

Karabayır, A. (2025). İklim Değişikliğinin Tarım ve Hayvancılığa Etkileri. *Şura Akademi* (*8 ÇEVRE*), 11-22. https://dergipark.org.tr/tr/pub/suraakademi/issue/90488/1602057

Lalander, C., Ermolaev, E., Wiklicky, V., Vinnerås, B. (2020). Process efficiency and ventilation requirement in black soldier fly larvae composting of substrates with high water content. *Science of The Total Environment* Volume 729, 10 August 2020, 138968 https://doi.org/10.1016/j.scitotenv.2020.138968

Lan, P.T.P., Ngoan, L. D., & Tram, N. D. Q. (2025). Effect of replacing gradually fishmeal protein by full-fat black soldier fly larvae meal in diets on growth performance, digestive enzymes and haematological indices of Asian seabass (*Lates calcarifer*) fingerlings reared in freshwater. *Livestock Research for Rural Development, 37*, Article16. http://www.lrrd.org/lrrd37/2/3716ndqt.html

Lee, J-H., Kim, T.-K., Cha, J.Y., Jang H.W., Yong H.I., Choi Y.-S. (2022). How to develop strategies for using insects as animal feed: digestibility, functionality, safety and regulation. J Animal Science Technology; 64(3):409-431. https://doi.org/10.5187/jast.2022.e27

Lopes, I. G., Lalander, C., Vidotti, R.M., Vinneras, B. (2020). Using *Hermetia illucens* larvae to process biowaste from aquaculture production. *Journal of Cleaner Production* Volume 251, 1 April 2020, 119753, https://doi.org/10.1016/j.jclepro.2019.119753

Lopes, I. G., Lalander, C., Vidotti, R. M., & Vinnerås, B. (2020a). Reduction of Bacteria in Relation to Feeding Regimes When Treating Aquaculture Waste in Fly Larvae Composting. *Frontiers in Microbiology*. Volume 11, https://doi.org/10.3389/fmicb.2020.01616

Lu, S., Taethaisong, N., Meethip, W., Surakhunthod, J., Sinpru, B., Sroichak, T., Archa, P., Thongpea, S., Paengkoum, S., Purba, R. A. P., & Paengkoum, P. (2022). Nutritional Composition of Black Soldier Fly Larvae (*Hermetia illucens* L.) and Its Potential Uses as Alternative Protein Sources in Animal Diets: A Review. *Insects*, *13*(9), 831. https://doi.org/10.3390/insects13090831

Makkar, H. P. S., Tran, G., Heuzé, V., & Ankers, P. (2014). State-of-the-art on use of insects as animal feed. *Animal Feed Science and Technology, 197(38),* 1–33. DOI:10.1016/j.anifeedsci.2014.07.008

Pang, W., Hou, D., Chen, J., Nowar, E. E., Li, Z., Hu, R., Tomberlin, J. K., Yu, Z., Li, Q., & Wang, S. (2020). Reducing greenhouse gas emissions and enhancing carbon and nitrogen conversion in food wastes by the black soldier fly. *Journal of environmental management*, *260*, 110066. https://doi.org/10.1016/j.jenvman.2020.110066

Pérez-Pacheco, R., Hinojosa-Garro, D., Ruíz-Ortíz, F., Camacho-Chab, J. C., Ortega-Morales, B. O., Alonso-Hernández, N., Fonseca-Muñoz, A., Landero-Valenzuela, N., Loeza-Concha, H. J., Diego-Nava, F., Arroyo-Balán, F., & Granados-Echegoyen, C. A. (2022). Growth of the Black Soldier Fly *Hermetia illucens* (Diptera: Stratiomyidae) on Organic-Waste Residues and Its Application as Supplementary Diet for Nile Tilapia *Oreochromis niloticus* (Perciformes: Cichlidae). *Insects*, *13*(4), 326. https://doi.org/10.3390/insects13040326

Schiavone, A., De Marco, M., Martínez, S. *et al.* (2017). Nutritional value of a partially defatted and a highly defatted black soldier fly larvae (*Hermetia illucens* L.) meal for broiler chickens: apparent nutrient digestibility, apparent metabolizable energy and apparent ileal amino acid digestibility. *J Animal Sci Biotechnol* **8**, 51 https://doi.org/10.1186/s40104-017-0181-5

Sheppard, D.C., Tomberlin, J.K., Joyce, J.A., Kiser, B.C., Sumner, S.M., (2002). Rearing Methods for the Black Soldier Fly (Diptera: Stratiomyidae), *Journal of Medical Entomology*, Volume 39, Issue 4, 1 July 2002, Pages 695–698, https://doi.org/10.1603/0022-2585-39.4.695

Smetana, S., Bhatia, A., Batta, U., Mouhrim, N., Tonda, A., (2023). Environmental impact potential of insect production chains for food and feed in Europe, *Animal Frontiers*, Volume 13, Issue 4, August 2023, Pages 112–120, https://doi.org/10.1093/af/vfad033

Spranghers, T., Ottoboni, M., Klootwijk, C., Ovyn, A., Deboosere, S., De Meulenaer, B., Michiels, J., Eeckhout, M., De Clercq, P. and De Smet, S. (2017), Nutritional composition of black soldier fly (*Hermetia illucens*) prepupae reared on different organic waste substrates. J. Sci. Food Agric., 97: 2594-2600. https://doi.org/10.1002/jsfa.8081

Tomberlin, J.K., Adler, P.H., Heidi M. Myers, (2009). Development of the Black Soldier Fly (Diptera: Stratiomyidae) in Relation to Temperature, *Environmental Entomology*, Volume 38, Issue 3, 1 June 2009, Pages 930–934, https://doi.org/10.1603/022.038.0347

Van Huis, A., Oonincx, D.G.A.B., Rojo, S., Tomberlin, J.K. (2020). Insects as feed: House fly or black soldier fly? Wageningen Academic Publishers. June. Journal of Insects as Food and Feed 6(3), DOI:10.3920/JIFF2020.x003

Zlaugotne, B., Pubule, J., & Blumberga, D. (2022). Advantages and disadvantages of using more sustainable ingredients in fish feed. *Heliyon*, *8*(9), e10527. https://doi.org/10.1016/j.heliyon.2022.e10527

FEAR-BASED VOCALİSATİON RESPONSES İN RED-LEGGED PARTRİDGES DEPENDİNG ON DİFFERENT SOCİAL AND ENVİRONMENTAL CONDİTİONS

KINALI KEKLİKLERDE FARKLI SOSYAL VE ÇEVRESEL KOŞULLARA BAĞLI KORKU TEMELLİ VOKALİZASYON TEPKİLERİ

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ABSTRACT

Auditory communication in animals is a fundamental biological tool for deciphering behavioral and emotional responses to environmental stimuli. Vocalizations are not simple sound productions but complex signals reflecting physiological state, threat perception, social position, and environmental stress. Analyzing vocal behavior is therefore critical for monitoring animal welfare, objectively measuring stress and fear, and understanding adaptation to rearing conditions. In species with strong social structures and high sensitivity to environmental changes, auditory communication ensures social cohesion, territory defense, danger signaling, and group coordination. The chukar partridge (*Alectoris chukar*) is a model species used in research on auditory communication and behavior-based stress due to these traits. In this study, experimental tests were performed under different social and environmental conditions to evaluate fear-based vocal behavior in partridges. Individuals were first tested in their familiar environment in large groups, then transferred to a novel environment and tested in pairs and individually. The experimental design also included threat scenarios involving the human factor. All vocal responses were recorded using high-resolution audio devices, and call type, frequency structure, and duration were analyzed. The findings showed that partridges produced distinct alarm and coordination calls when tested in large groups in their home environment. However, when tested in pairs or alone in a novel setting, vocalizations were significantly reduced, and only female individuals produced fear-induced calls in these contexts. These results indicate that social context, group safety, and gender differences play a critical role in the emergence of fear-based vocal responses. In conclusion, vocalization data obtained under different experimental conditions provide comprehensive behavioral indicators for assessing stress and threat perception in partridges, offering important insights for improving husbandry and animal welfare practices.

Keywords: Partridge, auditory communication, vocalization, fear response, social context, sex differences, animal welfare

ÖZET

Hayvanlarda işitsel iletişim, çevresel uyaranlara karşı davranışsal ve duygusal tepkileri çözmek için temel bir biyolojik araçtır. Seslendirmeler basit ses üretimleri değil, fizyolojik durumu, tehdit algısını, sosyal konumu ve çevresel stresi yansıtan karmaşık sinyallerdir. Bu nedenle, vokal davranışın analizi, hayvan refahını izlemek, stresi ve korkuyu objektif olarak ölçmek ve yetiştirme koşullarına adaptasyonu anlamak için kritik öneme sahiptir. Güçlü sosyal yapılara ve çevresel değişikliklere karşı yüksek hassasiyete sahip türlerde, işitsel iletişim sosyal uyumu, bölge savunmasını, tehlike sinyalini ve grup koordinasyonunu sağlar. Bu özelliklerinden dolayı, keklik (*Alectoris chukar*) işitsel iletişim ve davranışa dayalı stres araştırmalarında kullanılan bir model türdür. Bu çalışmada, kekliklerde korkuya dayalı vokal davranışı değerlendirmek için farklı sosyal ve çevresel koşullar altında deneysel testler yapılmıştır. Bireyler önce tanıdık ortamlarında büyük gruplar halinde test edilmiş, daha sonra yeni bir ortama transfer edilerek çiftler halinde ve bireysel olarak test edilmiştir. Deneysel tasarım ayrıca insan faktörünü içeren tehdit senaryolarını da içermiştir. Tüm ses tepkileri yüksek çözünürlüklü ses cihazları kullanılarak kaydedildi ve çağrı türü, frekans yapısı ve süresi analiz edildi. Bulgular, kekliklerin kendi doğal ortamlarında büyük gruplar halinde test edildiklerinde belirgin alarm ve koordinasyon çağrıları ürettiklerini gösterdi. Bununla birlikte, yeni bir ortamda çiftler halinde veya tek başına test edildiklerinde, seslendirmeler önemli ölçüde azaldı ve bu bağlamlarda yalnızca dişi bireyler korku kaynaklı çağrılar üretti. Bu sonuçlar, sosyal bağlamın, grup güvenliğinin ve cinsiyet farklılıklarının korkuya dayalı ses tepkilerinin ortaya çıkmasında kritik bir rol oynadığını göstermektedir. Sonuç olarak, farklı deneysel koşullar altında elde edilen seslendirme verileri, kekliklerde stres ve tehdit algısını değerlendirmek için kapsamlı davranışsal göstergeler sağlamakta ve hayvancılık ve hayvan refahı uygulamalarını iyileştirmek için önemli bilgiler sunmaktadır.

Anahtar Kelimeler: Kınalı keklik, işitsel iletişim, vokalizasyon, korku tepkisi, sosyal bağlam, cinsiyet farklılıkları, hayvan refahı

INTRODUCTION

The partridge, which holds an important place among game birds, is the common name for birds belonging to the Perdix and *Alectoris* genera of the Phasianidae family (Aysöndü 2008). Although native to Southern Europe and Asia, it is now widespread throughout the world and has a broad geographical distribution (Fuller et al., 2000; Petersan, 2001; Aysöndü, 2008). It has been reported that factors such as global warming in recent years, the rapidly increasing world population, the loss of agricultural land, the excessive use of agricultural pesticides and fertilizers, the increase in mechanization in agriculture, and poaching have caused significant declines in partridge populations (Özek, 2001; Kantarlı 2018; IUCN, 2025). Although no serious decline has been observed in the global population of the chukar partridge (*Alectoris chucar*), a study conducted in Bulgaria compared the data obtained with the IUCN criteria and reported that the future of this species is at risk at the regional level (Gruychev, 2016).

The red-legged partridge is used as a focal species in both intensive breeding programs and wildlife reintroduction programs in many countries due to its high adaptability. Breeding these partridges and similar species at risk of extinction in the wild at production stations and releasing them into the wild has become a common conservation strategy. However, factors such as rearing individuals bred under intensive conditions in confined spaces, exposure to human interaction, feeding them a monotonous diet, and suppressing their natural behavioral repertoire lead to low survival rates and poor adaptation performance when released into the wild (Yolcu et al., 2016; Özkan & Başdoğan, 2020). This situation necessitates the improvement of breeding environments in terms of animal welfare and the promotion of natural behaviors.

Communication in animals is generally studied in three basic modalities: visual, tactile, and auditory. Auditory communication, particularly in terrestrial birds, plays a central role in regulating important behaviors such as territory defense, mate selection, alarm calling, threat signaling, and intragroup coordination (Sezer, 2008; Webster & Podos, 2018). Studies on *Alectoris* species have shown that they

possess a rich vocalization repertoire specific to contexts such as alarm, social, agonistic, and mating calls (Peterson, 2001; Özkan et al., 2021). Recent research indicates that bird vocalizations reflect internal processes such as an individual's stress level, fear response, and overall emotional state. Therefore, auditory cues offer effective, non-invasive tools for assessing animal welfare and stress (Briefer, 2020; Whitham & Miller, 2024).

In this context, examining the vocal responses of partridges raised under controlled conditions to different environmental situations provides an important approach to understanding emotional state, environmental well-being, and natural behaviors. This study aims to determine how partridges modulate their vocalizations under different environmental conditions and to evaluate the effect of environmental enrichment on the emergence of natural behaviors.

MATERIALS AND METHODS

This study was conducted at the Animal Husbandry Facilities of the Department of Animal Science, Faculty of Agriculture, Akdeniz University. The animal material used in the study was the chukar partridge (*Alectoris chukar*). In the experiment, 300 chukar partridge eggs obtained from a different farm were placed in incubators located in the same unit, and the experiment was started with 222 chukar partridge chicks after a 24-day incubation period. The chukar partridge chicks were kept in their main machines for the first 4 weeks after hatching and then transferred to the ground system. Due to mortality, 155 partridges were transferred to the ground system. The ground system was designed to mimic the natural habitat of partridges; sand pits, tree branches, rocks, etc. were placed in the shelters for environmental enrichment. To reduce stress caused by crowding, the animals were raised in three separate groups. The number of partridges, which was initially distributed equally, changed due to mortality.

To determine the effect of fear on vocalizations, recordings were made of partridges when they reached 8–9 months of age (32–36 weeks). At this stage, there were 70 partridges. The recordings were made in the natural environment where the individuals were raised and under different experimental conditions. To evaluate the fear response caused by human influence, three different individuals who had no previous contact with the flock were introduced into the environment according to a defined protocol. Additionally, vocalizations were recorded under different experimental conditions, including in an isolated room created to differ from the partridges' natural environment. The recordings obtained are as follows:

- In their natural environments,
- In their natural environments with human factors
- Female and male in a closed room,
- Female and male in a closed room with human factors
- Female and male in a closed room and in the dark,
- Female, alone in a closed room,
- Female, alone with human factors,
- Female alone, in a closed room and in the dark
- Male, alone in a closed room
- Male alone with human factors
- Male alone, in a closed room in the dark

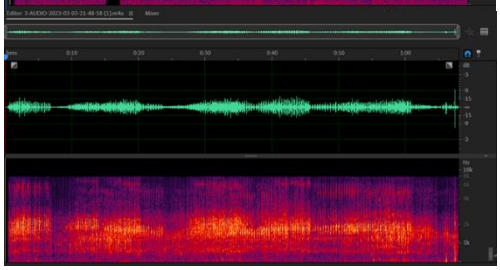
Each group's sounds produced in their natural environments under human-influenced and unaffected conditions were recorded for 1 minute each. Following this, sound recordings were taken in an isolated room with individuals individually and in pairs, again under human-influenced and unaffected conditions, for 1 minute each. 236 mkb mp3 player were used for the sound recordings. Frequency and intensity analyses of the sound recordings obtained were performed using Adobe Audition CC 2019 software.

RESULTS

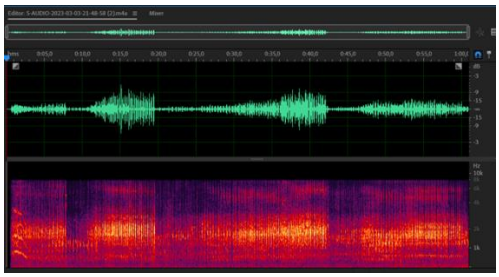
Figures (1, 2, 3) show the sound frequencies and intensities recorded by the familiar caretaker, without disturbing the partridges as much as possible, in the areas where they were kept for 8-9 months, with males and females mixed together. During this period, based on our remote observations, we observed courtship behaviors directed at the opposite sex, as well as behaviors such as eye contact between males and territorial defense, and the associated sounds.

1)

2)



3)



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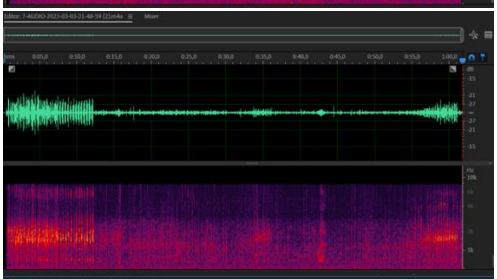

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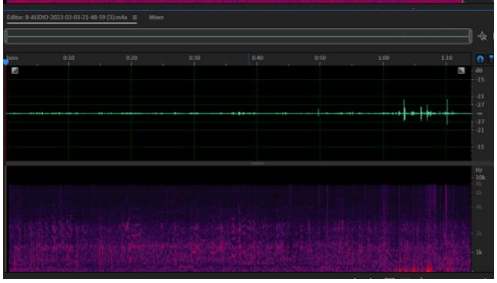


Figure 1: Sound intensity (dB) and frequency (Hz) in natural environments of group 1
Figure 2: Sound intensity (dB) and frequency (Hz) in natural environments of group 2
Figure 3: Sound intensity (dB) and frequency (Hz) in natural environments of group 3
Figure 4: Sound intensity (dB) and frequency (Hz) in natural environments with human factor for group 1
Figure 5: Sound intensity (dB) and frequency (Hz) in natural environments with human factor for group 2
Figure 6: Sound intensity (dB) and frequency (Hz) in natural environments with human factor for group 3

Examination of the figures reveals variations in intensity and frequency of repetition. Figures (4, 5, 6) show that three different people entered the area where they were located, apart from their caretakers, creating an atmosphere of fear. Figures 4 and 5 show that the partridges expressed their fears and stress through their sounds.

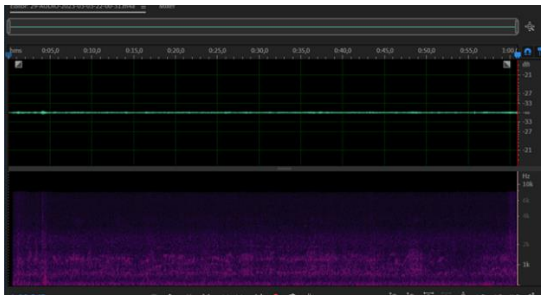
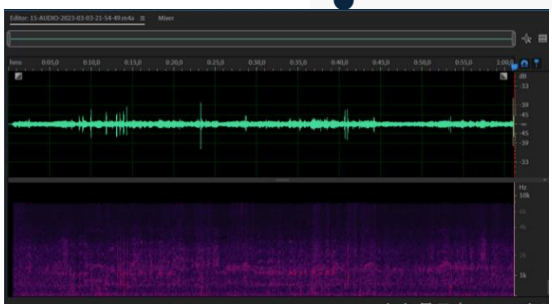
7)  8) 

Figure 7: Sound intensity (dB) and frequency (Hz) in different environments, dark environments, and human-induced environments for males and females, males, and females within each of the 3 groups.
Figure 8: Sound intensity (dB) and frequency (Hz) in dark and human-induced environments in females of groups 1 and 3

When taken in pairs from their familiar environments and placed in different environments (either in pairs or alone), the partridges did not exhibit fear-based vocalizations related to the different environment, darkness, or human presence (Figure 7). In all cases, the partridges remained silent. A rumbling sound was only heard in the females belonging to the 1st and 3rd groups (Figure 8).

CONCLUSION AND DISCUSSION

One of the most important criteria for animal welfare in intensive production systems is that the animals raised are able to exhibit species-specific behaviors that they would display in their natural environment (in the wild) (Dereli Fidan, 2012). It is accepted that allowing animals to freely exhibit their natural behavioral repertoire has positive effects on both their physical and mental health. Healthy animals mean healthy products and a sustainable environment (Akbaş, 2013). In this regard, efforts to support animal housing with environmental enrichment elements appropriate to the species and to improve care and management practices are becoming increasingly important.

In this study, vocalization, one of the means of communication, was examined in partridges selected as sample material to see how it was shaped by the phenomenon of fear. The findings revealed that individuals living in their natural environment and among their own kind exhibited higher self-confidence; they increased their vocal intensity in times of danger, individuals in leadership positions came to the fore, and the group gathered together. In contrast, partridges in an unfamiliar environment became silent and immobile. Under these conditions, only female individuals were observed to produce a low-frequency growling sound, distinct from normal vocalization.

These findings suggest that a hierarchical structure may have developed within the community of partridges raised in farm environments, and that individuals seek safety by turning to leader individuals in times of danger. On the other hand, the quietening and immobility of animals in a foreign and isolated environment can be interpreted as a tendency to protect themselves through a freezing response when unable to develop escape or defense behaviors. The growling sound observed in isolated female individuals may be an evolutionary-based call for help, as incubation and offspring care in nature are undertaken by female individuals.

In conclusion, vocalization can be considered an important and non-invasive indicator for determining changes in animal welfare, identifying care and management errors, and understanding the emotional state of animals (Whitham & Miller, 2024). Accurate identification of sounds specific to the mental state of animals will provide significant advantages in solving welfare-based problems. Increasing research

on vocalization in different animal species will play a pioneering role in developing animal welfare criteria and supporting sustainable farming practices.

Ethical statement

This research was approved by Akdeniz University, Experimental Animals Application and Research Center local ethics committee for animal experiments.

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REFERENCES

Akbaş, A. A., (2013). Çiftlik Hayvanlarında Davranış ve Refah İlişkisi. MAKÜ Sağlık Bilimleri Enstitüsü Dergisi 1 (1): 42-49.

Aysöndü M.H., Özbey O. (2008) Kaya Kekliklerinde *(Alectoris graeca)* Farklı Barındırma Şeklinin Yumurta Verimi ve Kuluçka Özellikleri Üzerine Etkisi. F. Ü. Sağ. Bil. Dergisi. 22(5):267-271.

Briefer, E. F. (2020). *Vocal expression of emotional arousal and valence in non-human animals. In book: Coding Strategies in Vertebrate Acoustic Communication (pp.137-162)* DOI:10.1007/978-3-030-39200-0_6

Dereli Fidan, E., (2012). Türkiye'de Çiftlik Hayvanları ile İlgili Refah Uygulamaları. Animal Health, Production and Hygiene 1:39- 46

Gruychev, G., (2016). Bulgaristan'da Çukar Kekliği (Alectoris chukar) popülasyonlarının azalması. *Türk Zooloji Dergisi 40* (5): 818-823. https://doi.org/10.3906/zoo-1508-5

Fuller, R.A., Carroll, J.P., and McGowan, P.J.K. (eds.). (2000). Partridges, Quails, Francolins, Snowcocks, Guineafowl, and Turkeys. Status Survey and Conservation Action Plan 2000–2004. WPA/BirdLife/SSC Partridge, Quail, and Francolin Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK, and the World Pheasant Association, Reading, UK. vii + 63 pp.

Iucn, (2025). Red List of Threatened Species. https://www.iucnredlist.org/ Erişim tarih:12.12.2025

Kantarlı M. (2018) Ülkemizdeki Kınalı Keklik Popülasyonlarının Biyolojik ve Ekolojik Değerlendirilmesi. Doğanın Sesi. Sayı:1, 12-28

Özek K., 2001. Keklik Yetiştiriciliği. Tavukçuluk Araştırma Dergisi. Cilt 3, Sayı 1.

Özkan, Ç. Ö., & Başdoğan, H. (2020). Kınalı kekliklerin (*Alectoris chukar*) telemetri ile takibi ve adaptasyon durumları. ADYÜTAYAM, 8(2), 1–16.

Peterson, L. (2001). *Alectoris chukar*, Animal Diversity. Erişim tarihi:13.12.2025 https://animaldiversity.org/accounts/Alectoris_chukar/

Sezer, M. (2008). Kuşlarda Sessel İletişim. *Türk Bilimsel Derlemeler Dergisi*, *1* (1), 01–06. https://derleme.gen.tr/index.php/derleme/article/view/10

Webster, M. S., & Podos, J. (2018). Acoustic communication. *Ornithology: foundation, critique, and application. Johns Hopkins University Press, Baltimore*, 409-436.

Whitham JC and Miller LJ (2024) Utilizing vocalizations to gain insight into the affective states of non-human mammals. Front. Vet. Sci. 11:1366933. doi: 10.3389/fvets.2024.1366933

Yolcu H. I., Aslan A., Serttas A., Saribasak H., Uysal H., Cobanoglu A. (2016). Monitoring the survival rate of released chukars: a case study in Elmalı Cedar Forest, Antalya, Turkey. Turkısh Journal of Zoology, cilt.40, sa.2, ss.272-278

THE STRATEGIC STRUCTURE OF OPEN-SOURCE INNOVATION ECOSYSTEMS: NETWORK AND TOPIC MODELING ANALYSIS OF POPULAR AI/ML PROJECTS ON GITHUB

AÇIK KAYNAK İNOVASYON EKOSİSTEMLERİNİN STRATEJİK YAPISI: GITHUB'DA POPÜLER AI/ML PROJELERİNİN AĞ VE KONU MODELLEME ANALİZİ

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ABSTRACT

Open-source software ecosystems have become central components of contemporary innovation processes, particularly in rapidly evolving technological domains such as Artificial Intelligence (AI) and Machine Learning (ML). Beyond purely technical infrastructures, these ecosystems constitute strategic socio-technical systems in which knowledge production, governance, competition, and value creation are deeply intertwined. From a strategic management and innovation management perspective, open-source ecosystems are shaped by network effects, platform leadership, and collaborative production dynamics.

This study examines the structural and thematic architecture of open-source AI/ML innovation ecosystems using GitHub as an empirical setting. Drawing on data retrieved via the GitHub REST API, the analysis focuses on metadata from the 100 most-starred AI/ML repositories. Topic modeling based on Latent Dirichlet Allocation (LDA) is employed to identify dominant thematic clusters, while network analysis is used to examine contributor–repository interaction patterns and the overall ecosystem structure.

The findings reveal five dominant thematic clusters—deep learning frameworks, natural language processing, learning and educational resources, computer vision, and data science—indicating a concentration of innovative activity around core technological building blocks and knowledge diffusion tools. Network analysis further demonstrates a highly centralized, star-shaped ecosystem structure, with platform-leading projects such as TensorFlow and PyTorch occupying highly central positions. These results provide empirical support for cumulative advantage and platform leadership dynamics within open-source innovation environments. In addition, a strong positive relationship is identified between repository popularity (stars) and collaborativeness (forks).

By integrating open innovation theory with computational methods, the study contributes to the strategic management literature by advancing a data-driven and ecosystem-level understanding of open-source innovation and offering an initial empirical mapping of AI/ML open-source ecosystems..

Keywords: Open-source innovation; Platform ecosystems; Network analysis; Topic modeling; AI/ML projects; Platform leadership; Strategic management

ÖZET

Açık kaynak yazılım ekosistemleri, özellikle Yapay Zekâ (Artificial Intelligence – AI) ve Makine Öğrenmesi (Machine Learning – ML) gibi hızla gelişen teknolojik alanlarda çağdaş inovasyon süreçlerinin merkezî bileşeni hâline gelmiştir. Bu ekosistemler yalnızca teknik üretim ortamları değil; aynı zamanda bilgi üretimi, yönetişim, rekabet ve değer yaratımının iç içe geçtiği stratejik sosyo-teknik yapılardır. Stratejik yönetim ve inovasyon yönetimi perspektifinden bakıldığında, açık kaynak ekosistemleri ağ etkileri, platform liderliği ve işbirlikçi üretim dinamikleri tarafından şekillendirilmektedir.

Bu çalışma, GitHub'ı ampirik bağlam olarak ele alarak açık kaynak AI/ML inovasyon ekosistemlerinin yapısal ve tematik mimarisini incelemektedir. GitHub REST API aracılığıyla elde edilen veriler kullanılarak, en yüksek yıldız sayısına sahip 100 AI/ML deposunun meta verileri analiz edilmiştir. Konu modelleme kapsamında Latent Dirichlet Allocation (LDA) yöntemiyle baskın tematik kümeler belirlenmiş; ağ analizi yoluyla katkıcı–depo etkileşim örüntüleri ve ekosistem yapısı incelenmiştir.

Bulgular, derin öğrenme çerçeveleri, doğal dil işleme, öğrenme ve eğitim kaynakları, bilgisayarlı görü ve veri bilimi olmak üzere beş baskın tematik kümenin öne çıktığını göstermektedir. Ağ analizi sonuçları ise TensorFlow ve PyTorch gibi lider projelerin ekosistemde yüksek merkezilik değerlerine sahip olduğunu ve açık kaynak inovasyon ortamlarında kümülatif avantaj ve platform liderliği dinamiklerinin güçlü biçimde işlediğini ortaya koymaktadır. Ayrıca depo popülerliği (stars) ile işbirlikçilik düzeyi (forks) arasında güçlü ve pozitif bir ilişki tespit edilmiştir.

Çalışma, açık inovasyon teorisini hesaplamalı yöntemlerle birleştirerek stratejik yönetim literatürüne veri odaklı ve ekosistem düzeyinde bir anlayış sunmakta ve açık kaynak AI/ML ekosistemlerine ilişkin ilk kapsamlı ampirik haritalamalardan birini önermektedir.

Anahtar kelimeler: Açık kaynaklı inovasyon; Platform ekosistemleri; Ağ analizi; Konu modelleme; AI/ML projeleri; Platform liderliği; Stratejik yönetim

1. GİRİŞ

Dijital çağda inovasyon, giderek kapalı örgütsel sınırlar yerine açık ve dağınık bilgi ortamları içerisinde ortaya çıkmaktadır. Açık kaynak yazılım (Open Source Software – OSS) ekosistemleri, bu dönüşümün en belirgin örneklerinden biri olarak kolektif bilgi üretimini, hızlı deneyselliği ve yeniliklerin geniş ölçekli yayılımını mümkün kılmaktadır. Benkler'in (2006) ağ temelli üretim yaklaşımı, açık kaynak inovasyonunu piyasa-dışı ancak yüksek koordinasyon kapasitesine sahip bir üretim biçimi olarak konumlandırmaktadır. Özellikle Yapay Zekâ ve Makine Öğrenmesi alanları, açık kaynak geliştirme pratiklerinin hem teknolojik hem de stratejik açıdan belirleyici olduğu alanlar hâline gelmiştir.

GitHub, açık kaynak işbirliğinin baskın platformu olarak inovasyon ekosistemlerinin nasıl yapılandığını, ölçeklendiğini ve yönlendirildiğini gözlemlemek için benzersiz bir ampirik ortam sunmaktadır. Stratejik yönetim perspektifinden bakıldığında bu tür ekosistemler, nötr bilgi havuzları değil; platform liderliği, mimari kontrol ve ağ dışsallıkları yoluyla şekillenen rekabetçi alanlardır (Tiwana, 2014). Bu yapısal özelliklerin anlaşılması, açık inovasyon ortamlarında değerin nasıl üretildiğini ve dağıtıldığını açıklamak açısından kritik önemdedir.

Bu bağlamda çalışma aşağıdaki araştırma sorularına odaklanmaktadır:

1. Açık kaynak AI/ML projeleri hangi tematik alanlar etrafında yoğunlaşmaktadır?
2. AI/ML açık kaynak ekosisteminde işbirliği ağlarının yapısal konfigürasyonu nasıldır?
3. Proje popülerliği ile işbirlikçilik düzeyi arasında sistematik bir ilişki var mıdır?

Çalışma, bu sorulara yanıt ararken açık inovasyon literatürünü ağ temelli analiz ve platform ekosistemleri perspektifi ile bütünleştirerek, açık kaynak AI/ML ekosistemlerinin stratejik yapısına ilişkin ilk kapsamlı ampirik haritalamalardan birini sunmayı amaçlamaktadır.

2. LİTERATÜR TARAMASI

Bu çalışma üç tamamlayıcı literatür hattına dayanmaktadır: açık inovasyon, ağ temelli inovasyon ve platform ekosistemleri. Açık inovasyon yaklaşımı, örgütsel sınırların geçirgenliğini ve dış bilgi akışlarının inovasyon süreçlerindeki stratejik rolünü vurgulamaktadır (Chesbrough, 2003). Baldwin ve von Hippel (2011), üretici-merkezli inovasyondan kullanıcı ve topluluk temelli inovasyona geçişi teorize ederek açık kaynak ekosistemlerinin neden hızla ölçeklenebildiğini açıklamaktadır.

Ağ temelli inovasyon literatürü, ilişkisel yapıların öğrenme, bilgi yayılımı ve yenilikçi performans üzerindeki belirleyici etkisine dikkat çekmektedir (Powell et al., 1996). Bu perspektife göre inovasyon çıktıları; ağ merkeziliği, aracılık konumları ve yapısal örüntülerle yakından ilişkilidir. Açık kaynak topluluklarında yönetişim ve liderliğin nasıl ortaya çıktığını inceleyen O'Mahony ve Ferraro (2007), merkezî projelerin ekosistemin yönünü belirlemedeki rolünü ampirik olarak göstermektedir.

Platform ekosistemleri literatürü ise dijital platformların ekosistemleri kurallar, standartlar ve mimari kontrol noktaları aracılığıyla yönettiğini vurgulamaktadır (Tiwana, 2014). Bu bağlamda açık kaynak projeleri, klasik anlamda hiyerarşik firmalar olmasalar da, fiilî platform liderleri aracılığıyla stratejik merkezileşme eğilimleri sergilemektedir. GitHub ekosisteminde popüler projelerin etrafında yoğunlaşan katkıcı ağları bu dinamiğin somut örneklerini sunmaktadır (Crowston et al., 2012).

3. YÖNTEM

3.1 Veri Toplama

Veriler GitHub REST API kullanılarak elde edilmiştir. "Artificial intelligence" ve "machine learning" anahtar kelimeleriyle yapılan arama sonucunda, yıldız sayısına göre sıralanan en popüler 100 AI/ML deposu örnekleme dâhil edilmiştir. Her bir depo için açıklamalar, kullanılan programlama dili, yıldız sayısı, fork sayısı ve katkıcı bilgileri toplanmıştır.

Örneklemin yıldız sayısına göre belirlenmesi, çalışmanın araştırma sorularıyla uyumlu biçimde ekosistem içinde yüksek görünürlük, benimsenme ve etki kapasitesine sahip projelere odaklanmayı amaçlamaktadır. Bu yaklaşım, platform ekosistemleri literatüründe sıklıkla kullanılan "çekirdek proje" odaklı örnekleme stratejisiyle örtüşmektedir.

Veri toplama süreci, Mayıs 2025 itibarıyla tek bir zaman kesitinde gerçekleştirilmiş olup, böylece dinamik katkı değişimlerinden kaynaklanabilecek zamansal yanlılıkların sınırlandırılması hedeflenmiştir. API üzerinden elde edilen tüm veriler JSON formatında indirilmiş ve analiz öncesinde yapılandırılmış veri setlerine dönüştürülmüştür.

3.2 Veri Ön İşleme

Depo açıklamaları; küçük harfe dönüştürme, noktalama işaretlerinin kaldırılması, durak kelimelerin elenmesi ve lemmatizasyon gibi standart doğal dil işleme adımlarından geçirilmiştir. Doğal dil işleme sürecinde İngilizce diline özgü durak kelime listeleri kullanılmış ve teknik anlam taşımayan genel ifadeler analiz dışı bırakılmıştır. Lemmatizasyon işlemi, kavram çeşitliliğini azaltarak tematik yapıların daha net biçimde ortaya çıkarılmasını amaçlamaktadır.

Ağ analizi için katkıcı–depo etkileşim matrisi iki parçalı (bipartite) bir ağ yapısı olarak kurgulanmış; daha sonra katkıcılar arası işbirliği ilişkilerini incelemek amacıyla tek modlu (contributor–contributor) projeksiyon ağı türetilmiştir. Bu işlem, aynı projede katkı sunan geliştiriciler arasında dolaylı işbirliği bağlarının modellenmesine olanak tanımaktadır.

3.3 Analitik Teknikler

Çalışmada üç tamamlayıcı analiz yöntemi kullanılmıştır:

- Konu modelleme (LDA)
- Ağ analizi (merkezilik ölçütleri)
- İstatistiksel analiz (Spearman korelasyonu)

Konu modelleme analizinde Latent Dirichlet Allocation (LDA) yöntemi tercih edilmiş; farklı konu sayıları denenerek model uyumu ve yorumlanabilirlik açısından en uygun yapı belirlenmiştir. Konular, depo açıklamalarında birlikte ortaya çıkan kelime örüntülerine dayalı olarak yorumlanmış ve AI/ML ekosistemindeki baskın tematik alanları temsil edecek şekilde adlandırılmıştır.

Ağ analizinde derece merkeziliği, aracılık (betweenness) merkeziliği ve yakınlık (closeness) merkeziliği gibi ölçütler kullanılarak projelerin ve katkıcıların ekosistem içindeki konumları değerlendirilmiştir. Bu ölçütler, belirli projelerin yalnızca popülerlik açısından değil, aynı zamanda bilgi akışını yönlendirme ve işbirliğini koordine etme kapasiteleri açısından da analiz edilmesini mümkün kılmaktadır.

İstatistiksel analiz aşamasında, proje popülerliği (yıldız sayısı) ile işbirliği yoğunluğu (fork sayısı, katkıcı sayısı ve ağ merkeziliği ölçütleri) arasındaki ilişkiler Spearman sıra korelasyonu kullanılarak test edilmiştir. Parametrik olmayan bu yaklaşım, değişkenlerin dağılım özellikleri ve olası uç değerler dikkate alınarak tercih edilmiştir.

Tüm analizler Python tabanlı açık kaynak kütüphaneler (ör. scikit-learn, NetworkX) kullanılarak gerçekleştirilmiş; yöntemsel şeffaflık ve tekrar edilebilirlik ilkeleri gözetilmiştir.

3.4 Araştırma Tasarımı ve Analitik Model

Bu çalışma, keşfedici (exploratory) ve açıklayıcı (explanatory) nitelikleri bir arada barındıran karma bir araştırma tasarımına dayanmaktadır. Araştırma tasarımı, açık kaynak AI/ML ekosistemlerinin yapısal ve tematik özelliklerini eş zamanlı olarak incelemeyi amaçlayan çok katmanlı bir analitik çerçeve üzerine kuruludur. Bu bağlamda çalışma, mikro düzeyde proje ve katkıcı etkileşimlerinden hareketle, ekosistem düzeyinde ortaya çıkan yapısal örüntüleri analiz etmektedir.

Analitik model üç temel bileşenden oluşmaktadır. Birinci bileşen, içerik temelli analizdir ve açık kaynak AI/ML projelerinin hangi teknolojik ve metodolojik temalar etrafında yoğunlaştığını belirlemeyi amaçlamaktadır. Bu aşamada konu modelleme yöntemi kullanılarak, proje açıklamalarında tekrar eden kelime kümeleri aracılığıyla ekosistemin tematik haritası çıkarılmaktadır.

İkinci bileşen, ilişkisel yapı analizidir. Bu aşamada açık kaynak ekosistemi, katkıcılar ve projeler arasındaki etkileşimler üzerinden bir işbirliği ağı olarak modellenmektedir. Ağ analizi, belirli projelerin veya aktörlerin ekosistem içinde merkezî konumlar üstlenip üstlenmediğini, bilgi akışının hangi düğümler üzerinden yoğunlaştığını ve platform liderliğine işaret eden yapısal konfigürasyonları ortaya koymayı hedeflemektedir.

Üçüncü bileşen ise açıklayıcı ilişkisel testlerden oluşmaktadır. Bu aşamada, proje popülerliği gibi görünür performans göstergeleri ile işbirliği ağındaki yapısal konumlar arasındaki ilişkiler istatistiksel olarak test edilmektedir. Böylece çalışmada, açık kaynak ekosistemlerinde görünür başarının kolektif işbirliği yoğunluğu ve ağ merkeziliği ile sistematik biçimde ilişkili olup olmadığı değerlendirilmiştir.

Bu çok katmanlı araştırma tasarımı, açık kaynak inovasyonunu yalnızca teknik üretim süreçleri olarak değil; aynı zamanda stratejik güç, koordinasyon ve yönetişim ilişkilerinin şekillendiği bir platform ekosistemi olarak ele almaktadır. Analitik model, açık inovasyon literatüründeki içerik odaklı yaklaşımlar ile ağ temelli stratejik analizleri bütünleştirerek dijital inovasyon ekosistemlerinin yapısal doğasına ilişkin daha bütüncül bir açıklama sunmayı amaçlamaktadır.

3.5 Araştırma Hipotezleri

Çalışmanın araştırma sorularına dayalı olarak aşağıdaki hipotezler geliştirilmiştir:

H1: Açık kaynak AI/ML ekosisteminde projeler, rastgele dağılmak yerine belirli çekirdek teknolojik ve metodolojik temalar etrafında anlamlı biçimde yoğunlaşmaktadır.

H2: Açık kaynak AI/ML projeleri arasındaki işbirliği ağı, eşitlikçi ve yatay bir yapıdan ziyade, merkezî düğümler etrafında yoğunlaşan bir ağ konfigürasyonu sergilemektedir.

H3: Proje popülerliği arttıkça, ilgili projenin işbirliği ağı içerisindeki merkezî konumu da artmaktadır.

H4: Açık kaynak AI/ML ekosisteminde merkezî konumda yer alan projeler, yalnızca daha fazla katkı çekmekle kalmamakta; aynı zamanda ekosistemin tematik yönelimlerini şekillendirme kapasitesine de sahip olmaktadır..

4. BULGULAR

Bulgular, açık kaynak AI/ML inovasyonunun belirli çekirdek teknolojiler etrafında yoğunlaştığını ve bu yoğunlaşmanın platform liderliği ile pekiştiğini göstermektedir. Konu modelleme sonuçları, beş baskın tematik kümeye işaret etmektedir: derin öğrenme çerçeveleri, doğal dil işleme, öğrenme ve eğitim kaynakları, bilgisayarlı görü ve veri bilimi. Bu kümeler, ekosistemdeki yenilikçi etkinliğin hem temel teknolojik yapıtaşları hem de bilgi yayılımını sağlayan araçlar etrafında toplandığını göstermektedir.

Ağ analizi sonuçları, katkıcı–depo etkileşimlerinin yüksek derecede merkezileşmiş, yıldız biçimli bir yapı sergilediğini ortaya koymaktadır. TensorFlow ve PyTorch gibi projeler, derece ve aracılık merkeziliği açılarından ekosistemin en merkezî düğümleri olarak öne çıkmakta; bu projeler hem teknik standart belirleyici hem de ekosistem koordinatörü rolü üstlenmektedir.

İstatistiksel analizler, depo popülerliği (yıldız sayısı) ile işbirlikçilik düzeyi (fork sayısı ve katkıcı sayısı) arasında güçlü ve pozitif ilişkiler bulunduğuna işaret etmektedir. Bu bulgular, görünür başarının (popülerliğin) açık kaynak AI/ML ekosistemlerinde artan işbirliği yoğunluğu ve daha merkezî ağ konumları ile birlikte seyrettiğini göstermektedir.

Genel olarak bulgular, açık kaynak AI/ML ekosistemlerinin hem tematik hem de yapısal düzeyde rastgele ve tamamen yatay yapılardan ziyade, çekirdek teknolojiler ve lider platformlar etrafında örgütlenen bir ekosistem mantığı ile işlediğini ortaya koymaktadır.

5. TARTIŞMA

Bulgular, açık kaynak inovasyonun yatay ve tamamen dağıtık bir yapıdan ziyade, merkezî çekirdekler etrafında örgütlenen bir ekosistem mantığıyla işlediğini ortaya koymaktadır. Bu durum, bu çalışmayı açık inovasyonun romantize edilmiş eşitlikçi anlatılarından ayırarak, daha gerçekçi ve stratejik bir çerçeveye yerleştirmektedir.

Genel olarak çalışma;

- Açık inovasyonu platform ekosistemleri perspektifiyle yeniden konumlandırmakta,
- Ağ merkeziliği üzerinden gizli güç ilişkilerini görünür kılmakta,
- Açık kaynak AI/ML ekosistemlerini bilişsel (tematik) ve yapısal (ağsal) olarak birlikte analiz eden bütünleşik bir çerçeve sunmaktadır.

Bu yönüyle çalışma, stratejik yönetim ve inovasyon literatüründe açık kaynak ekosistemlerine ilişkin daha gerçekçi ve çok boyutlu bir okuma önermektedir. Elde edilen bulgular, platform liderliği ve kümülatif avantaj dinamiklerinin yalnızca mülkiyete dayalı kapalı platformlarda değil, mülkiyetsiz ve topluluk temelli açık kaynak ortamlarında da güçlü biçimde işlediğini göstermektedir.

6. SONUÇ

Bu çalışma, açık kaynak Yapay Zekâ ve Makine Öğrenmesi (AI/ML) inovasyon ekosistemlerini konu modelleme, ağ analizi ve ilişkisel istatistiksel yöntemleri bir arada kullanan bütünleşik bir analitik çerçeveyle incelemiştir. Elde edilen bulgular, açık inovasyonun yaygın biçimde varsayıldığı gibi yapısız, tamamen yatay ve eşitlikçi bir süreç olmadığını; aksine tematik yoğunlaşma, yapısal merkezileşme ve stratejik yönlendirme dinamiklerinin birlikte var olduğu hibrit bir ekosistem yapısına işaret ettiğini ortaya koymaktadır.

Kuramsal açıdan çalışma, açık inovasyon literatürüne birkaç yönden katkı sunmaktadır. Öncelikle, açık kaynak inovasyonun bilişsel olarak sınırlı sayıda baskın teknolojik paradigma etrafında örgütlendiğini göstererek "açıklık" ile "dağınıklık" arasındaki örtük eşitliği sorgulamaktadır. Ayrıca, açık kaynak ekosistemlerinde formel hiyerarşiler bulunmasa dahi, belirli projelerin ağ merkeziliği yoluyla fiilî platform liderliği üstlenebildiğini ortaya koyarak platform ekosistemleri literatürünü mülkiyetsiz ve topluluk temelli ortamlara genişletmektedir. Proje popülerliği ile ağ merkeziliği arasındaki pozitif ilişki ise, açık inovasyon ortamlarında birikimli avantaj ve tercihli bağlanma dinamiklerinin işlediğini göstermektedir. Son olarak, merkezî projelerin yalnızca işbirliğini değil, aynı zamanda ekosistemin tematik ve bilişsel yönelimlerini şekillendirdiği bulgusu, platform gücünün bilişsel bir boyutu olduğunu vurgulamaktadır.

Yönetsel ve politika düzeyinde ise çalışma, açık kaynak AI/ML ekosistemlerine katılan aktörler için önemli çıkarımlar sunmaktadır. Bulgular, değer yaratımının yalnızca teknik katkıyla sınırlı olmadığını; ekosistem içindeki yapısal konumlanma ve baskın temalarla uyumun da kritik önemde olduğunu göstermektedir. Açık kaynak ekosistemlerinde liderlik hedefleyen aktörler açısından, formel kontrol mekanizmaları yerine teknik standart belirleme, problem tanımı ve işbirliği koordinasyonu yoluyla dolaylı bir liderlik stratejisinin daha etkili olabileceği anlaşılmaktadır. Politika yapıcılar açısından ise, açık kaynak ekosistemlerinin doğası gereği tamamen merkeziyetsiz alanlar olarak ele alınmasının sınırlı etki yaratabileceği; bunun yerine ekosistem içinde bütünleştirici rol oynayan merkezî projelerin desteklenmesinin daha yüksek sistemik fayda sağlayabileceği sonucuna ulaşılmaktadır.

Genel olarak çalışma, açık kaynak AI/ML inovasyon ekosistemlerini açıklık, yapı ve stratejinin iç içe geçtiği dinamik sistemler olarak ele alarak, dijital inovasyonun örgütlenme biçimlerine ilişkin daha gerçekçi ve çok boyutlu bir anlayış sunmaktadır. Çalışmanın kapsamı, GitHub üzerindeki en popüler 100 AI/ML deposu ile sınırlıdır; bu nedenle bulgular, daha geniş veri setleri ve boylamsal analizlerle derinleştirilmeye açıktır. Bu açıdan çalışma, ileride gerçekleştirilecek kapsamlı ampirik incelemeler için keşfedici bir başlangıç noktası ve referans çerçeve işlevi görmektedir.

KAYNAKÇA

Baldwin, C. Y., & von Hippel, E. (2011). Modeling a paradigm shift: From producer innovation to user and open collaborative innovation. *Organization Science*, 22(6), 1399–1417.

Benkler, Y. (2006). *The Wealth of Networks: How Social Production Transforms Markets and Freedom*. Yale University Press.

Chesbrough, H. W. (2003). *Open Innovation*. Harvard Business School Press.

Crowston, K., Wei, K., Howison, J., & Wiggins, A. (2012). Free/libre open-source software development: What we know and what we do not know. *ACM Computing Surveys*, 44(2), 1–35.

O'Mahony, S., & Ferraro, F. (2007). The emergence of governance in an open source community. *Academy of Management Journal*, 50(5), 1079–1106.

Powell, W. W., Koput, K. W., & Smith-Doerr, L. (1996). Interorganizational collaboration and the locus of innovation. *Administrative Science Quarterly*, 41(1), 116–145.

Tiwana, A. (2014). *Platform Ecosystems: Aligning Architecture, Governance, and Strategy*. Morgan Kaufmann.

DIGITAL PLATFORM CAPITALISM AND INNOVATION: VALUE CREATION AND EXPLOITATION FROM A CRITICAL PERSPECTIVE

DİJİTAL PLATFORM KAPİTALİZMİ VE İNOVASYON: ELEŞTİREL BİR PERSPEKTİFTEN DEĞER YARATIMI VE DEĞER SÖMÜRÜSÜNÜN ANALİZİ

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Abstract

Digital platform capitalism is increasingly reshaping the dynamics of value creation, innovation, and labor organization by embedding algorithmic management, data extraction, and ecosystem-based forms of control into everyday economic activity. This study presents the conceptual design and analytical framework of a broader research project that aims to examine how innovation processes operate within this emerging accumulation regime—not only as mechanisms of technological advancement, but also as instruments of value capture, labor disciplining, and structural dependency.

Grounded in a critical political economy perspective, the study conceptualizes digital platforms as value regimes in which innovation is simultaneously mobilized to generate economic value and to legitimize asymmetrical relations of control over labor, data, and market access. The research focuses on major actors in Turkey's platform economy—namely Trendyol, Getir, and Yemeksepeti—as analytically relevant cases for exploring how platform-based innovation is organized, justified, and governed.

Methodologically, the project is designed as a qualitative multi-case study. The planned empirical strategy combines semi-structured interviews with platform workers and ecosystem participants, alongside digital ethnography of online worker forums and social media communities. The analytical approach is structured around the Gioia methodology, enabling the identification of key conceptual dimensions such as value creation mechanisms, value capture strategies, invisible labor processes, and algorithmic forms of control.

The anticipated contribution of the study is to advance innovation management literature by offering a critical and context-sensitive account of value appropriation under platform capitalism, while also providing a conceptual basis for future empirical research and policy debates on fair value distribution, algorithmic transparency, and labor rights in digital economies.

Keywords: Digital Platform Capitalism; Innovation; Algorithmic Management; Value Regimes; Invisible Labor; Value Capture

Özet

Dijital platform kapitalizmi, algoritmik yönetim, veri çıkarımı ve ekosistem temelli kontrol biçimlerini gündelik ekonomik faaliyetlerin merkezine yerleştirerek değer yaratımı, inovasyon ve emek örgütlenmesi dinamiklerini giderek daha fazla dönüştürmektedir. Bu çalışma, inovasyon süreçlerinin bu yeni birikim rejimi içerisinde yalnızca teknolojik ilerleme mekanizmaları olarak değil, aynı zamanda değer el koyma, emeğin disipline edilmesi ve yapısal bağımlılık ilişkilerinin üretimi bağlamında nasıl işlediğini incelemeyi amaçlayan daha geniş bir araştırma projesinin kavramsal tasarımını ve analitik çerçevesini sunmaktadır.

Eleştirel politik ekonomi perspektifine dayanan çalışma, dijital platformları inovasyonun hem ekonomik değer ürettiği hem de asimetrik kontrol ilişkilerini meşrulaştırdığı değer rejimleri olarak kavramsallaştırmaktadır. Araştırma, Türkiye'de platform ekonomisinin önde gelen aktörleri olan Trendyol, Getir ve Yemeksepeti'ni, platform temelli inovasyonun nasıl örgütlendiğini, gerekçelendirildiğini ve yönetildiğini analiz etmek açısından analitik olarak anlamlı örnekler olarak ele almaktadır.

Yöntemsel olarak çalışma, nitel bir çoklu vaka çalışması şeklinde tasarlanmıştır. Planlanan ampirik strateji; platform çalışanları ve ekosistem katılımcılarıyla yapılacak yarı-yapılandırılmış derinlemesine görüşmeleri ve çevrimiçi çalışan forumları ile sosyal medya topluluklarını kapsayan dijital etnografiyi bir araya getirmektedir. Analitik yaklaşım, Gioia metodolojisi temelinde yapılandırılarak; değer yaratımı mekanizmaları, değer el koyma stratejileri, görünmez emek süreçleri ve algoritmik kontrol biçimleri gibi temel kavramsal boyutların ortaya çıkarılmasını hedeflemektedir.

Çalışmanın, inovasyon yönetimi literatürüne dijital platform kapitalizmi bağlamında eleştirel ve bağlamsal bir değer el koyma modeli sunarak katkı sağlaması; aynı zamanda dijital ekonomilerde adil değer dağılımı, algoritmik şeffaflık ve emek haklarına ilişkin politika tartışmaları için kavramsal bir zemin oluşturması beklenmektedir.

Anahtar Kelimeler: Dijital Platform Kapitalizmi; İnovasyon; Algoritmik Yönetim; Değer Rejimleri; Görünmez Emek; Değer El Koyma

1. GİRİŞ

Dijital platformlar, son yıllarda küresel kapitalizmin temel örgütlenme biçimlerinden biri hâline gelmiş; veri, algoritma ve ağ etkileri etrafında yeni bir değer yaratımı ve değer tahsisi rejimi üretmiştir. Platform kapitalizmi olarak kavramsallaştırılan bu yapı, yalnızca yeni iş modelleri ve inovasyon pratikleri yaratmakla kalmamakta; aynı zamanda emeğin örgütlenmesi, piyasa yapıları ve güç ilişkileri üzerinde derin dönüşümlere yol açmaktadır.

Mevcut inovasyon yönetimi literatürü, dijital platformları çoğunlukla verimlilik, ölçeklenebilirlik ve rekabet avantajı bağlamında ele almakta; inovasyonu teknik ve yönetsel bir çıktı olarak değerlendirmektedir. Buna karşın, inovasyon süreçlerinde üretilen değerin kim tarafından, hangi mekanizmalarla ve hangi toplumsal maliyetler üzerinden tahsis edildiği sorusu sınırlı biçimde incelenmiştir. Bu durum, özellikle platform ekosistemlerinde ortaya çıkan görünmez emek, algoritmik yönetim ve veri temelli gözetim pratiklerinin inovasyonla nasıl iç içe geçtiğini analiz etmeyi zorunlu kılmaktadır.

Bu çalışma, dijital platform kapitalizmi bağlamında inovasyonun yalnızca değer yaratan değil, aynı zamanda değer sömürüsünü yeniden üreten bir süreç olarak nasıl işlediğini eleştirel bir politik ekonomi perspektifiyle incelemeyi amaçlayan planlanan bir araştırma olarak kurgulanmıştır. Çalışma, inovasyonu teknik bir ilerleme olarak değil; ekonomik, normatif ve yönetişimsel boyutların birlikte işlediği politik bir süreç olarak ele almaktadır.

2. KURAMSAL ARKA PLAN

Platform kapitalizmi, bilgi-yoğun değer yaratımının bulut altyapıları, veri kümeleri ve algoritmik koordinasyon etrafında yoğunlaştığı yeni bir birikim rejimi olarak tanımlanmaktadır (Srnicek, 2017). Bu rejimde platform firmaları, ağ etkileri ve veri tekelleşmesi yoluyla inovasyonun hem yönünü hem de koşullarını belirleyen "kapı bekçileri" hâline gelmektedir (van Dijck vd., 2018). Platformlar, piyasaya erişimi düzenleyen ve ekonomik etkileşimleri yönlendiren kurumsal aktörler olarak giderek daha merkezî bir rol üstlenmektedir.

Eleştirel kuram geleneği, teknolojik gelişmenin iktidar ilişkilerinden bağımsız ele alınamayacağını vurgulamaktadır (Horkheimer & Adorno, 1947; Habermas, 1984). Bu çerçevede dijital platformlar, Harvey'nin (1987) esnek birikim yaklaşımıyla birlikte düşünüldüğünde, sürekli inovasyonu teşvik ederken artı-değerin merkezîleştirilmesini mümkün kılan sosyo-teknik yapılara dönüşmektedir. Platformların veri ve algoritmalar üzerindeki kontrolü, yalnızca ekonomik değil; aynı zamanda politik

ve toplumsal bir güç yoğunlaşması yaratmaktadır. Bu dönüşüm, platformları fiilî düzenleyici aktörler hâline getirmekte ve piyasa davranışlarını algoritmik mekanizmalar yoluyla yönlendirmelerine imkân tanımaktadır (Rahman & Thelen, 2019).

İnovasyon literatürü, açık inovasyon (Chesbrough, 2003), dijital inovasyon (Nambisan, 2017) ve değer yakalama (Teece, 1986) gibi yaklaşımlar üzerinden zenginleşmiş olsa da, bu çalışmalar çoğunlukla değer yaratımı sürecine odaklanmakta; değerin el koyma ve sömürü boyutunu ikincil plana itmektedir (Lazonick & Mazzucato, 2013). Dijital emek literatürü bu boşluğu kısmen doldurmakla birlikte, inovasyon süreçleri ile görünmez emek arasındaki ilişkinin bütüncül bir analitik çerçeveye kavuştuğunu söylemek güçtür.

Bu çalışma, söz konusu literatür boşluğunu değer rejimleri yaklaşımı ile ele almayı hedeflemektedir. Bu yaklaşım, platform ekosistemlerinde değer yaratımı ve değer sömürüsünün eşzamanlı olarak nasıl üretildiğini analiz etmeye olanak tanımaktadır (Dantas, 2019).Değer rejimleri, değerin yalnızca ekonomik bir çıktı olmadığını; ekonomik, normatif ve yönetişimsel unsurların belirli bir bileşimi olarak üretildiğini savunmaktadır (Levy, Reinecke & Manning, 2016). Platform kapitalizmi bağlamında inovasyon söylemi, bu değer rejiminin merkezî bir unsuru olarak işlev görmekte; verimlilik, hız ve kullanıcı katılımı gibi kavramlar etrafında meşrulaştırılan inovasyon pratikleri, değer sömürüsünü görünmez kılabilmektedir. Kullanım değeri ve anlam üretimi üzerinden ilerleyen katkılar, platform ekosistemlerinde görünmez emeğin nasıl değere dönüştürüldüğünü analiz etmeye olanak tanımaktadır (Andueza, 2020).

3. ARAŞTIRMA AMACI VE SORULARI

Bu planlanan araştırmanın temel amacı, dijital platformlarda inovasyon süreçlerinin hangi örgütsel ve sosyo-teknik mekanizmalar aracılığıyla değer yarattığını ve bu süreçlerin aynı anda nasıl sömürü ilişkileri ürettiğini analiz etmektir.

Bu doğrultuda çalışma şu araştırma sorularına odaklanacaktır:

1. Dijital platformlar inovasyonu hangi mekanizmalarla üretmekte ve yönlendirmektedir?
2. Aynı mekanizmalar, değer yaratımı ile değer sömürüsünü nasıl eşzamanlı hâle getirmektedir?
3. Bu süreçler, çalışanlar, tedarikçiler ve kullanıcılar açısından ne tür bağımlılık ve eşitsizlik biçimleri üretmektedir?

4. YÖNTEM:

4.1. Araştırma Tasarımı

Araştırma, çoklu vaka çalışması olarak tasarlanmıştır (Yin, 2018). Türkiye bağlamında dijital platform kapitalizminin farklı sektörlerdeki tezahürlerini incelemek amacıyla Trendyol, Getir ve Yemeksepeti platformları eleştirel vaka örneklemesi yoluyla seçilmiştir (Flyvbjerg, 2006). Bu platformlar, inovasyon söylemleri, veri temelli iş modelleri ve emek örgütlenme biçimleri bakımından karşılaştırmalı analiz için uygun örnekler sunmaktadır.

4.2. Veri Kaynakları

Araştırmada aşağıdaki veri kaynaklarının birlikte kullanılması planlanmaktadır:

- İkincil veriler: Şirket raporları, basın bültenleri, politika belgeleri, pazar ve rekabet raporları, TÜRKPATENT patent başvuruları.
- Birincil veriler: Yaklaşık 40 yarı-yapılandırılmış derinlemesine mülakat (yazılımcılar, kuryeler, esnaf ve yöneticiler) ile altı aylık dijital etnografi (çalışan forumları, sosyal medya grupları ve şikâyet platformları).

4.3. Analitik Yaklaşım

Verilerin, Gioia yöntemi temelinde çok aşamalı kodlama sürecine tabi tutulması planlanmaktadır (Gioia vd., 2013). Analiz süreci; değer yaratımı, değer el koyma, görünmez emek ve algoritmik sömürü

temaları etrafında yapılandırılacaktır. Kuramsal çerçeve ile saha verileri arasında abduktif bir ilişki kurulması hedeflenmektedir.

5. BEKLENEN BULGULAR VE ANALİTİK MİMARİ

Araştırmanın, dijital platformlarda inovasyonun:

- veri kontrolü ve algoritmik yönetim yoluyla merkezîleştirildiğini,
- görünmez emek ve katılımcı emeğin sistematik biçimde değere dönüştürüldüğünü,
- bu süreçlerin çalışanlar ve tedarikçiler açısından yeni bağımlılık ve sömürü biçimleri ürettiğini

göstermesi beklenmektedir.

Analitik çıktıların, platformların "kapı bekçiliği" rolü ve değer rejimleri bağlamında karşılaştırmalı olarak sunulması planlanmaktadır.

6. BEKLENEN KATKILAR

Bu çalışmanın, inovasyon yönetimi literatürüne eleştirel kuram temelli bir perspektif kazandırması ve dijital platformlarda değer yaratımı ile değer sömürüsünün aynı analitik çerçevede ele alınmasına katkı sunması beklenmektedir. Ayrıca Türkiye bağlamında platform kapitalizmine ilişkin ampirik bir araştırma zemini oluşturarak, politika ve düzenleme tartışmalarına kavramsal girdiler sağlaması amaçlanmaktadır.

KAYNAKÇA

Chesbrough, H. W. (2003). *Open innovation: The new imperative for creating and profiting from technology*. Harvard Business School Press.

Dantas, M. (2019). The financial logic of internet platforms: The turnover time of money at the limit of zero. *tripleC: Communication, Capitalism & Critique, 17*(1), 132–158. https://doi.org/10.31269/triplec.v17i1.1004

Flyvbjerg, B. (2006). Five misunderstandings about case-study research. *Qualitative Inquiry, 12*(2), 219–245. https://doi.org/10.1177/1077800405284363

Gioia, D. A., Corley, K. G., & Hamilton, A. L. (2013). Seeking qualitative rigor in inductive research: Notes on the Gioia methodology. *Organizational Research Methods, 16*(1), 15–31. https://doi.org/10.1177/1094428112452151

Habermas, J. (1984). *The theory of communicative action, Vol. 1: Reason and the rationalization of society* (T. McCarthy, Trans.). Beacon Press.

Harvey, D. (1987). Flexible accumulation through urbanization: Reflections on "post-modernism" in the American city. *Antipode, 19*(3), 260–286. https://doi.org/10.1111/j.1467-8330.1987.tb00375.x

Horkheimer, M., & Adorno, T. W. (1947). *Dialectic of enlightenment: Philosophical fragments*. Querido Verlag.

Lazonick, W., & Mazzucato, M. (2013). The risk–reward nexus in the innovation–inequality relationship. *Industrial and Corporate Change, 22*(4), 1093–1128. https://doi.org/10.1093/icc/dtt019

Levy, D., Reinecke, J., & Manning, S. (2016). The political dynamics of sustainable coffee: Contested value regimes and the transformation of sustainability. Journal of Management Studies, 53(3), 364–401. https://doi.org/10.1111/joms.12144

Nambisan, S. (2017). Digital entrepreneurship: Toward a digital technology perspective of entrepreneurship. *Entrepreneurship Theory and Practice, 41*(6), 1029–1055. https://doi.org/10.1111/etap.12254

Rahman, K. S., & Thelen, K. (2019). The rise of the platform business model and the transformation of twenty-first-century capitalism. *Politics & Society*, *47*(2), 177–204. https://doi.org/10.1177/0032329219838932

Srnicek, N. (2017). *Platform capitalism*. Polity Press.

Teece, D. J. (1986). Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. *Research Policy*, *15*(6), 285–305. https://doi.org/10.1016/0048-7333(86)90027-2

Van Dijck, J., Poell, T., & de Waal, M. (2018). *The platform society: Public values in a connective world*. Oxford University Press.

Yin, R. K. (2018). *Case study research and applications: Design and methods* (6th ed.). Sage Publications.

BREZİLYA'NIN EKOLOJİK BAŞKENTİ: CURİTİBA MODEL'İNDE RIT SİSTEMİ, EKOLOJİ ve SOSYAL POLİTİKA ENTEGRASYONU

BRAZİL'S ECOLOGİCAL CAPİTAL: INTEGRATİON OF THE RIT SYSTEM, ECOLOGY and SOCİAL POLİCY İN THE CURİTİBA MODEL

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ÖZET

Yarım asırdan fazla bir zamana yayılan inovatif planlama deneyimiyle Curitiba/Brezilya ekolojik başkent imajının karşılık bulduğu bir kent olarak belirginleşmiştir. Özellikle 70'li yıllardaki belediye yönetimi toplu taşımanın merkeze alındığı, yayaların öncelendiği, yeşil alanları güçlendiren bir yaklaşımla diğer yerel yönetim birimlerinden ayrılmıştır. Elbette coğrafi ve ekonomik yoksunlukların yarattığı mali sınırlılıkların etkisi yönlendirici olmakla birlikte mekânsal düzeyde elde edilen rasyonelliğe dayalı kazanımlar paradigmanın ön plana çıkmasını desteklemiştir. Mevcut doğrultuda küresel düzeyde popüler olan örneği Rede Integrada de Transporte (RIT) olarak bilinen transit ulaşım uygulamasıdır. Buradaki mekânsal rasyonalite kazanımı bilinen şekliyle bir metro projesi gerçekleştirmeden yolcu kapasitesi ve bunun için gerekli olan hizmet ölçeğine ulaşılmış olmasıdır. Ayrıca uygulamayla kent çevresinde yoğunlaşmış sosyoekonomik olarak alt seviyelerde yer alan grupların kent öbeklerine ulaşımı kolaylaşarak mal ve hizmet sunumlarına erişimi arttırılmıştır.

Taşkınla mücadeledeki tutumu yapay müdahalelerden ziyade doğayı reddetmeyen bir perspektif sunar. Açık veya kapalı beton kanallarla kontrol altında tutulmaya çalışılan akarsu güzergâhlarında bu yöntem tercih edilmeyerek su kontrolü park ve göletler kullanılarak sağlanmıştır. Yeşil alan ve parklara daha fazla kamusal alan ayrılmasını da sağlayan bu yaklaşım vatandaşların beklenti ve ihtiyaçlarını da karşılayan bir imkân olarak değer kazanmıştır. Aynı zamanda ekosistemin sürdürülebilirliğine de katkı sunan paradigma, tarihsel kabul gördüğü dönem dikkate alındığında önemli bir örnek olarak güçlenmiştir.

Curitiba hem sosyal politikaları destekleyen hem de atık yönetimine katkı sunan programlar geliştirmiştir. Bunlardan en popüler olanları çöp olmayan çöp ve yeşil takas gibi isimlerle küresel olarak da bilinirliğe erişmiş öncü uygulamalardır. Temel olarak programın esas başarısı geri dönüştürülebilir atıkları getirenleri ödüllendirmesine dayanmaktadır. Uygulamaya katılanlara bilet, meyve, sebze ve benzeri ödüller verilmektedir. Böylece bir yandan geri dönüşüm süreçleri güçlendirilirken diğer yandan özellikle ekonomik alt sınıfa destek sağlanmaktadır. Çalışma ekolojik başkent olarak anılan Curitiba'nın kazanımlarına odaklanarak başarısının arkasındaki temel dinamikleri incelemeyi amaçlamaktadır.

Anahtar Kelimeler: Curitiba, Sürdürülebilir Kentleşme, Entegre Ulaşım Ağı, Sosyal İnovasyon, Yeşil Altyapı

ABSTRACT

With an innovative planning trajectory spanning more than half a century, Curitiba (Brazil) has emerged as a city in which the image of an "ecological capital" has found concrete expression. In particular, the

municipal administration of the 1970s distinguished itself from other local governments through an approach that placed mass transit at the centre, prioritised pedestrians, and strengthened green areas. Although the financial constraints generated by geographical and economic disadvantages functioned as a guiding factor, the gains achieved through spatial rationality have supported the prominence of this paradigm. In this regard, the globally renowned example is the integrated transit system known as *Rede Integrada de Transporte* (RIT). The main achievement in terms of spatial rationality lies in reaching metro-level passenger capacity and service scale without implementing a conventional underground metro project. At the same time, the system has facilitated the access of socioeconomically disadvantaged groups concentrated on the urban periphery to different parts of the city, thereby improving their access to the provision of goods and services.

Curitiba's stance on flood management reflects a perspective that does not reject nature, rather than relying on heavy artificial interventions. Instead of attempting to control rivers through open or covered concrete channels, water management has been ensured through the use of parks and ponds. This approach, which also enables the allocation of more public space to green areas and parks, has generated amenities that meet citizens' expectations and needs. At the same time, the paradigm contributes to the sustainability of the ecosystem and, considering the historical period in which it gained recognition, has been consolidated as a significant and pioneering example.

Curitiba has also developed programmes that both support social policy and contribute to waste management. The most prominent among these are pioneering initiatives that have gained global visibility under labels such as Garbage That Is Not Garbage and Green Exchange. Fundamentally, the success of these programmes rests on rewarding those who bring in recyclable waste. Participants receive incentives such as tickets, fruit, vegetables and similar benefits. In this way, recycling processes are strengthened on the one hand, while on the other hand support is provided particularly to lower-income groups. Focusing on the achievements of Curitiba, often referred to as an ecological capital, this study aims to analyse the core dynamics underlying its success.

Keywords: Curitiba, Sustainable Urbanization, Integrated Transport Network, Social Innovation, Green Infrastructure

GİRİŞ

Kentlerin gelişimi nüfus artış hızının olumlu ve olumsuz etkilerine maruz kalmaktadır. Olumlu etkileri ise olumsuz etkilerine göre daha sınırlıdır. İşgücüne yönelik emek havuzunun artması, pazar büyümesi, farklı kültürdeki insanlar arasındaki etkileşimlerin getirdiği kazanımlar, kamu gelirlerinde artış veya kentsel ekosistemin büyümesiyle ortaya çıkan canlanma olumlu etkiler olarak değerlendirilebilir. Öngörülemeyen hızlarda yükselen nüfus artışlarının neden olabileceği olumsuzlukların başında ise kira ve konut fiyatlarındaki yükselişler; su, elektrik, iletişim, kanalizasyon kapasitesi ve atık yönetiminin yetersiz kalması; trafiğin neden olduğu zaman kayıpları, ses ve hava kirliliğinde artış; gelir eşitsizliğinin yükselmesi, artan nüfusla birlikte hizmet kalitesinde düşüş, gecekondulaşma ve bu gelişmeler dolayısıyla oluşan yönetimsel zorluklar yer almaktadır. Curitiba/Brezilya kenti de nüfus artışının etkilerine maruz kalan geçmişe sahiptir. Curitiba nüfusa dayanan problemleri aşabilmek için yenilikçi çözümler üretmeyi başararak tüm dünyaya örnek olmayı başarmıştır. Öyle ki kent 2023 senesinde en akıllı kent ödülüne layık görülmüştür ve bu kapsamda 25 bilgi teknolojisi içeren birime sahiptir (Chu et al., 2025; Pereira et al., 2025). Elbette bu ve benzer ödüllerle kentin takdir edilmesi tesadüfen elde edilen bir arka plana sahip değildir. Kent 20.yüzyılın ortalarından itibaren büyümenin kontrol altında tutularak insanlar için yaşanabilir ekosistemler üretmenin amaçlandığı bir anlayışı benimsemiştir (Araujo et al., 2025). Bu durum kente yönelik kararların oluşmasında çıkar ağlarına göre değil de kamusal akılla hareket edildiğinin açık bir göstergesi olarak takip edilebilmektedir. Zira kentin planlamayı içeren tarihi

yüzyıllar öncesine dayanmakta ve ulaşım planlamanın önemli başlıkları arasında yer almaktadır (Khayesi & Amekudzi, 2011). Dolayısıyla nüfus artışlarına yönelik gelişebilecek problemlerin çözümleri sadece bugünün politikaları olarak değil geçmişin katkılarını da barındırmaktadır. Radyal sistem öneren Agache planı ve doğrusal sistem öneren Wilheim planı geçmişin sunduğu katkıların başında gelmektedir (Khayesi & Amekudzi, 2011; Macedo, 2004). Fakat kentin ulaşım alanındaki deneyimi kusursuz değildir. Zira 2023 senesi itibariyle otomobil sayısı nüfus artışından fazladır (Chaves et al., 2024). Ulaşım için izlenen planlama yöntem ve çözümleri bugünün teknolojik sınırlılığı ve bugünün ulaşım araçlarını içerdiğinden planlamaların zaman içerisinde gerçekleşecek inovasyonlara yenik düşme olasılığı yüksektir. Bu nedenle planlamalar mümkün olduğunca dönüştürülebilecek esnekliğe sahip olmalıdır.

Nüfus artışının etkilediği bir diğer alanda erişebilirliğe dayalı eşitsizliklerde yarattığı farklılaşmalardır. Özellikle düşük gelire sahip bireylerin nispeten daha yavaş olan ulaşım süreçleri erişebilirliklerine de yansımaktadır (Araujo et al., 2025). Örneğin nüfusun hızla yükselmesiyle daha çok düşük gelirli insanların yoğunlaştığı toplu taşıma araçlarının verimliliği artan talepten negatif olarak etkilenmektedir. Benzer biçimde yoğun nüfus etkili doğum kontrol ve yönetim süreçlerini de etkileyebilmektedir. Örneğin doğum öncesi bakımda gerekli özverinin sağlanamaması ya da yeterli eğitim olmayışı prematüre ile ilişkilendirilebilmektedir (Fernandes Da Silva Frigotto et al., 2025). Bakım desteklerinin sağlanamaması veya bilgilendirme eğitimlerinin verilememesi de bu kapsamda değerlendirildiğinde insan hayatını etkileyen ve şekillendiren en önemli dinamiklerden birisi olarak nüfus başlığı öne çıkmaktadır.

CURİTİBA ve SOSYAL POLİTİKA ENTEGRASYONU

Curitiba da ulaşımın merkezini triner sistem üzerinden çalışan otobüsler oluşturmakla birlikte bu toplu taşıma sistemi entegre ulaşım ağı (RIT- Rede Integrada de Transporte) olarak bilinmektedir (Macedo, 2004). Temel olarak ulaşım ağı etrafında şehrin geliştirilmesinin kontrol edilerek çevresel yükün düşürülmesi ve sosyal olarak toplumun genelini kucaklamayı hedefler. Özel araçların azaltılması, yeşil takas gibi uygulamalarla bu hedef güçlendirilmeye çalışılır. Fakat ulaşım alanında anlamlı katkıları olmakla birlikte RIT toplumun sahip olduğu problemlerin bertaraf edilmesini tam olarak sağlayamamıştır. Örneğin kentte erkekler kadınlara oranla daha fazla imkana ulaşabilirken kadınların bu negatif statüsü gelir düştükçe daha fazla derinleşmektedir (Araujo et al., 2025). Dolayısıyla entegre ulaşım ağı her ne kadar pürüzsüz denebilecek şekilde lanse edilse de eşitsizliklerin azaltılabilmesi ve ortadan kaldırılması için revizyona ihtiyaç duyduğu açıktır.

Ekolojik ve çevresel problemlerin küresel ve yerel etkileri; bölgeler, ülkeler ve şehirler boyutu düşünüldüğünde birbirinden farklılıklar gösterebilmektedir. Bu nedenle aynı problemlere yönelik üretilen cevaplar birbirinden farklı olabilmektedir. Kent bu doğrultuda inovatif çözümler ortaya koymaktadır. Örneğin ülkedeki başka yerleşimler için serin çatı tercih edilirken Curitiba iklimi için sürdürülebilir tercih yeşil çatıdan yana olmuştur (Scolaro & Ghisi, 2025). Çöp olmayan çöp ve yeşil takas gibi kampanyalara rağmen atık yönetimi ve döngüsel ekonominin güçlendirilmesinde problemler varlığını sürdürmektedir. Curitiba özelinde geri dönüşüm oranı %5,7 gibi düşük bir değere sahiptir (da Silva, 2018). Nüfus artışının etkileri sadece insan merkezli problemlerle sınırlı değildir. Curitiba da yaşanan çevresel olumsuzluklar ve kentleşmeye dayalı problemler sel risklerini de arttırmış, bu olumsuzluğun önlenmesi içinde makine öğrenimi kullanılan metotlardan yararlanılmıştır (Prokopiuk et al., 2025; Rodrigues & Souza, 2024). Kentleşmenin doğayla uyumunun sağlanması ve insanın doğayı dikkate alarak politikalar oluşturması çevresel felaketlerin ortadan kaldırılabilmesi için elzem bir adım

olarak her zaman ön sıralarda yerini almaktadır. Fakat Brezilya'nın yük kapasitesi faktörü yaklaşık olarak son 50 senede 7,9'dan 3,35'e kadar düşmüştür (Saleem et al., 2024). Tahmin edilebileceği üzere bu durumda ülkenin ekolojik olarak ciddi problemleri olduğunu yansıtmaktadır.

Kenti bütüncül bir yaklaşımla ele alan sosyal politikaların oluşturulması multidisipliner bağlamda karşılık bulmaktadır. Örneğin prematürite ile sosyo-demografik etkenler ilişkilendirilirken bireyin kişisel gelişimini mikro sistemlerin biçimlendirdiği ifade edilmektedir (Fernandes Da Silva Frigotto et al., 2025; Jms et al., 2013). Dolayısıyla kentin ulaşım ve ekolojik alanda elde ettiği inovatif ilerlemeler her ne kadar pozitif olarak algılansa da sağlık ve sosyal alanlarda yaşanabilecek olumsuzlukların önüne geçebilmek için daha etkili önlemler alınması gerekmektedir. Zira kente ait 2019 senesi verilerine göre en zengin %10'un en yoksul %40'a oranla toplu taşıma üzerinden ulaşabildiği iş fırsatı 2,6 kat fazla olarak hesaplanmıştır (Turbay et al., 2024). Özellikle toplu taşımaya dayalı ulaşımın eşitlik sunması beklenirken eşitsizliğin kaynağı biçimine dönüşmesi faydaların dağıtımına ilişkin problemin en temel göstergesi olarak okunabilmektedir.

SONUÇ

Curitiba da toplu taşıma odaklı gelişmeye yönelik planlamalar makul çözümler olarak oluşturulmuş olsalar da zaman içerisinde bu temel hedeften uzaklaşılmıştır. Transit sistemlerin varlığı mekâna dayanan eşitsizliklerin güçlenmesini neden olmuştur. Başka bir ifadeyle ulaşıma dayanan soylulaştırma kendiliğinden gerçekleşmiştir. Bu durumun temel nedeni transit güzergahları, durakları ve yakın alanlarında ekonomik olarak güçlü olanların konumlanarak ekonomik olarak zayıf olanların ötelenmesidir. Böylece düşük gelire sahip gruplar güzergahlardan giderek uzaklaşmış ve kentin çevresini oluşturur konuma gelmiştir.

Sanayi öncesi kentlere benzer biçimde merkezde veya merkeze yakın alanlarda yüksek gelirli bireyler yaşarken merkezden uzaklaşıldıkça bireylerin gelirleri de benzer biçimde azalmaktadır. Bu durum Curitiba da toplu taşıma güzergahlarının etrafında yüksek gelirli bireyleri konumlandırmakta güzergahlardan uzaklaşıldıkça gelir düzeyi azalmaktadır. Ama bu uzaklaşma sadece ulaşımdan uzaklaşma değil yaşamın kendisinden de uzaklaşmak gibi bir anlama karşılık gelmektedir. Zira iş fırsatları başta olmak üzere sağlık, eğitim ve yaşama dair diğer olanaklardan da uzaklaşmak anlamına gelmektedir.

KAYNAKLAR

Araujo, A. S. de, Massucheto, J., Bugs, G. T., Saraiva, M. V. P., & Duarte, F. (2025). Unveiling inequalities: The intersection of gender and income in accessibility in Curitiba, Brazil. *Journal of Transport Geography*, *123*. https://doi.org/10.1016/j.jtrangeo.2025.104136

Chaves, M. G. D., da Silva, A. B., Mercuri, E. G. F., & Noe, S. M. (2024). Particulate matter forecast and prediction in Curitiba using machine learning. *Frontiers in Big Data*, *7*. https://doi.org/10.3389/fdata.2024.1412837

Chu, G. D., Torquato, J. V., Gallego, A. R., Rezende, D. A., & Okon, G. U. (2025). Public Services With Information Technologies in the Strategic Digital City Context: Curitiba, Brazil. *Revista de Gestão Social e Ambiental*, *19*(1), e011035. https://doi.org/10.24857/rgsa.v19n1-152

da Silva, C. L. (2018). Proposal of a dynamic model to evaluate public policies for the circular economy: Scenarios applied to the municipality of Curitiba. *Waste Management*, *78*, 456–466. https://doi.org/10.1016/j.wasman.2018.06.007

Fernandes Da Silva Frigotto, M., Santos Freire de Paula, I. C., Daniel, I. C., de Macedo Brondani, A., Mendes, A. L., Baldani, M. H., Carvalho, D. R., Rocha Orsi, J. S., & Werneck, R. I. (2025). Time series and factors associated with prematurity in live births in curitiba, brazil: time series analysis between the years 2000 and 2021. *BMC Pregnancy and Childbirth*, *25*(1). https://doi.org/10.1186/s12884-025-08152-4

Jms, B., Th, T., Mh, L., Va, M., & Lm, L. (2013). Assistência de enfermagem na violência doméstica (Vol. 17, Issue 1).

Khayesi, M., & Amekudzi, A. A. (2011). Kingdon's multiple streams model and automobile dependence reversal path: The case of Curitiba, Brazil. *Journal of Transport Geography*, *19*(6), 1547–1552. https://doi.org/10.1016/j.jtrangeo.2011.06.012

Macedo, J. (2004). Curitiba. *Cities*, *21*(6), 537–549. https://doi.org/10.1016/j.cities.2004.08.008

Pereira, G., Israel, C., Firmino, R., Kramer, H., & Abad, J. (2025). Building a Digital Wall: the political economy of smart surveillance in Curitiba, Brazil. *Globalizations*. https://doi.org/10.1080/14747731.2024.2447672

Prokopiuk, M., Rosa, A., & Nascimento Neto, P. (2025). Urban River Policies: Multilevel Analysis and Community Engagement in Curitiba. *Environmental Management*, *75*(4), 996–1011. https://doi.org/10.1007/s00267-025-02109-1

Rodrigues, G. T., & Souza, F. T. de. (2024). Urban flood forecast model: a data-based approach from the Ribeirão dos Padilhas river Basin, Curitiba (PR). *OBSERVATÓRIO DE LA ECONOMÍA LATINOAMERICANA*, *22*(5), e4575. https://doi.org/10.55905/oelv22n5-065

Saleem, S. H., Ahmed, D. H., & Samour, A. (2024). Examining the Impact of External Debt, Natural Resources, Foreign Direct Investment, and Economic Growth on Ecological Sustainability in Brazil. *Sustainability (Switzerland)*, *16*(3). https://doi.org/10.3390/su16031037

Scolaro, T. P., & Ghisi, E. (2025). Life cycle integrated multi-criteria decision model for roof assessment. *Energy and Buildings*, *336*. https://doi.org/10.1016/j.enbuild.2025.115628

Turbay, A. L. B., Pereira, R. H. M., & Firmino, R. (2024). The equity implications of TOD in Curitiba. *Case Studies on Transport Policy*, *16*. https://doi.org/10.1016/j.cstp.2024.101211

MEDELLÍN'DE SOSYAL KENTSELCİLİK: BÜTÜNLEŞİK KENTSEL PROJELER ve DOĞA TEMELLİ ÇÖZÜMLER

SOCİAL URBANİSM İN MEDELLÍN: INTEGRATED URBAN PROJECTS and NATURE-BASED SOLUTİONS

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ÖZET

Kentlerin kendine özgün tarihinden izler taşıyan sosyo-mimari dokuları toplumların geçirdiği değişimlerle farklılaşabilmektedir. Medellin bu değişimlerin takip edilebildiği bir gerçekliğe sahiptir. Medellin 20.yüzyılın son çeyreğinde küresel ölçekte en tehlikeli kentlerden birisi olarak gösterilmekteyken 21.yüzyılın ilk yıllarından itibaren sosyal kentselcilik örneklerinden birisine dönüşmüştür. Kentte sürekli olarak tırmanan kriminal gelişmeler bertaraf edilerek kentin sahip olduğu mal ve hizmetlere ulaşmada eşitliğin sağlanmasına yönelik adımlar atılmıştır. Bunların başında sosyal kapsayıcılığın güçlendirilmesi, yeşil koridor uygulamaları ve park kütüphaneleri gelmektedir.

Sosyal kentselciliğin somut yansımaları mekânsal farklılaşmalarda karşılığını bulmuştur. Özellikle Metrocable projesi sosyal kapsayıcılığı da destekleyen yönüyle gece kondu bölgelerini teleferik sistemle metro ağına dahil ederek iş, sağlık ve eğitim gibi ihtiyaçların karşılanmasını kolaylaştırmıştır. Ulaşım imkanının güçlendirilmesi algısının ötesinde kentsel aidiyetin içselleştirilmesine de katkı sunan uygulama; bütünleşik kentsel projeler çerçevesinde altyapı, sosyal yatırımlar ve kamusal alanlarda çeşitli inovasyonları da beraberinde getirmiştir. Ağaçlandırma çalışmaları başta olmak üzere yeşil alanların belirgin olarak gözlemlendiği yeşil koridorlar oluşturularak ısı adası etkisi azaltılmıştır. Kentin barınma için güvenli bulunmayan alanları toplumun ortak yararlanımına katkı sunan kamusal alanlar olarak planlanarak hem sosyal kapsayıcılık hem de ekolojik sürdürülebilirliğe yönelik tasarımlar gerçekleştirilmiştir. Böylece toplum afet risklerinden uzaklaştırılırken vatandaş memnuniyetine yönelik proje alanları yaratma fırsatı da doğmuştur.

Park kütüphaneler ekolojik katkılarının yanında çağın gerektirdiği dijital erişimi kolaylaştırmaktadır. Park ve kütüphaneleri bir araya getiren perspektif toplumsal etkileşimi de güçlendirmektedir. Bilgiye ulaşmadaki eşitsizliğin kaldırılması anlamı da taşıyan bu yapılar ayrıca dönüşümün simgesel boyutlarından birisi olarak da öne çıkmaktadır. Zira park kütüphaneler özellikle kentin sosyoekonomik anlamda dezavantajlı olarak tanımlanan bölgelerinde inşa edilmiştir. Sonuç olarak sosyal kentselcilik bağlamında Medellin de başarılı adımlar atılmış olsa da eşitsizlikler tamamen ortadan kaldırılarak beklenen başarıya istenilen düzeyde ulaşılamamıştır. Çalışma Medellin özelinde gerçekleştirilmiş önemli projeleri önceleyerek özellikle dezavantajlı kesimde yer alan gruplara yönelik uygulamaları analiz etmeyi amaçlamaktadır.

Anahtar Kelimeler: Medellin, Sosyal Kentselcilik, Bütünleşik Kentsel Projeler, Yeşil Koridorlar, Mekansal Adalet

ABSTRACT

The socio-architectural fabric of cities, which bears traces of their particular histories, can be reshaped by the social transformations that societies undergo. Medellín represents a striking case in which such transformations can be clearly observed. While Medellín was portrayed as one of the most dangerous cities in the world during the last quarter of the twentieth century, from the early years of the twenty-first century onwards it has become a prominent example of social urbanism. Escalating criminal dynamics in the city have been progressively contained, and steps have been taken to promote greater equity in access to urban goods and services. Central to these efforts are the strengthening of social inclusion, the implementation of green corridors, and the development of library parks.

The concrete manifestations of social urbanism have found expression in spatial transformations. In particular, the Metrocable project has supported social inclusion by integrating informal settlements into the metropolitan transport network through a cable car system, thereby facilitating access to employment, health and education. Beyond the perception of improved transport provision, this intervention has contributed to the internalisation of a sense of urban belonging and, within the framework of integrated urban projects, has been accompanied by various innovations in infrastructure, social investments and public spaces. Green corridors, in which green areas and especially tree-planting initiatives are visibly present, have been created to reduce the urban heat island effect. Areas of the city deemed unsafe for housing have been re-planned as public spaces that serve the common use of society, thus enabling designs that promote both social inclusion and ecological sustainability. In this way, communities are distanced from disaster risks, while new project areas are created that enhance citizen satisfaction.

Library parks not only generate ecological benefits but also facilitate the digital access required in contemporary society. The perspective that brings together parks and libraries also strengthens social interaction. These facilities, which are intended to mitigate inequalities in access to knowledge, stand out as one of the symbolic dimensions of Medellín's transformation. Indeed, library parks have been constructed particularly in neighbourhoods defined as socioeconomically disadvantaged. In conclusion, although significant steps have been taken in Medellín in the context of social urbanism, inequalities have by no means been fully eliminated and the anticipated level of success has not been entirely achieved. Focusing on the major projects implemented in Medellín, this study aims to analyse interventions that target groups located within the disadvantaged segments of society.

Keywords: Medellín, Social Urbanism, Integrated Urban Projects, Green Corridors, Spatial Justice

GİRİŞ

Sosyal şehircilik ve bütüncül şehircilik kavramları merkezi yönetim veya yerel yönetim birimlerinin şehre nasıl yaklaştıklarını, şehrin geleceğini nasıl tasavvur ettiklerine yönelik güçlü ipuçları sunmaktadır. Sosyal şehircilik kente yönelik politikaların ya da politikalara dayalı birbirinden farklı uygulamaların odağına rutin hayata yönelik iyileştirmeleri, toplumsal eşitliği ve dolayısıyla kapsayıcılığı oturtur. Temel çıkış noktası insan hayatını şekillendiren; güvenlik, sağlık, eğitim ve benzeri ihtiyaçları herkes için ulaşılabilir kılmaktır. Bu amaç doğrultusunda uygulanacak politikalar belirli bileşenler üzerinde yoğunlaşmayı gerektirir. Kentsel hizmetlere erişim eşitliği, kamusal alanın güçlendirilmesi, sosyal altyapı yatırımları, güvenliğin pürüzsüz biçimde sağlanması, yönetişim gibi çeşitli alanlar bunların başında gelir. Bütüncül şehircilik, sosyal şehirciliğin aksine kente tekil bileşenler üzerinden yaklaşmak yerine kenti bir bütün olarak ve tıpkı bir ekosistemi oluşturan farklı sistemlerin birlikte çalışarak var olması gibi ele alır. Bütüncül şehircilikte entegre planlama, çok ölçekli karar alma,

kurumsal eşgüdüm ve özellikle sürdürülebilirlikle dirençlilik ön plana çıkar. Medellin de gerçekleştirilen ise sosyal şehircilik amacıyla bütünsel kentsel projeler üzerine kurgulanan bir reform stratejisidir (Corburn et al., 2020; Perafán Del Campo, 2023). Şehrin güvenliğinin sağlanması noktasındaki karanlık geçmişi ve bu doğrultudaki global popülerliği ise şehirde yaşanan değişimin daha dikkat çekici bir boyuta taşınmasına katkı sağlamıştır.

Bütünsel kentçilik yaklaşımı Medellin çerçevesinde değerlendirildiğinde 20.yüzyılın son çeyreğindeki olumsuz durumdan 21.yüzyılın ilk yıllarındaki örnek gösterilen şehir imajına kavuşması yoğun bir dönüşüm stratejisi ve sosyal şehircilik kabulünün izlerini taşır. Kente sosyal bir bakış açısıyla yaklaşmak kentin adaletsiz, eşitsiz, sağlıksız yapısının ortadan kaldırılmasını gerektirir. Sosyal şehircilik böylece; adaletin, eşitliğin, güvenliğin sağlandığı toplumun tamamına ulaşmayı hedefleyen ve önkoşulsuz olarak tüm bireyleri kapsayan bir dinamikle hareket etmektedir. Sosyal şehircilik alt gelir grubuna dahil olmuş ya da gelir grubuna dayalı olarak belirli bölgelerde yaşamaya zorlanmış insanların hayatlarını kolaylaştırmak için yapılan yapı stoğunun değişmesi odaklı adımlarla gerçekleştirilemez. Buna ek olarak benzer zamanlar içinde burada yaşayan insanlara ve özellikle bu insanları hedefleyen politikaların hayata geçirilmesini de amaçlamaktadır (Corburn et al., 2020). Bu doğrultuda kentsel akupunktur, entegre altyapı ve hizmet yatırımları, yönetişim ve katılım ön plana çıkmaktadır.

MEDELLİN ve BÜTÜNSEL KENTÇİLİK

İnsanların kimlikleri gibi kentlerinde kendine özgü kimlikleri vardır. Bu kimlikliklerin oluşması kentin kültürel ve tarihsel toplamlarının bir yansıması olarak okunabilmektedir. Örneğin doğu Sibirya'da -60/65 santigrat derecelerde yaşayan toplumların giyinme standartları ile Basra körfezinde +50/55 santigrat derecelerde yaşayan toplumların giyinme standartlarının aynı olması beklenemez. Örnek; koşulların farklılaşmasıyla yaşamında benzer biçimde farklılaşmasının zorunluluğunu açıklamak adına anlamlıdır. Medellin de yaşanan değişimin merkezinde yer alansa coğrafi şartlardaki farklılığa benzer biçimde koşulların farklılaşması temeline dayanmaktadır. Sosyal kentçiliğin oluşması için gerekli olan temel bileşenler, farklılığa neden olan koşulların oluşturulması için dinamik bir role sahiptir.

Medellin özelindeki koşulların farklılaşması ise bütünsel kentsel projeler olarak ifade edilen kapsayıcı ve kent planlamasının parça parça veya spesifik bir alana özgü değil de kentin tamamını içerecek şekilde gerçekleştirilmesidir. Böylece kentin geçmişteki şiddet ve eşitsizliğe dayanan kötü popülaritesi yerini küresel alanda daha pozitif olan bir seviyeye taşımıştır (Garcia Ferrari et al., 2018; Humphrey & Valverde, 2017; Perafán Del Campo, 2023). Küresel problemlerin başında gelen ve çok sayıda insanın hayatını etkileyen eşitsizlik, ayrımcılık, gelir adaletsizliği ve güvenlik sorunları gibi problemlerin ortadan kaldırılması sosyal kentçiliğin birincil amaçlarındandır. Medellin 'deki problemlere yönelik oluşturulan politikaların odağında ise özellikle ekonomik olarak en alt seviyede yer alan grupların güçlendirilmesi hedeflenmiştir (Bonfantini et al., 2025; Corburn et al., 2020). Bu amaçla fiziksel bağlantı ve erişebilirlik, estetik ve sembolik yatırım, bütünleşik projeler ile yönetişim ve katılım konuları öncelikli alanlar olarak belirginleşmiştir.

Kentlerin en önemli problemlerinden birisi hizmet sunumlarının her zaman ve her yerde mutlak bir eşitlik sunamamasıdır. Toplumu oluşturan tüm üyelerin sunulan hizmetlerden benzer biçimde yararlanabilmesi için hizmete erişimdeki engeller veya zorluklar kaldırılmalıdır. Hizmet sunumları ister özel ister kamu kesimi tarafından gerçekleştirilsin toplumun tamamı için erişilebilir olmalıdır. Fakat yaşamın rutin gerçekleri bu beklentiyi engelleyebilmektedir. Özellikle özel kesimin kâr amacını önceleyerek gerçekleştirdiği yatırımlar ve politikalar dolayısıyla yüksek ekonomik gelire sahip bireylerin bulunduğu bölgeler; sunulan mal ve hizmetlere daha hızlı ve ihtiyaç duyduğu an ulaşabilirken, bireylerim ekonomik gücü azaldıkça mal ve hizmet erişimine olan mesafede artmaktadır. Medellin de gerçekleştirilen çalışmalar fiziksel bağlantı ve erişebilirlik temelinde yürüttüğü uygulamalarla kentin hizmet sunumunun yoğun olduğu bölgelere kentin çevresinde ve nispeten dış bölgelerinde kalan farklı ekonomik sınıftaki grupları da dahil etmeyi hedeflemiştir. Metrocable gibi projeler teleferik gibi uygulamalarla metro hatlarına ulaşımı kolaylaştıran imkanlar sunmaktadır. Ayrıca bu ve benzer projelerin bir diğer getirisi de bölgede yaşayan grupların görünürlüğünün arttırılmasını sağlamasıdır

(Dávila & Daste, 2013). Görünürlüğün artması kentsel var oluş ve farkındalığın güçlenmesini desteklemektedir.

Estetik ve sembolik yatırım çerçevesindeki yaklaşım, yoksul bölgelere metropol alanlardakine benzer biçimde en gösterişli, dikkat çeken ve kullanılabilir binalar inşa etmek gibi bir yöntemi izlemektedir. Bu binaların bölgede yaşayan insanların itibar, kendilerine saygı ve kabul görme gibi siyasi anlamlar iletmede güçlü bir rol oynadığı düşünülmektedir. Örneğin kütüphane parkları bu binalar arasında gösterilmektedir (Davey, 2018; Perafán Del Campo, 2023). Her ne kadar bina veya yapılar kullanılarak insanın farklılaşabileceği ya da değişebileceği konusu özellikle farklı ekonomik sınıflar dikkate alındığında geçici bir heyecan yaratabilir. Ne var ki insanı yücelten asıl gerçeklik binalardan ziyade bireylerin kendi içlerinde inşa ettikleri ikonik yapılara dayanır. Ayrıca devasa yapılar yanında küçücük kalan insana binanın gerçek sahibi ben büyüğüm mesajını da iletebilmektedir. Böylece bina sahibini güçlendirirken kullanan kişiyi ise zayıflatabilmektedir.

Bütünleşik projeler sadece metrocable gibi ulaşımla sınırlanan tek bir proje olmanın ötesine geçerek park kütüphanelerinde bu projeye eklenmesini gerektirir. Böylece kamu alanlarından konut bölgelerine, sosyal hizmetlerden çevresel düzenlemelere kadar pek çok alan bütüncül bir kapsamda gerçekleştirilmiş olur (Bonfantini et al., 2025; Corburn et al., 2020). Yönetişim ve katılım da bu süreçlerin güçlendirilmesi ve istenilen verimin elde edilebilmesi için vazgeçilmez katalizörlerin başında gelir. Karar alıcıların hangi politikaları uygulamaya koyacağı sorunsalı toplumun tüm kesimlerinin aktif katılımlarının sağlanabilmesini gerektirir. Demokratik zeminin güçlenmesi anlamına da gelen bu yaklaşım bireyin bir yandan farkındalığını arttırırken bir yandan da kendisine olan saygısına da çeşitli düzeylerde katkılar sunabilir.

Kentler; ekonomik gelir düzeylerine, statülere, ırklara, dinlere, dillere, ideolojilere veya cinsel yönelimlere dayanan ayrıştırıcı ve sınıflandırıcı bölünmelere tabi olabilir. Bu yapıya sahip kentlerde farklılığı keskinleştirecek politikalar üretilmesi geleceğin çatışma zeminini bugünden inşa etmek anlamına gelir. Bu bağlamda Medellin ‘in bütünsel kentçilik yaklaşımı fiziksel değişimlerle sınırlı kalmayıp geniş toplumsal katılımcılık ve kentsel kapsayıcılık alanlarında da kazanımlar elde etmiştir. Diğer taraftan pozitif kazanımlara rağmen eşitsizlikler devam etmektedir (Rojas-DeFrancisco et al., 2025; Stiller et al., 2025).. Zira kentsel problemin kökeninde yer alan ırksal eşitsizlikler ile yerleşik eşitsizlik örüntülerine gerektiği gibi yaklaşılmamıştır (Esquivel-Suarez, 2023). Güçlü sonuçlar elde edilebilmesi özellikle insanları farklılaştıran, ayrıştıran ve dışlayan söylemler ile bunlara dayalı eylemlerin bertarafının ne kadar sağlanabildiğine bağlıdır.

SONUÇ

Kentsel planlama da bütüncül olarak gerçekleştirilen bir yaklaşımla ortaya konulan politikalar zamanla karşılığını verebilmektedir. Medellin bu kapsamda değerlendirilebilecek kentler arasından elde ettiği başarılarla sıyrılmaktadır. Özellik en fakir kesimin yaşadığı bölgelere yapılan bilinçli yatırımlar altyapı ve eğitim gibi alanlar da değerli kazanımlar sağlamıştır. Fakat belirtilmelidir ki ulaşılan ilerlemelere rağmen fakirlik, eşitsizlik ve mekânsal zeminde yaşanan ayrışma varlığını devam ettirmektedir (Bonfantini et al., 2025; Corburn et al., 2020; Garcia Ferrari et al., 2018). Bu durum da ikonik yapılarla elde edilmek istenen verimin yeterli olamayacağını ispatlamaktadır. Zira bölge nüfusunun gıda, konut, eğitim gibi temel ihtiyaçlara erişimindeki güçlükler tamamen yok edilememiştir.

Medellin deneyimi sonraki kentsel planlamalar için kıymetli veriler içermektedir. Medellin de gerçekleştirilmek istenen; kentin çevresinde kalarak, uzun bir süre yeterli adım atılmamış bölgeleri kentle bir araya getirmektir. Bu amaçla yönetişim, katılımcılık, sosyal programlar, ulaşım ve eğitim gibi alanlar başta olmak üzere çeşitli boyutları kapsayacak biçimde bütüncül adımlar atılmıştır. Sonuç olarak süreç öncesi ve sonrasıyla bir bütün olarak değerlendirildiğinde; bir kentin dönüşümü ve ilerlemesinin teknokratların kusursuz planlamalarının yanında yönetişim, toplumsal katılımcılık ve politik istikrarla yakın ilişki içinde olduğunu göstermektedir.

KAYNAKLAR

Bonfantini, G. B., Galimberti, B., & Ventura, E. (2025). There Are No 'Solutions' in Urban Planning: Against the Idea of a Ready-Made Urbanism and the 15-Minute City's Uncritical Branding. *Land*, *14*(10), 2090. https://doi.org/10.3390/land14102090

Corburn, J., Asari, M. R., Pérez Jamarillo, J., & Gaviria, A. (2020). The transformation of Medellin into a 'City for Life:' insights for healthy cities. *Cities & Health*, *4*(1), 13–24. https://doi.org/10.1080/23748834.2019.1592735

Davey, T. (2018). Architecture in the News. *Thresholds*, *46*, 246–261. https://www.jstor.org/stable/48768636

Esquivel-Suarez, F. (2023). The Wiz Khalifa Controversy and Hip-Hop's Pablo Escobar Archives. *Cultural Politics*, *19*(2), 241–260. https://doi.org/10.1215/17432197-10434405

Garcia Ferrari, S., Smith, H., Coupe, F., & Rivera, H. (2018). City profile: Medellin. *Cities*, *74*, 354–364. https://doi.org/10.1016/j.cities.2017.12.011

Humphrey, M., & Valverde, E. (2017). A Tale of Dual Cities: The Urban Miracle and Humanitarian Crisis Maps of Medellín (2002–2015). *Journal of Iberian and Latin American Research*, *23*(2), 159–177. https://doi.org/10.1080/13260219.2017.1365927

Dávila, & Daste. (2013). Pobreza, participación y Metrocable. Estudio del caso de Medellín . *Boletín CF+S, 54*, 121–131.

Perafán Del Campo, E. A. (2023). The Aesthetics of the Social Rule of Law: The Case of Parque Biblioteca España in the City of Medellín. *Novum Jus*, *17*(2), 375–402. https://doi.org/10.14718/NovumJus.2023.17.2.15

Rojas-DeFrancisco, L., Mejía-Gil, M. C., & Giraldo Aristizábal, J. C. (2025). Transformation as city brand attribute for Medellín, Colombia: bottom-up tourist destination brand strategy. *Tourism Critiques: Practice and Theory*, *6*(1), 112–132. https://doi.org/10.1108/TRC-05-2024-0019

Stiller, D., Wurm, M., Sapena, M., Nieland, S., Dech, S., & Taubenböck, H. (2025). Does formal public transport serve the city well? The importance of semiformal transport for the accessibility in Medellín, Colombia. *PLOS One*, *20*(4), e0321691. https://doi.org/10.1371/journal.pone.0321691

FRAGILE BALANCES: EVIDENCE OF THE BUDGET DEFICIT-CURRENT ACCOUNT DEFICIT INTERACTION IN TURKEY (2010-2025)

KIRILGAN DENGELER: TÜRKİYE'DE BÜTÇE AÇIĞI-CARİ AÇIK ETKİLEŞİMİNİN KANITLARI (2010-2025)

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ABSTRACT

This study aims to empirically test the validity of the Twin Deficits Hypothesis in Turkey for the after 2008 global economic crises, characterized by significant economic transformations and policy shifts. Monthly data from 2010:01 to 2025:09 were obtained from official sources of Turkiye (The Central Bank of the Republic of Turkiye). The study employed time series econometric techniques, including structural unit root test, Granger causality and Johansen cointegration analysis. The analysis revealed a significant positive relationship between budget deficits and current account deficits in the long run (Johansen cointegration test). Granger causality tests showed that there is a bidirectional causality relationship between budget deficits and current account deficits. The empirical validity of the Twin Deficits Hypothesis for Turkey during the 2010–2025 period underscores a fundamental macroeconomic interdependence: ***fiscal and external imbalances are mutually reinforcing***. This finding necessitates an integrated and coordinated policy approach rather than isolated interventions. Turkey's path toward sustainable macroeconomic stability requires breaking this vicious cycle through a policy mix that combines ***fiscal discipline, structural transformation, and monetary policy coherence***. While fiscal consolidation is a prerequisite for easing external financing pressures, it must be carefully designed to avoid undermining growth and employment objectives in the short term. Therefore, expenditure rationalization and revenue enhancing reforms should be complemented by productivity-oriented industrial policies, energy independence initiatives, and incentives to boost private savings. In the long run, reducing twin deficits depends on elevating Turkey's production capacity, export sophistication, and national savings rate. This calls for institutional reforms that enhance the investment climate, encourage innovation, and build human capital. Ultimately, the simultaneous pursuit of ***responsible fiscal policy, competitive real sector transformation, and stability oriented monetary policy*** supported by transparent communication and strong institutions will enable Turkey to move from a twin deficits trap to a sustainable, investment driven growth model.

Key Words: Twin Deficits Hypothesis; Current Account Deficit; Budget Deficit; Johansen Cointegration.

ÖZET

Bu çalışma, önemli ekonomik dönüşümler ve politika değişiklikleriyle karakterize edilen 2008 küresel ekonomik kriz sonrasında, Türkiye'de İkiz Açıklar Hipotezinin geçerliliğini ampirik olarak test etmeyi amaçlamaktadır. 2010:01'den 2025:9'a kadar olan aylık veriler Türkiye'nin resmi kaynaklarından (Türkiye Cumhuriyet Merkez Bankası) elde edilmiştir. Çalışmada yapısal birim kök testi, Granger nedensellik ve Johansen eş-bütünleşme analizi de dahil olmak üzere zaman serisi ekonometrik teknikler

kullanılmıştır. Analiz, bütçe açıkları ile cari işlem açıkları arasında uzun vadede anlamlı bir pozitif ilişki olduğunu ortaya koymuştur (Johansen eş-bütünleşme testi). Granger nedensellik testleri, bütçe açıkları ile cari işlem açıkları arasında çift yönlü bir nedensellik ilişkisi olduğunu göstermiştir. 2010-2025 dönemi için Türkiye'de İkiz Açıklar Hipotezinin ampirik geçerliliği, temel bir makroekonomik karşılıklı bağımlılığın altını çizmektedir: mali ve dışsal dengesizlikler birbirini güçlendirmektedir. Bu bulgu, izole müdahalelerden ziyade bütünleşik ve koordineli bir politika yaklaşımını gerekli kılmaktadır. Türkiye'nin sürdürülebilir makroekonomik istikrar yolculuğu, mali disiplin, yapısal dönüşüm ve para politikası tutarlılığını birleştiren bir politika karışımı yoluyla bu kısır döngüyü kırmayı gerektirmektedir. Mali konsolidasyon, dış finansman baskılarını hafifletmek için bir ön koşul olsa da, kısa vadede büyüme ve istihdam hedeflerini baltalamaktan kaçınmak için dikkatlice tasarlanmalıdır. Bu nedenle, harcama rasyonalizasyonu ve gelir artırıcı reformlar, verimlilik odaklı sanayi politikaları, enerji bağımsızlığı girişimleri ve özel tasarrufları artırmaya yönelik teşviklerle desteklenmelidir. Uzun vadede, ikiz açıkların azaltılması Türkiye'nin üretim kapasitesini, ihracat kapasitesini ve ulusal tasarruf oranını yükseltmeye bağlıdır. Bu da yatırım ortamını iyileştiren, inovasyonu teşvik eden ve beşeri sermayeyi geliştiren kurumsal reformları gerektirmektedir. Sonuç olarak, sorumlu mali politika, rekabetçi reel sektör dönüşümü ve şeffaf iletişim ile güçlü kurumlar tarafından desteklenen istikrar odaklı para politikasının eşzamanlı takibi, Türkiye'nin ikiz açıklar tuzağından sürdürülebilir, yatırım odaklı bir büyüme modeline geçmesini sağlayacaktır.

Anahtar Kelimeler: İkiz Açıklar Hipotezi; Cari İşlem Açığı; Bütçe Açığı; Johansen Eşbütünleşme.

INTRODUCTION

The relationship between the budget balance and the current account balance, which are among the fundamental components of macroeconomic stability, is one of the current central debates in economic literature. Particularly, the economic transformations and policy changes following the 2008 global economic crisis have increased the importance of investigating the relationship between domestic and external balances, referred to as the fragile duality in developing countries like Turkey. There are three hypotheses examining the relationship between internal and external balances. The first of these is the Twin Deficits Hypothesis. The Twin Deficits Hypothesis was first introduced into the literature in the early 1980s, primarily based on research concerning the US economy. According to the hypothesis, budget deficits caused by expansionary fiscal policies lead to a current account deficit through channels of low national savings, high interest rates, and real exchange rate appreciation (Mundell, 1963; Fleming, 1962). Today, the Twin Deficits Hypothesis is seen not as an absolute economic law but as an important relationship to consider in shaping economic policies. The hypothesis is formulated based on the national saving-investment balance. According to the national accounting identity (Equation 1):

$$(T - G) = (S - I) + (NX) \quad (1)$$

In Equation 1, T-G = Public saving, S-I = Private sector saving-investment balance, NX = Trade balance. When rearranged (Equation 2):

$$\textit{Budget Deficit } (G\text{-}T) \approx \textit{Private Sector Investment-Saving Gap } (I\text{-}S) + \textit{Trade Deficit } (X\text{-}M) \quad (2)$$

According to Equation 2, the Twin Deficits Hypothesis posits that, under the assumption that (S and I) remain constant, an increasing budget deficit (G-T) will lead directly to an increase (i.e., a more negative value) in the current account deficit (NX). According to this hypothesis, fiscal discipline will positively contribute to achieving external balance.

Another hypothesis concerning the relationship between internal and external balances is the Current Account Deficits Hypothesis. According to this, the direction of causality between internal and external balances is the opposite of the Twin Deficits Hypothesis. Current account deficits arising from external shocks, structurally low savings rates, or loss of competitiveness disrupt the budget balance and cause deficits by leading to a slowdown in economic growth and consequently a decrease in tax revenues

(Makin, 2005). The proposed solution according to this hypothesis is addressing the structural problems feeding the current account deficit.

The third hypothesis to be considered in this field is the Ricardian Equivalence Hypothesis. This hypothesis rejects both of the above hypotheses (Barro, 1974). According to it, rational and forward-looking individuals know that government expenditures financed by today's borrowing (tax cuts) are equivalent to the present value of future tax liabilities. Therefore, individuals save the entirety of today's tax cut and do not change their consumption; accordingly, budget deficits do not have an effect on the current account. This hypothesis argues that there is no systematic relationship between the two deficits.

This study examines the validity of the Twin Deficits Hypothesis in the Turkish economy using monthly data from the period 2010:01-2025:09. Using data obtained from the Central Bank of the Republic of Turkey (CBRT, 2025), unit root tests accounting for structural breaks, Granger causality analysis, and the Johansen cointegration method will be employed. The findings aim to contribute to understanding the dynamics of Turkey's chronic twin deficits problem, determining the direction of causality, and thus providing an empirical basis for coordinating fiscal, monetary, and structural reform policies.

LITERATURE REVIEW

The theoretical foundation of the Twin Deficits Hypothesis is based on the work of Feldstein and Horioka (1980), which detected a high correlation between national saving and investment rates in OECD countries. This finding suggests that in contexts of limited capital mobility, budget deficits financed by domestic savings could raise interest rates and affect the exchange rate. McKinnon (1980s) reached results empirically supporting this hypothesis through the budget and current account expansions in the US during the Reagan era. On the other hand, Bernanke (2005) suggested that the primary cause of the US current account deficit in the 2000s was the global savings glut rather than budget deficits, offering a critical perspective on the hypothesis. Generally, in studies examined in the literature, it is observed that the Twin Deficits Hypothesis is supported for the US and some EU member countries, while a strong or stable relationship between budget deficits and current account deficits is not confirmed in countries like Japan and Germany. Regarding Turkey, it can be stated that due to differences in variables, analysis methods, and periods in the reviewed studies, debates on the Twin Deficits Hypothesis continue.

Table 1. Literature Review

Year	Author(s)	Country(ies)	Period	Method/Model	Hypothesis
2024	Hussain et al.	Asia-Pacific	1972-2021	ARDL, DOLS, FMOLS, CCR	Twin Deficits
2020	Nurudeen & Gamal	Nigeria	1981-2017	ARDL, DOLS, Toda-Yamamoto	Twin Deficits
2018	Chen & Liu	China	1995-2015 (Q)	SVAR	Twin Deficits
2018	Goyal & Kumar	India	1996-2015 (Q)	SVAR	Twin Deficits

Year	Author(s)	Country(ies)	Period	Method/Model	Hypothesis
2018	Helmy	Egypt	1975-2014	VECM	Ricardian Equivalence
2017	Magazzino & Forte	APEC	1980-2013	Panel VAR	Twin Deficits
2016	Kaygısız et al.	Turkey	2001-2014	Toda Yamamoto Causality	Ricardian Equivalence
2016	Kumar	India	1970-2013	ARDL	Twin Deficits
2016	Sevinç	Turkey	2006:1-2015:1	Granger Causality	Twin Deficits
2014	Şen et al.	Turkey	1980-2010	Granger Causality, VAR	Twin Deficits
2013	Uçal & Bölükbaş	Turkey	1996:1-2011:4	Johansen Cointegration	Current Account Deficits
2013	İyidoğan	Turkey	1987:1-2005:4	Toda-Yamamoto Causality	Current Account Deficits
2011	Tunçsiper, Sürekçi	Turkey	1987:1-2007:3	VAR-Granger Causality	Ricardian Equivalence
2008	Erdinç	Turkey	1950-2005	Cointegration, Granger	Twin Deficits
2001	Kuştepeli	Turkey	1975-1995	Johansen Cointegration, Causality	Ricardian Equivalence
2001	Kutlar & Şimşek	Turkey	1984:4-2000:2	Johansen Cointegration, ECM, Granger	Current Account Deficits

Year	Author(s)	Country(ies)	Period	Method/Model	Hypothesis
1989	Barro	Theoretical	-	Theoretical Article	Ricardian Equivalence

MODEL AND FINDINGS

Monthly data from the period 2010:01 to 2025:09 were obtained from official sources of the Republic of Turkey (Central Bank of the Republic of Turkey). The analyzed variables include the budget balance and the current account balance. The budget balance variable is the "General Budget Balance" account from CBRT EVDS's HMB - General Budget Balance and Financing (Thousand TL) (Monthly) data. The CA variable is the "Current Account" from CBRT EVDS's Balance of Payments Analytical Presentation data. In the study, unit root tests, Johansen cointegration, and Granger causality analyses were used to examine the relationship between the deficits. The Minimized Dickey-Fuller Unit Root Test with Structural Breaks was used to determine the stationarity properties of the variables.

Table 2. Minimized Dickey-Fuller Unit Root Test with Structural Breaks

Variable	Level	Specification	Break	t-stat.	Probability
CA_SM	Level	Trend & Constant	2010:04	-1.964	0.114
				(-3.465)	
BD_SM	Level	Trend & Constant	2012:05	-1.385	0.197
				(-4.008)	
CA_SM	First Difference	Trend & Constant	2022:08	-6.360*	0.000
				(-3.465)	
BD_SM	First Difference	Trend & Constant	2020:10	-8.385*	0.000
				(-4.008)	

*Note: * indicates significance at the 1% level.*

Table 2 shows that the variables become stationary when their first differences are taken. At this stage, to observe the relationship between the variables, a VAR model must first be constructed. As can also

be observed in Table 3, some basic information criteria are used to determine the optimal lag length for the VAR model.

Table 3. VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-7243.408	NA	2.10e+30	75.4938	75.5617	75.5213
1	-6792.956	882.1339	2.00e+28	70.8433	70.9790	70.8983
2	-6778.004	28.97081	1.79e+28	70.7292	70.9328	70.8117
3	-6707.775	70.26767	1.02e+28	70.1643	70.6394	70.3567
4	-6666.165	76.28573	6.87e+27	69.7726	70.3154	69.9924
5	-6642.803	42.34449*	5.62e+27*	69.5709*	70.1816*	69.8182*
* indicates lag order selected by the criterion						

Note: LR: sequential modified LR test statistic (each test at 5% level), FPE: Final prediction error, AIC: Akaike information criterion, SC: Schwarz information criterion, HQ: Hannan-Quinn information criterion

According to Table 3, all criteria suggest estimating a VAR model with five lags. Table 4 shows the partial correlation analysis (LM Test) results for the 5-lag VAR model, and Table 6 presents the heteroskedasticity test results for the same model. The model does not suffer from partial correlation or heteroskedasticity issues.

Table 4. Partial Correlation Analysis (LM Test)

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	16.68149	4	0.0022	4.254980	(4, 366.0)	0.0022
2	53.43704	4	0.0000	14.34164	(4, 366.0)	0.0000
3	41.14790	4	0.0000	10.85617	(4, 366.0)	0.0000

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
4	13.56616	4	0.0088	3.445589	(4, 366.0)	0.0088
5	7.131152	4	0.1291	1.795316	(4, 366.0)	0.1291

Table 6. VAR Residual Heteroskedasticity Tests (Levels and Squares)

Joint test:		
Chi-sq	df	Prob.
326.0088	66	0.11301

Table 7 presents the results of the VAR Granger Causality/Block Exogeneity Wald Tests. According to these, a bidirectional causality relationship is observed between the current account and the budget balance.

Table 7. VAR Granger Causality/Block Exogeneity Wald Tests

Dependent variable: D(CAD_SM)			
Excluded	Chi-sq	df	Prob.
D(BD_SM)	17.33408	5	0.0039
All	17.33408	5	0.0039

Dependent variable: BD_SM			
Excluded	Chi-sq	df	Prob.

Dependent variable: BD_SM			
D(CAD_SM)	19.06693	5	0.0019
All	19.06693	5	0.0019

Table 8 analyzes the existence of long-term relationships between the variables. Since the variables are stationary in first differences, Johansen cointegration analysis was used.

Table 8. Johansen Cointegration Analysis Results

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.332798	79.74029	15.49471	0.0000
At most 1	0.006350	1.235903	3.841465	0.2663

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level denotes rejection of the hypothesis at the 0.05 level*.**MacKinnon-Haug-Michelis (1999) p-values*

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.332798	78.50438	14.26460	0.0000
At most 1	0.006350	1.235903	3.841465	0.2663

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level denotes rejection of the hypothesis at the 0.05 level, **MacKinnon-Haug-Michelis (1999) p-values*

According to the Trace and Max-eigenvalue tests, there is one cointegrating equation at the 0.05 level. Within this scope, the cointegration equation is:

D(CAD_SM) = 0.10076 D(BD_SM)

t statistic: 2.18519

(Standard error in parentheses: 0.04611)

Table 9. Residual Stationarity Analysis: Minimized Dickey-Fuller t-statistic

Break Selection: Minimize Dickey-Fuller t-statistic
Lag Length: 0 (Automatic - based on Schwarz information criterion, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-7.598	< 0.01
Test critical values:	1% level	-5.347
	5% level	-4.860
	10% level	-4.607

*Vogelsang (1993) asymptotic one-sided p-values.

Table 9 presents the results of the residual stationarity analysis. The residuals are stationary at the level. Based on this result, an Error Correction Model (ECM) was estimated. According to the ECM results in Table 10, the EC(-1) variable indicates that approximately 57% of the long-term disequilibrium is corrected each period. The D(BD_SM) variable, with a positive and statistically significant coefficient of 0.511, shows that short-term changes in the budget have a significant effect on the dependent variable. The R^2 value of the model is 0.72, explaining 72% of the variation in the dependent variable.

Table 10. ECM Analysis Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.626	0.784	2.074	0.002
D(BD_SM)	0.511	0.155	3.297	0.000
EC(-1)	-0.574	0.232	2.474	0.000
R-squared	0.72			
Adjusted R-squared	0.71			

CONCLUSION AND RECOMMENDATIONS

The economic transformations and policy changes following the 2008 global economic crisis have increased the importance of investigating the relationship between domestic and external balances, referred to as the fragile duality in developing countries like Turkey. This study aims to empirically test the validity of the Twin Deficits Hypothesis in Turkey in the period following the 2008 global economic crisis, characterized by significant economic transformations and policy changes. Monthly data from 2010:01 to 2025:09 were obtained from Turkey's official sources (Central Bank of the Republic of Turkey). The study employed a structural unit root test, Granger causality, and Johansen cointegration analysis. According to the Johansen analysis results, there is a statistically significant ***long-term equilibrium relationship*** between the budget balance and the current account. In this context, the study supports the Twin Deficits Hypothesis. Policymakers, considering this strong and long-term connection between the budget balance and the current account balance, should anticipate that any policy intervention on the budget will have ***lasting and systemic effects*** on the current account balance and design policies accordingly.

The fact that the ***EC(-1) coefficient in the ECM result is negative (-0.57)*** indicates that deviations from equilibrium are corrected quickly (at a rate of 57%) in the next period. The model tends to self-correct toward equilibrium. In this context, the potential automatic correction mechanism will provide an advantage for policymakers. Knowing that the economy inherently seeks stability, ***avoiding overreaction to small-scale and temporary shocks*** is possible. Policies should be supportive of this natural stabilizing force. However, this also means that policy errors will produce results quickly; a wrong policy decision can rapidly negatively affect the economy.

The ***coefficient of the BD variable being positive (0.511) and statistically significant*** shows that short-term changes in the budget create a ***rapid effect*** on the current account. As a policy recommendation, budget policy can be evaluated. The Johansen test indicates that there is ***only one cointegration relationship***, meaning the system is shaped around a single long-term equilibrium. Based on this result, the view emerges that policymakers should focus on the fundamental long-term equilibrium as well as complex multiple balance goals.

REFERENCES

Barro, Robert J. (1989). The Ricardian Approach to Budget Deficits. Journal of Economic Perspectives, 3(2), 37-54.

Chena, Yong &, Liu, Dingming (2018). Government spending shocks and the real exchange rate in China: Evidence from a sign-restricted VAR model, Economic Modelling, 68, 543-554.

Fleming, J. M. (1962). Domestic financial policies under fixed and under floating exchange rates. *IMF Staff Papers, 9*(3), 369-380.

Ashima Goyal & Abhishek Kumar, 2018. "The effect of oil shocks and cyclicality in hiding Indian twin deficits," Journal of Economic Studies, Emerald Group Publishing Limited, vol. 45(1), 27-45.

Erdinç, Z. (2008), İkiz Açıklar Hipotezinin Türkiye'de 1950-2005 Yılları Arasında Eşbütünlesme Analizi ve Granger Nedensellik Testi İle İncelenmesi, Anadolu Üniversitesi Sosyal Bilimler Dergisi, 8(1), 209-222.

Heba E. Helmy (2018). The twin deficit hypothesis in Egypt, Journal of Policy Modeling Volume 40(2), 328-349.

Hussain, I., Hayat, U., Alam, M. S., & Khan, U. (2024). A dynamic analysis of the twin-deficit hypothesis: The case of a developing country. Asia-Pacific Financial Markets, 31(1), 25-52.

İyidoğan, V. P. (2013). The Twin Deficits Phenomenon in Turkey: An Empirical Investigation, Journal of Business, Economics & Finance, 2 (3), 36-42.

Kaygisiz, A, D, Kaya, D, G. & Kösekahyaoğlu, L. (2016). Test of 'Twin Deficit Hypothesis' for Turkey: An Analysis for 2001-2014 Period, Ömer Halisdemir Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, 9(4), 211-228.

Kuştepeli, Y. R. (2001). An Empirical Investigation of the Feldstein Chain for Turkey, Dokuz Eylül Üniversitesi İşletme Fakültesi Dergisi, 2(1), 99-108

Kutlar, A. & Şimşek, M. (2001). Türkiye'deki Bütçe Açıklarının Dış Ticaret Açıklarına Etkileri, Ekonometrik bir Yaklaşım: 1984:4–2000:2. Dokuz Eylül Üniversitesi İİBF Dergisi. 16(1), 1-13.

Magazzino, C. & Forte, F. (2015). Ricardian equivalence and twin deficits hypotheses in the euro area Journal of Social and Economic Development, 17, 148-166

Makin, A. J. (2005). *Global finance and the macroeconomy*. Palgrave Macmillan.

Mundell, R. A. (1963). Capital mobility and stabilization policy under fixed and flexible exchange rates. *The Canadian Journal of Economics and Political Science*, *29*(4), 475–485.

Nurudeen, A. & Gamal, A. A. M. (2020). An empirical investigation of the twin deficits hypothesis in Nigeria: evidence from cointegration techniques Contemporary Economics, 14(3), 285-305

Sevinç, E. (2016). Türkiye'de Cari Açık ve Bütçe Açığı Arasındaki İlişkinin Nedensellik Analizi, Bankacılar Dergisi, 96, 79-101.

Şen, A., Şentürk, M., Sancar, C. & Akbaş, Y. E. (2014). Empirical Findings on Triplet Deficits Hypoyhesis: The Case of Turkey, Journal of Economic Cooperation and Development, 35 (1), 81-102.

Tunçsiper, B. & Sürekçi, D. (2011). Türkiye'de İkiz Açıklar Hipotezinin Geçerliliğinin Zaman Serisi Analizi, Anadolu Üniversitesi Sosyal Bilimler Dergisi, 11 (3): 103-120.

Türkiye Cumhuriyet Merkez Bankası. (2025). *Elektronik Veri Dağıtım Sistemi (EVDS)*. https://evds2.tcmb.gov.tr

Uçal, H. & Bölükbaş, M. (2013). The Role of Twin Deficits Problem in Sustainable Growth: An Econometric Analysis for Turkey, Journal of Economic and Social Studies, 3 (2): 39-52.

SOL–GEL OXİDE BARRİERS FOR SUPERİOR CORROSİON RESİSTANCE: A $TİO_2$–ZRO_2 COMPARATİVE STUDY

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ABSTRACT

In this work, coatings of TiO_2 and ZrO_2 were synthesized by the sol–gel method and applied onto low-carbon steel and aluminum substrates using the dip-coating technique for enhancing their corrosion resistance. Polarized light microscopy was used to study the structural continuity, film density, and homogeneity of the surface of the coatings. It was found that the coatings on the aluminum substrate possessed a more homogeneous and stable morphology.

The corrosion performance was quantitatively assessed by means of electrochemical impedance spectroscopy (EIS). From Nyquist plots, charge-transfer resistance, film resistance and the capacitive responses were derived. The EIS data indicated that both types of oxide coatings significantly hampered ion transport at the metal-electrolyte interface due to the presence of an effective barrier. Significantly higher values of impedance modulus and R_ct

were recorded with the ZrO_2 coating deposited onto aluminum compared with other sample groups, confirming its better corrosion protection capability.

In all, results obtained from both coatings show that the surface modification approach based on the use of sol–gel-derived TiO_2 and ZrO_2 coatings can effectively improve the corrosion resistance of lightweight metal substrates at low cost and with practical applicability. Of the tested combinations, the ZrO_2–aluminum combination provided the highest protective performance observed in this study.

Key Words: Sol–Gel; Dip-Coating; Corrosion; TiO_2–ZrO_2

DİCLE'NİN KAYIP DÖNGÜSÜ: MİTOLOJİK BAKIŞ AÇISIYLA EKOLOJİK YAS

THE LOST CYCLE OF THE TİGRİS: ECOLOGICAL MOURNING THROUGH A MYTHOLOGİCAL LENS

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ÖZET

Bu bildiri, Mezopotamya coğrafyasının ekolojik ve kültürel boyutlarını Dicle Nehri üzerinden ele alarak, baraj projelerinin yol açtığı etkileri, mitolojik ve ekolojik yas perspektifleriyle tartışmaktadır. Özellikle Ilısu Barajı'nın inşasıyla birlikte Hasankeyf'in sular altında kalması ve Dicle Vadisi'nin ekosistemlerinin zarar görmesi, yalnızca çevresel bir tahribat değil, aynı zamanda kolektif hafıza ve kültürel ritüeller üzerinde de derin etkiler yaratmıştır. Çevrenin bu kaybına karşı duyulan bireysel/ toplumsal üzüntünün ve kederin, yani ekolojik yasın, görünür ve deneyimlenebilir bir biçimde ortaya çıkmasına yol açmaktadır.

Çalışmada, mitolojik anlatılar bu sürecin anlaşılmasında temel bir araç olarak kullanılmaktadır. Mezopotamya mitolojisinde su, yaşamın kaynağı ve dönüştürücü bir güç olarak konumlandırılmıştır. Enki'nin bilgelik suları, insan ile doğa arasındaki ilişkiyi düzenlerken; İnanna (İştar) ve Dumuzi'nin bereket döngüsü, doğanın ölüm ve yeniden doğuş ritmini temsil eder. Gılgameş'in yası ise ölümün ardından doğa ile yeniden bağ kurma arayışını simgeler. Günümüzde Dicle Nehri'nin akışının barajlarla kesilmesi, bu mitolojik döngülerin sembolik olarak kırılması anlamına gelmektedir. Mitolojik çerçeve, kaybın yalnızca fiziksel değil, duygulanımsal, kültürel ve etik boyutlarını da görünür kılar.

Ekolojik yas kavramı, bu bağlamda kaybın duyumsanmasını, hatırlanmasını ve yeniden yorumlanmasını mümkün kılar. Bu yas, sadece duygusal bir tepki değil, aynı zamanda toplumsal farkındalık, etik sorgulama ve yaratıcı eylem alanı olarak çevresel kimliği ele almaktadır. Sanatsal ve kültürel anlatılar, bu yasın ifadesinde ve dönüştürülmesinde merkezi bir rol oynar; kaybolan türlerin, kültürlerin, kimliklerin ve hafızanın sesini yeniden duyurur.

Sonuç olarak, Dicle Nehri'ni yalnızca bir su kaynağı olarak değil, hafıza, kimlik, mitoloji ve ekolojik yas hattı olarak konumlandırır. Bu perspektif, doğa ile ilişkilenmenin yeniden etik, duygulanımsal ve yaratıcı yollarını önermektedir. Ekolojik yasın farkındalığı hem doğayı, kültürel mirası hem de ekolojik kimliği (doğa/çevresel kimliği) koruma ve hatırlama pratiği olarak önem kazanmaktadır.

Anahtar Sözcükler: Dicle Nehri, Hasankeyf, Ilısu Barajı, ekolojik yas, Mezopotamya mitolojisi

ABSTRACT

This paper examines the ecological and cultural dimensions of the Mesopotamian landscape through the Tigris River, discussing the impacts of dam projects from both mythological and ecological grief perspectives. The construction of the Ilısu Dam, which submerged Hasankeyf and damaged the ecosystems of the Tigris Valley, represents not only environmental degradation but also profound effects on collective memory and cultural rituals. The individual and communal sorrow arising from this loss—ecological grief—manifests in tangible and experiential ways.

Mythological narratives play a crucial role.in understanding this process. In Mesopotamian mythology, water is conceived as both the source of life and a transformative force. Enki's waters of wisdom regulate the relationship between humans and nature, while the fertility cycle of Inanna (Ishtar) and Dumuzi represents the rhythm of death and rebirth in nature. The mourning of Gilgamesh symbolizes the attempt to reconnect with nature after death. Nowadays, the interruption of the Tigris River's flow by. dams symbolically disrupts these mythological cycles, revealing the loss not only in physical terms but also in emotional, cultural, and ethical dimensions.

The concept of ecological mourning allows this loss to be felt, remembered, and reinterpreted. It is not merely an emotional response but also a form of social awareness, ethical inquiry, and creative engagement with environmental identity. Artistic and cultural expressions play a central role in articulating and transforming this grief, giving voice to lost species, cultures, identities, and collective memory.

In conclusion, this paper positions the Tigris River not only as a source of water but also as a conduit of memory, identity, mythology, and ecological grief. This perspective proposes renewed ethical, emotional, and creative ways of relating to nature, emphasizing ecological grief awareness as a practice for preserving and remembering both the natural and cultural heritage.

Keywords: Tigris River, Hasankeyf, Ilısu Dam, Ecological Mourning, Mesopotamian Mytholog.

GİRİŞ

İklim krizlerinin ve olağanüstü ekolojik kayıpların hızla arttığı bir çağda yaşamaktayız. İnsan eylemleri, teknolojinin sağladığı imkânlarla birlikte giderek daha yıkıcı bir nitelik kazanmış; yaşamın tüm bileşenlerinin hakkını gözeten bir varoluş yerine, nehirler, dağlar, göller ve tüm ekosistemler, ekonomik çıkarlar doğrultusunda tahrip edilmiştir. İnsan-merkezci (antroposentrik) zihniyet, dünyada birlikte yaşadığımız tüm varlıkların haklarını ikinci plana itmiş; doğayı, yalnızca sermayeye dönüşebilecek bir kaynak olarak görmeye başlamıştır. Bu yaklaşımın yarattığı çevresel tahribat, hava, su ve toprak gibi temel kaynakların tükenmesine yol açarken, ekosistemlerdeki her müdahalenin birbirine bağlı diğer sistemleri de etkilediği daha görünür hâle gelmiştir. Bu durum, insanın kendi dışındaki canlı ve cansız varlıklarla kurduğu ilişkinin doğasını sorgulatan Antroposen çağının temel karakteri olarak tanımlanmaktadır (Yazgünoğlu, 2017-2018)

Çevresel bozulmalar genellikle fiziksel terimlerle ifade edilse de bu kayıplar bireylerde derin duygusal tepkiler uyandırmaktadır. Butler'ın belirttiği gibi, "eğer kaybedilen kişi değilse, kayıp nedir, nerededir ve yas nasıl gerçekleşir?" sorusu bu noktada belirleyicidir (Butler, 2018)Ashlee Cunsolo ve Neville Ellis, bu duygulanımı "ekolojik keder" olarak adlandırmış ve ekolojik kayıplara verilen doğal bir tepki olduğunu vurgulamışlardır (Cunsolo & Ellis, 2018) Cunsolo ekolojik yası, kederin ötesine geçen etik, ontolojik ve toplumsal bir farkındalık alanı olarak ele alır.

Mezopotamya bu bağlamda özel bir örnek sunar; çünkü bölgenin uygarlık tarihi Dicle ve Fırat'ın akışlarıyla şekillenmiştir. Su, Enki'nin bilgelik suları mitinde ((Bottéro & Kramer, 2021)görüldüğü üzere, yalnızca bir doğal unsur değil; yaratıcı düzenin, etik ilişkinin ve yaşamın taşıyıcısıdır. Ancak günümüzde Dicle Nehri'nin akışının barajlarla kesilmesi, yalnızca ekolojik bir yıkım değil; aynı zamanda mitolojik bir sürekliliğin kırılmasıdır. Ilısu Barajı ile Hasankeyf'in sular altında kalması, suyun yönünün ve akış ritminin değiştirilmesi, bazı yerlerde de suların çekilmesi (DoğaDerneği, 2018) hem somut kültürel mirası hem de bölgenin duygulanımsal hafızasını parçalayarak ekolojik yası derinleştirmiştir.

Bu çalışma, Enki'nin su-bilgelik anlayışı, İnanna (İştar) ve Dumuzi'nin bereket döngüsü, Gılgameş'in yası ile Dicle Nehri'nin güncel ekolojik dönüşümü arasında bağ kurarak, bu kaybın nasıl anlamlandırılabileceğini ekolojik yas perspektifinden tartışmayı amaçlamaktadır.

KAVRAMSAL ÇERÇEVE

Bu çalışma, insan–doğa ilişkilerindeki kırılmaları ve Dicle Nehri havzasında yaşanan ekolojik tahribatı anlamlandırmak için üç temel kuramsal ekseni bir araya getirir: **antroposen, ekolojik yas** ve **duygulanımsal/kültürel kayıp.** Bu kavramsal yapı ekosistemlerin çöküşünü, bu çöküşün insanlar ve topluluklar üzerindeki etik, duygusal ve ontolojik etkilerini bütüncül bir perspektiften incelemeyi amaçlamaktadır.

Antroposen ve İnsan Merkezcilik Eleştirisi

İçinde yaşadığımız dönem, insan eylemlerinin dünya sistemleri üzerindeki belirleyici etkisi nedeniyle "antroposen" olarak tanımlanmaktadır. Yazgünoğlu'nun (2017-2018, s. 67)belirttiği gibi, modern dünyada insan ("antropos") sürekli merkeze yerleşmekte, doğa ise geri plana itilmekte; böylece yaşamın tüm bileşenlerinin karşılıklı bağımlılığı göz ardı edilmektedir. İnsan merkezci bu zihniyet, doğayı yalnızca ekonomik çıkarlarla ilişkilendirilen bir kaynağa indirgerken, nehirler, dağlar, göller ve tüm diğer varlıklar üzerinde sınırsız bir tasarruf hakkı kurulduğu yanılsamasını üretir. On binlerce yıl boyunca oluşmuş doğal dengeler, insan faaliyetlerinin hızlandırdığı müdahalelerle geri dönülmesi güç biçimde sarsılmakta; toprağın mikrobiyal yaşamından solucanlara ve mantarlara, arılardan böceklere ve balıklara, yabani hayvanlardan ırmak yatakları boyunca varlık gösteren sucul bitkilere ve orman ekosistemlerine kadar yaşamın tüm bileşenleri çok katmanlı bir risk alanı içine sürüklenmektedir (Başkaya, s. 85) . Bu kırılgan tablo, Aldo Leopold'un *"Bir Dağ Gibi Düşünmek"* metninde dile getirdiği etik uyarıyla birlikte düşünüldüğünde daha da anlam kazanır. Leopold, bir kurdun öldürülmesini tek başına bir türün ortadan kaldırılması olarak değil, uzun zaman içinde kurulmuş bütün bir ekolojik dengenin sessizce çözülmesi olarak okur. Kurdu yok eden insan, kısa vadede güvenlik ya da kontrol duygusu elde ettiğini sanırken, aslında geyiklerin çoğalmasıyla bitki örtüsünün tahrip edilmesine, toprağın zayıflamasına ve sonunda dağın yaşam taşıma kapasitesinin çökmesine yol açar (Leopold, 2020). "Dağ gibi düşünmek", insanın doğayı yalnızca kendi ihtiyaçları üzerinden değerlendiren dar bakışını terk etmesini; ekosistemin hafızasını, ritmini ve karşılıklı bağımlılıklarını dikkate alan daha alçakgönüllü ve sorumlu bir ilişki biçimini benimsemesini önerir. Bir zamanlar görece uyum içinde işleyen insan dünyası, insan-merkezci erişim biçimleri ve mevcut gerçeklikle yaşadığımız dünya arasındaki derinleşen boşluk nedeniyle bugün bütünüyle sarsılmaktadır. Doğayı yalnızca müdahale edilecek bir alan olarak kavrayan bu bakış, ekolojik ilişkilerin zamansal ve mekânsal bütünlüğünü göz ardı ederek hem doğal sistemleri hem de insanın dünyayla kurduğu anlamlı bağı aşındırmaktadır (Morton, 2020, s. 101). Bu noktada derin ekoloji yaklaşımı, insan ile doğayı birbirinden ayıran ve insanı merkeze yerleştiren düalist düşünceyi kesin bir biçimde reddeder. İnsan ve doğayı karşıt kutuplar olarak değil, aynı varoluşun birbirine bağlı parçaları olarak ele alır. İnsanın dünyadan ayrı ve üstün bir özne olduğu fikrini sorgulayarak, ekolojik krizin yalnızca çevresel değil, aynı zamanda ontolojik bir kopuşun sonucu olduğunu ortaya koyar (Önder, 2003, s. 96).Bu bağlamda Dicle Nehri'nin akışının kesilmesi, yalnızca ekolojik bir tahribat değil; antroposen çağın hâkim iktidar biçimlerinin mekânda ete kemiğe bürünmüş hâlidir.

Ekolojik Yas: Kayıp, Duygulanım ve Etik Tanıklık

Ekosistemlerin çöküşü, biyolojik çeşitlilik kaybı, iklimsel dönüşümler ve mekânsal yok oluşlar yalnızca fiziksel sonuçlar doğurmakla kalmaz; aynı zamanda bireylerde ve topluluklarda derin duygulanımsal tepkiler üretir. Butler (2018, s. 47), kaybın öznesi insan olmayan varlıklar olduğunda yasın nasıl tanımlanabileceğine dair temel bir soru ortaya koyar: "Eğer kaybedilen kişi biri değilse, o hâlde kayıp

nedir ve yas nasıl gerçekleşir?" Bu sorgulama, insan ve insan dışı yaşam formları arasındaki ontolojik bağı görünür kılar.

Cunsolo ve Ellis (Cunsolo & Ellis, 2018), çevresel bozulma karşısında ortaya çıkan bu duygulanımı "ekolojik keder" olarak tanımlamış; bu kederin, kayıp verilen canlı/cansız varlıklarla kurulan ilişkinin bir sonucu olduğunu belirtmiştir. Ekolojik yas, bu nedenle hem bir duygusal tepki hem de bir **etik tanıklık** biçimidir. Cunsolo ve Landman'ın (2017) çalışmaları ise ekolojik yası, kültürel, toplumsal ve varoluşsal düzlemlerde yeniden anlamlandırılabilen bir süreç olarak ele alır. Ekolojik yası bu bağlamda düşündüğümüzde, çevresel yıkımın ve aşırı değişimlerin insanlarda yalnızca fiziksel değil, derin bir duygusal karşılık yarattığı açıkça görülür; buna rağmen bu deneyim çoğu zaman görünmez kılınır ya da bireysel bir kırılganlık olarak ele alınır. Küresel ısınmanın milyonlarca insanın yaşam koşullarını ve sağlığını tehdit ettiği artık bilimsel olarak kabul edilirken, bu kayıpların yarattığı keder, kaygı ve yas hâli kamusal ve politik tartışmalarda yeterince yer bulmaz. Ekolojik yas, tam da bu sessizliğe işaret eder; insanın yaşadığı psikolojik sarsıntıyı doğadan kopuk değil, bozulan ekosistemlerle kurduğu bağın bir sonucu olarak okur ve iklim krizinin 21. yüzyılın en büyük tehditlerinden biri olmasının, yalnızca çevresel değil, aynı zamanda ruhsal bir kriz anlamına geldiğini hatırlatır (Shield, 2018). Ekolojik yas perspektifinden ele alındığında, yaşanan duygusal yükün bireysel deneyimlerle sınırlı olmadığı, aksine giderek yaygınlaşan ve yapısal bir nitelik kazanan bir durum olduğu görülür. Ekolojik keder, eko-kaygı ve solastalji kavramları, insanların henüz fiziksel olarak yerlerinden edilmemiş olsalar bile, yaşadıkları çevreyle kurdukları bağın çözülmesiyle ortaya çıkan kayıp duygusunu tanımlar; çevre hâlâ "ev"dir, ancak ev olma hâli yavaş yavaş aşınmaktadır. Altıncı kitlesel yok oluşun sürdüğüne dair bilimsel bulgular ve Dünya Sağlık Örgütü'nün iklim değişikliğini bu yüzyılın küresel sağlığa yönelik en büyük tehdit olarak nitelemesi, bu yas hâlinin kişisel bir hassasiyet değil, kolektif bir deneyim olduğunu ortaya koyar. Bu bağlamda ekolojik yas, yalnızca ani felaketlerin ardından yaşanan travmalarla sınırlı kalmaz; mevsimlerin tanınmaz hâle gelmesi, aşırı hava olaylarının sıradanlaşması ve çevrenin yavaş ama sürekli değişimiyle biriken stres ve kaygı aracılığıyla, çağın derin ve çoğu zaman görünmez ruhsal izlerinden biri olarak şekillenir (Cavanagh, 2019). Ekolojik kederi benzersiz kılan hem henüz tam olarak tanınmayan hem de zamana yayılan bir kayıp deneyimi olmasıdır. Diğer keder türlerinden farklı olarak, ekolojik kayıplar ancak yakın zamanda meşru bir yas nedeni olarak adlandırılmaya başlanmış; çoğu zaman görmezden gelinen, kamusal alanda karşılık bulmayan ve bu nedenle "haklarından mahrum bırakılmış keder" olarak tanımlanan bir deneyim hâline gelmiştir. Değişimin günümüzde ulaştığı hız ve ölçek tarihsel olarak eşi benzeri görülmemiştir; buna karşın toplum, ekolojik kayıplarla baş etmeye yardımcı olacak ortak ritüelleri ve yas pratiklerini henüz yeterince geliştirememiştir. Yine de buzullar için düzenlenen anma törenleri ya da kaybolan ekosistemlere adanan sanat ve anlatılar, bu boşluğun yavaş yavaş doldurulmaya çalışıldığını göstermektedir. Ekolojik keder aynı zamanda yalnızca yaşanmış kayıplara değil, hiç gerçekleşmeyecek geleceklerin yasına da dayanır; yok olacak türler, deneyimlenemeyecek mevsimler ve aktarılmayacak yaşam biçimleri için tutulan bu yas, özellikle genç kuşaklarda derin bir belirsizlik duygusu yaratır (Carr, 2020). Üstelik bu kayıpların çoğu ani değil, yavaş ve sürekli biçimde ilerlediğinden, ekolojik keder sonu olmayan, zamana yayılan bir yas hâli olarak çağın ruhsal manzarasına yerleşir.

Kültürel ve Mitolojik Sürekliliğin Kırılması

Dicle Nehri binlerce yıldır Mezopotamya kültürlerinin yaşam döngüsünü besleyen bir varlık olmuştur. Enki'nin "bilgelik suları" miti, Mezopotamya düşüncesinde suyun yalnızca yaşamı sürdüren maddi bir kaynak olmadığını, aynı zamanda varoluşun düzenleyici ilkesini temsil ettiğini gösterir. Enki, yeraltındaki tatlı su kaynağı **Abzu**'nun efendisi olarak, bilgiyi, yaratıcılığı ve düzen kurma yetisini bu sular aracılığıyla dünyaya dağıtan bir tanrıdır. Bilgelik suları, kozmik kaos ile düzen arasındaki geçiş alanını simgeler; yaratılışın sürekliliği, tanrılarla insanlar arasındaki ilişki ve doğanın döngüsel işleyişi bu akış içinde anlam kazanır. Bu bağlamda su, yalnızca bedenleri besleyen bir unsur değil, etik bilginin, adaletin ve sorumluluğun da taşıyıcısıdır (Bottéro & Kramer, 2021, s. 167-183). Enki'nin suları, yaşamın tüm formlarını birbirine bağlayan bir hafıza ve aktarım alanı olarak düşünülür; insanın doğayla kurduğu ilişkinin karşılıklı, koruyucu ve dengeli olması gerektiğine dair erken bir ekolojik bilinç önerir.

İnanna (İştar) ve Dumuzi'nin bereket döngüsü, Mezopotamya mitolojisinde doğanın mevsimsel ritmini, yaşam–ölüm–yeniden doğuş döngüsünü ve bereketin sürekliliğini anlatan en güçlü anlatılardan biridir. İnanna, aşkın, bereketin ve üretkenliğin tanrıçası olarak yeryüzündeki canlılığı harekete geçiren ilkeyi temsil eder; Dumuzi ise çoban-kral figürüyle toprağın verimliliğini, sürülerin çoğalmasını ve tarımsal bolluğu simgeler. Bu ikilinin birliği, doğanın canlanmasıyla eşdeğer görülür: İnanna'nın arzusu ve yaratıcı gücü, Dumuzi aracılığıyla toprağa işler ve bereket ortaya çıkar (Bottéro & Kramer, 2021, s. 312-333). Ancak döngü yalnızca çoğalmayı değil, kaybı da içerir. İnanna'nın yeraltı dünyasına inişiyle başlayan mitolojik süreçte, yaşam askıya alınır; İnanna'nın dönüşü için bir bedel gerekir ve bu bedel Dumuzi'nin yeraltına gönderilmesi olur. Dumuzi'nin yılın bir bölümünü yeraltında geçirmesi, kuraklık, kış ve doğanın geri çekilişiyle ilişkilendirilir (Williamson & McMenemy, 2023, s. 59-62). Onun yeryüzüne dönüşü ise baharın gelişi, bitkilerin yeniden yeşermesi ve yaşamın canlanması anlamına gelir.Bu anlatı, bereketin kesintisiz bir bolluk hâli değil, yas, kayıp ve dönüşümle iç içe geçen döngüsel bir süreç olduğunu vurgular. İnanna ve Dumuzi miti, doğanın ritminin insan yaşamıyla ayrılmaz biçimde bağlantılı olduğunu; üretimin, sevginin ve yaşamın ancak geçicilik ve fedakârlık kabul edildiğinde sürdürülebileceğini anlatır. Bu yönüyle mit, ekolojik dengeyi ve yaşamın sürekliliğini anlamak için erken bir kozmolojik ve etik çerçeve sunar.

Gılgameş'in yası, kavramsal düzeyde, insanın ölümle karşılaşmasının ardından varoluşunu yeniden konumlandırma ve doğayla kurduğu ilişkiyi sorgulama sürecini temsil eder. Enkidu'nun ölümü, Gılgameş için yalnızca bir dostun kaybı değil; insanın doğa karşısındaki kırılganlığının ve sınırlılığının açığa çıkmasıdır. Bu yas, insanı kültür, kent ve iktidar alanından çıkararak doğanın zamansal ve mekânsal ritimleriyle yüz yüze getirir. Gılgameş'in yolculuğu, ölümsüzlüğü arama çabası üzerinden, insanın doğayı aşma ve denetleme arzusunu görünür kılarken; bu çabanın kaçınılmaz başarısızlığı, insanın doğa içindeki yerini kabullenmeye zorlayan dönüştürücü bir eşik oluşturur (Bottéro & Kramer, 2021, s. 545). Kavramsal olarak Gılgameş'in yası, kaybın yalnızca yıkıcı değil, insanı doğayla yeniden bağ kurmaya yönelten, insan-merkezci yanılsamaları çözen ve varoluşu ekolojik bütünlük içinde yeniden düşünmeye açan bir süreç olduğunu ortaya koyar.

Nehrin modern müdahalelerle akışının kesilmesi, yalnızca ekolojik bir yıkım değil; **mitolojik ve kültürel sürekliliğin, bölge topluluklarının tarihsel hafızasının ve duygulanımsal bağlarının** kopması anlamına gelir. Böylece ekolojik kayıp, aynı zamanda **kültürel ve ontolojik bir kayba** dönüşür.

YÖNTEM

Bu çalışma, Dicle Nehri'nin ekolojik dönüşümünü, Mezopotamya mitolojisindeki su kavrayışıyla birlikte ele alan nitel ve yorumlayıcı bir araştırma yaklaşımını benimser. Araştırmanın amacı fiziksel ekolojik verileri ölçmekten ziyade, bu dönüşümlerin duygulanımsal, kültürel, etik ve ontolojik boyutlarını açığa çıkarmak olduğundan, yöntem temelde üç analitik düzlem üzerine kurulmuştur:

Metin-Analitik ve Mitolojik Çözümleme

Çalışmanın ilk aşamasında, Mezopotamya'nın su merkezli mitolojik anlatıları – özellikle Enki'nin bilgelik suları, İnanna–Dumuzi döngüsü ve Gılgameş anlatısındaki yas temaları – metin-analitik bir yaklaşımla incelenmiştir. Bu çözümleme, mitlerin doğa-insan ilişkisini nasıl kavramsallaştırdığını, suyu hangi etik ve kozmolojik anlamlarla yüklediğini ve bu anlamların güncel ekolojik tahribat bağlamında nasıl yeniden okunabileceğini ortaya çıkarmayı amaçlar. Bu aşamada mitler, toplumsal hafızayı, kültürel sürekliliği ve duygulanımsal ekolojiyi anlamlandırmak amacıyla hermenötik bir araç olarak ele alınmıştır.

Kavramsal Analiz: Antroposen ve Ekolojik Yas

İkinci aşamada, çalışmanın kavramsal çerçevesini oluşturan antroposen, insan merkezcilik, ekolojik kayıp ve ekolojik yas kavramları, doğrudan araştırmanın dayandığı temel kaynaklar üzerinden analiz edilmiştir (Başkaya, 2019) (Carr, 2020) (Butler, 2018) (Cavanagh, 2019) (DoğaDerneği, 2018) (Leopold, 2020) (Yazgünoğlu, 2017-2018) (Önder, 2003) (Bottéro & Kramer, 2021). Bu kavramsal analiz, ekolojik yıkımın yalnızca biyofiziksel bir süreç değil, aynı zamanda duygulanımsal ve etik bir deneyim olduğunu açıklamak için gerekli teorik zemini kurar. Ekolojik yasın bireysel ve kolektif düzeyde nasıl ortaya çıktığı, alan yazındaki bu temel çalışmalar ışığında tartışılmıştır.

Eleştirel Ekososyal Okuma ve Dicle Nehri İncelemesi

Üçüncü aşamada, Dicle Nehri'nin akışının baraj projeleriyle kesilmesi, Hasankeyf'in su altında kalması ve bölge ekosisteminin dönüşümü, eko sosyal bir perspektiften değerlendirilmiştir. Bu değerlendirme şu ilkeler doğrultusunda yapılmıştır: Doğa-insan ilişkilerini karşılıklı bağımlılık temelinde ele alma, kültürel ve ekolojik kaybı birlikte düşünme, mekânın yitimiyle ortaya çıkan duygulanımsal ve etik kırılmaları görünür kılma. Veriler nicel değil nitel olduğu için, Dicle Nehri'ndeki bu ekolojik müdahaleler yorumlayıcı bir analiz üzerinden çözümlenmiş; mitolojik, kültürel ve ekolojik temalar arasında ilişkisel bir okuma kurulmuştur. Dicle Nehri, mekânsal bir kaynak olmanın ötesinde bir mitolojik, duygulanımsal ve kültürel hafıza hattı olarak ele alındığından, araştırmada nicel bir çevresel değerlendirme yerine çok katmanlı nitel bir yaklaşım tercih edilmiştir. Bu yöntem sayesinde: Mitolojik anlatılar, modern ekolojik kriz, ekolojik yas kavramı tek bir bütüncül analitik çerçeve içinde okunabilmiştir.

ARAŞTIRMA PROBLEMİNİN ANALİZİ

Dicle Nehri ve Hasankeyf havzası üzerinde gerçekleştirilen büyük ölçekli baraj projeleri, özellikle Ilısu Barajı, yalnızca ekolojik bir tahribata değil, aynı zamanda kültürel, mitolojik ve duygulanımsal kırılmalara yol açan çok katmanlı bir yıkım üretmiştir. Ilısu Barajı Çevresel Etki Değerlendirme (ÇED) raporları ve bağımsız gözlemci raporları, bölgenin biyolojik çeşitliliğinde, hidrolojik döngülerinde ve yerleşim hafızasında geri dönüşsüz kayıplar meydana geldiğini açıkça göstermektedir (Hasankeyf Kordinasyonu, 2019). Bu kayıplar, Cunsolo ve Ellis'in (2018) kavramsallaştırdığı ekolojik yas çerçevesiyle okunduğunda, yalnızca fiziksel çevrenin yok oluşu değil, aynı zamanda bireysel ve kolektif kimliğin dayandığı anlam dünyalarının da sarsılması olarak değerlendirilmelidir. Ekolojik yas, çevresel tahribatın kişisel duygulanım, toplumsal hafıza ve kültürel süreklilik üzerindeki yıkıcı etkilerini görünür kıldığı için, bu araştırma probleminin merkezinde yer almaktadır. Dicle Nehri üzerindeki baraj müdahaleleri, Enki'nin sularında cisimleşen bilgeliğin dolaşımını kesintiye uğratan bir kırılma noktası olarak da okunabilir. Enki'nin suyla ilişkilendirilen kudreti, akışa müdahale etmeyen, yaşamın kendi ritmi içinde çoğalmasını mümkün kılan bir düzen fikrine dayanır (Bottéro & Kramer, 2021, s. 183). Oysa Ilısu Barajı örneğinde su, akışkan bir ilişki alanı olmaktan çıkarılarak teknik bir nesneye indirgenmiş; kontrol altına alınmış, ölçülmüş ve yönetilebilir bir varlık hâline getirilmiştir. Bu dönüşüm, yalnızca ekosistemin işleyişini değil, suyun anlam üretme kapasitesini de zayıflatmıştır. Nehrin serbest akışıyla taşınan hikâyeler, ritüeller ve yerle kurulan duygusal bağlar, baraj gövdesiyle birlikte askıya alınmış; böylece su, yaşamı birbirine bağlayan bir aracı olmaktan çok, kaybı sabitleyen bir sınır çizgisine dönüşmüştür. Bu bağlamda Enki'nin suları, bugün yokluğuyla konuşur: akışın kesilmesi, yalnızca ekolojik bir müdahale değil, insanın suyla kurduğu bilgisel ve etik ilişkinin de parçalanmasıdır.

İnanna'nın yeraltına inişi ve yeniden yeryüzüne dönüşü etrafında şekillenen ritüeller, doğanın kırılgan ama süreklilik gerektiren döngüsel yapısını temsil eder. Bu döngü, İnanna'nın yokluğunda yaşamın geri çekilmesini, Dumuzi'nin yeraltına gönderilmesiyle bereketin askıya alınmasını ve İnanna'nın dönüşüyle

birlikte doğanın yeniden canlanmasını içerir (Katz, 1996) İnanna–Dumuzi anlatısında bereket, kesintisiz bir bolluk hâli değil; kayıp, yas ve geri dönüşle birlikte işleyen hassas bir denge olarak kavranır. Dicle Nehri'nin akışının baraj projeleriyle kesilmesi, bu mitolojik çerçevede okunduğunda, bereketin kendini yenileyen ritminin modern bir müdahaleyle koparıldığını gösterir. Ekolojik yas perspektifi, bu kopuşu yalnızca üretim kaybı ya da çevresel bozulma olarak değil, yaşamın döngüselliğine duyulan güvenin zedelenmesi ve doğayla kurulan anlam ilişkisinde derin bir kırılma olarak ele alır. Böylece İnanna ve Dumuzi'nin bereket döngüsü, Dicle'de yaşanan ekolojik dönüşümü geçmişe ait bir mit olarak değil, güncel kaybı anlamlandıran ve yasını tutmayı mümkün kılan bir düşünme zemini olarak yeniden okunur.

Araştırma probleminin bir diğer katmanı, Gılgameş'in yası, Enkidu'nun ölümünün ardından insanın doğa karşısındaki kırılganlığını fark etmesiyle başlayan bir yeniden konumlanma sürecini temsil eder. Bu yas, yalnızca kişisel bir kaybın ifadesi değil; insanın kendisini doğadan ayrı ve üstün gören yanılsamasının çözülmesiyle ortaya çıkan varoluşsal bir sarsıntıdır. Gılgameş'in kenti terk ederek dağlara, denizlere ve bilinmeyen coğrafyalara yönelmesi, kaybın insanı doğadan koparmak yerine onunla yeniden ilişki kurmaya zorlayan dönüştürücü bir eşik olduğunu gösterir. Ekolojik yas çerçevesinde okunduğunda, Gılgameş'in yolculuğu, doğanın denetlenemez döngüleriyle yüzleşme ve ölümlülüğü kabullenme süreci olarak anlam kazanır. Ölümsüzlüğü vaat eden bitkinin kaybı, insanın doğayı aşma arzusunun kaçınılmaz sınırlarına işaret ederken, yasın iyileştirici gücü doğayla kurulan bu yeni, daha alçakgönüllü bağda ortaya çıkar. Bu bağlamda Gılgameş'in yası, çağdaş ekolojik krizler karşısında yaşanan kayıpları anlamlandırmak için güçlü bir anlatı sunar; yas, burada bir son değil, insanın dünyayla kurduğu ilişkinin yeniden düşünülmesine açılan bir başlangıçtır.

Judith Butler'ın beden, kırılganlık ve yas teorileri bu araştırma problemine yeni bir sorgulama zemini açmaktadır. Butler'a göre yas, kaybın tanınması yoluyla öznenin hem kırılganlığını hem de başkalarına bağlılığını kabul etmesini sağlar. Dicle Nehri'nin kaybı, Butler'ın kavramsallaştırdığı bu ilişkisel kırılganlığın eko sosyal düzleme uyarlanmış bir biçimi olarak değerlendirilebilir. Dicle'nin "kaybedilebilirliği", bölge halkının kimlik, hafıza ve toplumsal aidiyet süreçlerini kesintiye uğratmaktadır; bu nedenle baraj projesi yalnızca bir çevresel mesele değil, bir kimlik ve hafıza sorununa dönüşmektedir.

Bu araştırmanın problemi tam da burada belirginleşmektedir: Dicle Nehri'nin ekolojik, kültürel ve mitolojik işlevlerinin kesintiye uğraması, modern baraj politikalarının yalnızca fiziksel çevreyi değil, aynı zamanda binlerce yıllık bir sembolik düzeni, kolektif hafızayı ve toplumsal duygulanımı nasıl dönüştürdüğünü göstermektedir.

Dolayısıyla çalışma, Ilısu Barajı'nın ürettiği tahribatı salt çevresel bir kayıp olarak değil, Mezopotamya mitolojisinin kültürel sürekliliğiyle birlikte okunan bir ekolojik yas alanı olarak kavramsallaştırmaktadır. Bu yönüyle araştırma problemi, çevresel yıkımın duygulanımsal, mitolojik ve toplumsal boyutlarını birlikte ele alan disiplinler arası bir sorgulamayı zorunlu kılmaktadır.

SONUÇ VE TARTIŞMA

Bu çalışma, Dicle Nehri ve Hasankeyf havzasında yaşanan dönüşümü yalnızca çevresel bir tahribat olarak değil, aynı zamanda kültürel sürekliliğin, mitolojik anlam dünyalarının ve toplumsal duygulanımın kesintiye uğraması şeklinde değerlendirmiştir. Ilısu Barajı raporlarının ortaya koyduğu ekolojik kayıplar—habitat parçalanması, su döngüsünün kesintiye uğraması, biyolojik çeşitliliğin azalması—ekolojik yasın temelini oluşturan somut ve geri dönüşsüz değişimlerdir. Ancak bu değişimler, Cunsolo & Ellis'in (2018) tanımladığı biçimiyle yalnızca fiziksel çevrenin yok oluşundan ibaret değildir; aynı zamanda insanların mekâna dair kurduğu duygusal, kültürel ve varoluşsal ilişkiyi de dönüştürmektedir. Bu noktada, Dicle Nehri'nin kaybı hem bir ekosistemin hem de bu ekosistemi anlamlandıran kültürel hafızanın kaybı olarak değerlendirilmelidir.

Mezopotamya mitolojisi, bu kaybın boyutlarını daha görünür kılmak için güçlü bir analitik zemin sağlamaktadır. Enki anlatıları, suyun yalnızca fiziksel bir kaynak değil, kozmik düzenin taşıyıcısı olduğunu vurgular. Dicle'nin akışının kesintiye uğraması, bu kozmik düzenin çağdaş bir kırılması olarak okunabilir. İnanna ve Dumuzi döngüsü üzerine yorumları, bereket—ölüm—yeniden doğuş ekseninde kurulan doğa ritimlerinin bozulmasını sembolik düzeyde aydınlatır. Dicle'nin akmadığı bir coğrafyada bereket ritimleri hem ekolojik hem de mitolojik anlamda kesilir; bu durum, döngüsel zamanın yerine kesintiye uğramış, doğrusal ve müdahale edilmiş bir zaman algısının geçmesine neden olur.

Gılgameş yorumunda vurgulanan doğa tahribatı karşısında duyulan yas, günümüzde Dicle havzasındaki ekolojik yas ile paralel bir anlam taşımaktadır. Gılgameş'in ormanı tahrip ettikten sonra hissettiği pişmanlık, insan ile doğa arasındaki karşılıklılık ilişkisinin kurulduğu en eski anlatılardan biridir. Bugün baraj projelerinin yol açtığı kayıplar karşısında ortaya çıkan ekolojik yas, bu kadim duygulanım biçiminin modern bir karşılığıdır. Bu açıdan mitolojik kaynaklar, yalnızca tarihsel bilgi sunmamakta; aynı zamanda günümüz çevresel krizlerini anlamak için duygusal, etik ve kültürel bir çerçeve sağlamaktadır.

Butler'ın (2018) kırılganlık ve yas teorisi ise, bu mitolojik ve ekolojik okumaları toplumsal boyuta taşır. Butler'a göre yas, yalnızca kaybın tanınması değil; öznenin başkalarıyla olan ilişkinin kopuşunu fark etmesi ve bu kopuşla başa çıkmak için yeni bir etik çerçeve geliştirmesidir. Dicle'nin kaybı, bölge halkının yalnızca bir mekânla değil, o mekânın taşıdığı tarihsel, mitolojik ve kültürel anlamlarla kurduğu ilişkinin de kesintiye uğraması anlamına gelir. Bu nedenle ekolojik yas, bireysel bir duygu olmanın ötesinde bölgesel bir kimlik krizini ve toplumsal bir duygulanım yapısını açığa çıkarmaktadır.

Tartışma açısından değerlendirildiğinde, Dicle Nehri üzerine inşa edilen barajın yalnızca çevresel değil, kültürel ve mitolojik bir kopuş yarattığı açıktır. Bu kopuş hem kültürel hafızanın sürekliliğini hem de insan-doğa ilişkisine dair etkileşimsel etik çerçeveleri zedelemektedir. Mitolojik döngülerin sembolik olarak kırılması, yalnızca geçmişe ait bir anlamın kaybı değildir; aynı zamanda gelecekte yeniden kurulabilecek doğa-kültür ilişkilerinin zeminini de daraltmaktadır. Bu nedenle Dicle'nin kaybı, modern kalkınma projeleri ile ekolojik-kültürel süreklilik arasında derin bir çatışmayı açığa çıkarır.

Sonuç olarak bu çalışma, Ilısu Barajı'nın Dicle Nehri üzerindeki etkilerini yalnızca çevresel bir sorun olarak değil; mitolojik temsiller, kültürel ritüeller ve ekolojik yas bağlamında çok katmanlı bir dönüşüm olarak analiz etmiştir. Elde edilen bulgular, ekolojik yası görünür kılmanın, yalnızca kaybı tanımak değil; doğa ile ilişkilenmenin etik, duygulanımsal ve kültürel biçimlerini yeniden kurmak için bir başlangıç noktası olduğunu göstermektedir. Dicle'nin kaybı, bugün yalnızca bir nehrin değil, bir coğrafyanın hafızasının, kimliğinin ve geleceğinin de kesintiye uğraması anlamına gelmektedir. Bu nedenle ekolojik yas hem direniş hem hatırlama hem de yeniden anlamlandırma pratiği olarak bölgenin duygusal ve kültürel iyileşmesinde merkezi bir rol oynamaktadır.

KAYNAKÇA

Başkaya, F. (2019). Eko-Sosyalist Paradigma Komünist Topluma Giden Yol. F. Başkaya içinde, *Eko-Sosyalist Paradigma Komünist Topluma Giden Yol.* Yordam Kitap.

Bottéro, J., & Kramer, S. N. (2021). Mezopotamya Mitolojisi. J. Bottéro, & S. N. Kramer içinde, *Mezopotamya Mitolojisi* (s. 167-183). İstanbul: Türkiye İş Bankası.

Butler, J. (2018). *Kırılgan Hayatlar.* (B. Ertürk, Çev.) İstanbul: Metis.

Carr, S. (2020, Şubat 26). Ecological grief: New research on the mental health implications of working in marine conservation and management during a time of rapid global change. Aralık 15, 2025 tarihinde https://meam.openchannels.org/meam-staff adresinden alındı

Cavanagh, M. (2019, Ekim 01). It’s Time to Talk About Ecological Grief. Aralık 15, 2025 tarihinde https://undark.org/2019/01/10/its-time-to-talk-about-ecological-grief/ adresinden alındı

Cunsolo , A., & Ellis, N. (2018, Nisan 4). Hope and mourning in the Anthropocene: Understanding ecological grief. *The Conversation*.

Doğa Derneği. (tarih yok). *Hasankeyf Yok Olmazsın!* Doğa Derneği.

Hasankeyf Kordinasyonu. (2019). *Ilısu Barajı ve Hidroelektrik Santralı Projesi Eleştiri Raporu.* Hasankeyf Koordinasyonu.

Katz, D. (1996). How Dumuzi Became İnanna's Victim: On the Formation.

Leopold, A. (2020). *Bir Kum Yöresi Almanağı ve Oradan Buradan Eskizler.* (U. Özdağ, Çev.) İstanbul: Türkite İş Bankası.

Morton, T. (2020). İnsan Türü. T. Morton içinde, *İnsan Türü(İnsan Olmayanlarla Dayanışma)* (D. Dölek, Çev., s. 101). İstanbul: Profil Kitap.

Önder, T. (2003). "Derin Ekoloji" Üzerine. 95-111.

Shield, C. (2018, 08 31). Global warming's mental health cost. Aralık 15, 2025 tarihinde https://www.dw.com/en/climate-change-takes-a-toll-on-our-minds-too/a-45293148 adresinden alındı

Williamson, J., & McMenemy, G. (2023). *Dünya Mitolojisinde Kadınlar (Tanrıçalar, Kahramanlar ve Canavarlar).* (E. Duru, Çev.) İstanbul: Say Yayınları.

Yazgünoğlu, K. (2017-2018). İnsan Çağında Çevresel Estetik: Güzelin ve Çirkinin Ötesinde "Doğasonrası" Ekolojiler. (C. Ö. Özmen, Dü.) *Doğu Batı*, 67-83.

XIX. ve XX. YÜZYIL OSMANLI SİKKEKERİNİN KOMPOZİSYON ÖZELLİKLERİ AÇISINDAN DEĞERLENDİRİLMESİ (AMASYA MÜZESİ ÖLÇEĞİNDE)

EVALUATION OF 19TH- AND 20TH-CENTURY OTTOMAN COINS IN TERMS OF THEIR COMPOSITIONAL FEATURES (AT THE AMASYA MUSEUM SCALE)

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ÖZET

Eski çağlardan itibaren insanlar yaşamlarını devam ettirebilmek adına kendilerinde bulunmayan nesneleri birbirileriyle takas ederek gidermeye çalışmışlardır. Bunun için çivi, deniz kabuğu, boncuk vb. materyaller kullanmışlardır. Ancak takas işlemlerinin zaman alması ve kullanım zorluğundan işlerin daha hızlı ilerlemesini sağlayan sikke ortaya çıkmıştır. Sikke, üzerinde onu darp eden mutlak güce ait yazı, figür ya da bir simgenin bulunduğu madenî paralardır. Para basmak tarih boyunca bağımsızlığın göstergesi olmuş, özellikle İslam medeniyetlerinde hâkimiyet altına alınan topraklarda hutbe okutmayla birlikte sikke kestirmek hükümdarlığın alameti sayılmıştır. Başlangıçta tamamen ihtiyaca yönelik bastırılan sikkeler üzerindeki yazı, tarih, malzeme ve süsleme özellikleri ile uygarlıkların maddi ve manevi yansıması haline gelmiştir. Sikkeler aracılığıyla devletlerin bağımsızlığını, saltanat sahibini, ekonomik gelişmişliğini, coğrafi sınırlarını, dinlerini, dinlerini, sanat anlayışlarını ve birçok özelliklerini anlayabilmek mümkün olmuştur. Osmanlı Devleti 623 yıl hüküm sürmüş büyük bir imparatorluktur. Güçlü ve çok kültürlü bir yapıya sahip Osmanlı İmparatorluğu'nda, sultanların bastırdıkları sikkeler Nümismatik bilimi için oldukça önemlidir. Amasya, birçok medeniyete ev sahipliği yapmış, Osmanlının da önemli şehzade sancakları arasında yer almaktadır. Amasya'da farklı dönemlere ait çok sayıda eserin izlerini görmek mümkündür. Amasya Müzesi'nde saklanan sikkeler, bu eserler arasında önemli yer tutmaktadır. Çalışma kapsamına Amasya Müzesi'ndeki XIX. ve XX. yüzyıla tarihlenen II. Mahmud, Abdülmecid, Abdülaziz, II. Abdülhamid ve V. Mehmed Reşad dönemlerine ait 88 adet sikke içinden seçilen 35 adet Osmanlı sikkesi dâhil edilmiştir. Bu sikkelerin belirlenmesinde malzemesinin, birimlerinin ve süsleme özelliklerinin farklı olmasına dikkat edilmiştir. Bu açıdan bakıldığında Amasya Müzesi'ndeki ele alınan sikkelerin transkripsiyonunun yapılması, kompozisyon özelliklerinin detaylı şekilde incelenmesi, dönemin üslup özelliklerinin ortaya çıkarılması, kayıt altına alınıp kaynak haline getirilmesi birçok bilim dalı açısından önem arz etmektedir. Ayrıca sikkelerin kronolojik olarak incelenmesi malzeme, form ve üslup değişimlerinin somut biçimde algılanmasına imkân tanıdığından gelişimlerinin doğrudan izlenebilmesi Amasya Müzesi ölçeğinde mümkün hale gelecektir.

Anahtar Kelimeler: Amasya Müzesi, Osmanlı, Sikke, Para, Süsleme, Kompozisyon.

ABSTRACT

Since ancient times, people have attempted to obtain what they lacked by bartering to sustain their lives. They used materials such as nails, shells, beads, and so on. However, due to the time-consuming and difficult nature of bartering, coins emerged, enabling faster transactions. Coins are coins bearing an inscription, figure, or symbol representing the absolute power that minted them. Throughout history, minting money has been a symbol of independence; particularly in lands dominated by Islamic civilizations, the delivery of sermons and the minting of coins were considered a sign of sovereignty. Initially minted solely for necessity, coins became a material and spiritual reflection of civilizations through their inscriptions, dates, materials, and decorative features. Through coins, it is possible to understand the independence of states, their sultans, their economic development, their geographical borders, their religions, their artistic understanding, and many other characteristics. The Ottoman Empire was a vast empire that reigned for 623 years. In the Ottoman Empire, a powerful and

multicultural empire, coins minted by sultans are of great importance to the science of numismatics. Amasya hosted many civilizations and was among the important Ottoman sanjaks. Traces of numerous artifacts from different periods can be seen in Amasya. The coins preserved in the Amasya Museum hold a significant place among these artifacts. Thirty-five Ottoman coins were selected from 88 coins from the 19th and 20th centuries in the Amasya Museum, dating from the reigns of Mahmud II, Abdülmecid, Abdülaziz, Abdülhamid II, and Mehmed V Reşad. In identifying these coins, attention was paid to their distinctive materials, denominations, and decorative features. From this perspective, transcribing the coins in the Amasya Museum, examining their composition in detail, uncovering the stylistic characteristics of the period, and recording and converting them into a source are important for many disciplines. Furthermore, examining the coins chronologically allows for concrete perception of material, form, and stylistic changes, making it possible to directly trace their development at the Amasya Museum scale.
Keywords: Amasya Museum, Ottoman, Coin, Money, Decoration, Composition.

GİRİŞ

Sikke, insanların ihtiyaçlarını karşılama istekleri neticesinde ortaya çıkmış, üzerinde onu bastıran devletin ya da hükümdarın tuğra, yazı ya da simgesinin bulunduğu madeni parçalardır (Tekin, 2009, s. 179). Sikke, tarih boyunca gerek tedavüldeki coğrafyanın büyüklüğü gerekse fiziki varlığıyla ekonomik ilişkileri belirleyen en önemli unsur olmuştur. Ancak zaman içerisinde iktisadi özelliğinin yanı sıra darp edildiği dönemin olaylarını da kayıt altına alan, siyasi, ekonomik, sosyal ve kültürel tarihin gözlenebileceği tarihi belge durumuna gelmiştir. Sikkeler eski çağlardan beri bağımsız devlet olmanın ana unsurlarından olmuştur. Özellikle İslam coğrafyalarında hükümdarların fethettikleri topraklarda hutbe okutup, kendi adını taşıyan sikke bastırmaları hükümdarlık alameti olarak görülmüştür. Hâkim gücün yansıması olan sikkeler üzerindeki yazı, motif ve simgelerle onu kestiren hükümdarın kimliği, devletin ekonomisi, nerede basıldığı ve nerelere yayıldığı, dini, dili, sanat anlayışı ve kültürel özellikleri hakkında net bilgiler veren önemli kaynaklar arasında yerini almıştır.

Bağımsızlığın temel unsuru olan sikke bastırma geleneği 623 yıl hüküm sürmüş Osmanlı Devleti'nde de devam etmiştir. Osmanlının uzun süren hâkimiyeti ve geniş topraklara sahip olmasıyla farklı darphanelerde çeşitli malzeme, kalıp ve tekniklerle çok sayıda sikke darp edilmiştir. Darp edilen sikkelerin maden cinsi, ağırlık ve ayarları devletin ekonomik gücü oranında belirlenmiş, sikkeler basılırken kullanılan teknik, kompozisyonlar da dönemin şartlarına bağlı olarak değişim ve gelişim göstermiştir. Devletin başına geçen her padişah kestirdiği sikkelerin malzeme ve kompozisyon özelliklerini yeniden düzenleyerek gelişimine katkı sağlamıştır (Kemaloğlu, 2023, s. 516).

Osmanlıda sikke darbı üç şekilde gerçekleştirilmiştir. 1685 tarihine kadar çekiç ile darp yöntemi kullanılmıştır. Bu işlemde, potalarda eritilen madenler kalıplara dökülür ve çubuk haline getirilirdi. Çubuklar yassılaştırılıp sikke kalınlığına getirildikten sonra, kare plakalara dönüştürülürdü. Kare plakaların köşeleri yuvarlatılarak sikke pulu halini alırdı. Ardından bu pullar kürsü adı verilen kalıbın arasına yerleştirilip, alt kısmındaki sikke kompozisyonun yer aldığı çeliğin üst kısmına çekiç yardımıyla vurulması suretiyle işlem sonlandırılırdı (Sahillioğlu, 1993, s. 504). 1685'ten 1844 tarihine kadar mekanik pres tekniğiyle sikke basılmıştır. Mekanik pres tekniğinde, sikkelerin basımı çarh, kesme ve rakkas pres adı verilen üç aşamadan geçirilerek yapılırdı. İlk işlem olan çarhta madenler inceltilerek eşit kalınlardaki saç şeritler ortaya çıkarılırdı. Bu şeritler kesme tezgâhında, mekanik preslerle dairesel kalıplar yardımıyla sikke pulu haline getirilirdi. Son işlem olan rakkas pres tezgahında, sikke kompozisyonunun olduğu kalıplar arasına sıkıştırılarak kompozisyonun sikke üzerine aktarılması sağlanırdı (Damalı, 2010, s.

45). 1844'te ise Sultan Abdülmecid döneminde otomatik pres yöntemine geçilmiştir (Eroğlu, 2020, s. 19). Avrupa'dan getirilen makinelerle hızlı ve kompozisyonların ez hatalı çıkarılması sağlanmış, kısa sürede çok fazla sikke basımı gerçekleştirilmiştir (Yılmaz, 2019, s. 50).

Devletin ekonomik duruma göre, sikkelerin yapımında kullanılan madenlerin türü ve değer oranları değişkenlik göstermiştir. Osmanlı Devleti'nde altın, gümüş, bakır ve nikel olmak üzere dört farklı madenden sikkeler darp edilmiştir. Osmanlı devletinin kuruluş döneminde ağırlıklı olarak gümüş sikkeler kestirilmiştir. İlk akçe Osman Gazi tarafından kestirilmiştir. İlk dönem akçeleri İlkel baskı yöntemleriyle darp edildiğinden ve padişahların zaman zaman yaptıkları sikke tağşişi (ağırlık düşürme) nedeniyle standart bir şekle ve ağırlığa sahip olmamıştır. Bu yüzden değişik kalıplarda akçeler basılmıştır (Uslu, 2007, s. 10). Gümüşün yanında bakır sikkelerde basılmıştır; fakat Osmanlı Devleti'nde akçeler yoğun olarak kullanılan para birimi olmuştur. 16. yüzyılda yaşanan ekonomik dalgalanmalar, akçenin yanında imparatorluğun farklı eyaletlerinde, mahalli gümüş paraların darp edilmesine yol açmıştır (Sahillioğlu, 1965, s. 1). Osmanlı, İmparatorluğun pek çok yerinde mangır darp ettirmiştir. Kanuni Sultan Süleyman dönemi, en çok bakır paranın basılıp dağıtıldığı dönem olmuştur (Kabaklarlı, 1998, ss. 6-13). 17. yüzyılın başından Tanzimat'a kadar olan zaman zarfında mangır basımında önemli düşüş yaşanmış, hatta 17. yüzyılın ortalarında bakır para darbı durdurulmuştur. Fakat II. Viyana Seferi sonrasında ve çeşitli cephelerde savaşların başlamasıyla ekonomik krizi engellemek için 1688'de tekrar mangır darp edilmeye başlanmıştır (Tekin, 2003, s. 568). I. Murad döneminden itibaren darp edilmeye başlanan mangırın Sultan Abdülmecid zamanına kadar hacim ve kıymetlerinde çeşitli değişiklikler görülse de darp edilmeye devam edilmiştir. Abdülmecid tarafından paralarda yaptırılan düzenlemelerden sonra yeni tipteki bakırların kullanımı II. Abdülhamit zamanına kadar sürmüştür (Pere, 1968, s. 10). Mangır son olarak II. Abdülhamid devrinde darp edilmiş olup, bu dönemde çıkarılan 1879 kararnamesiyle tedavülden kaldırılmıştır (Tekin, 2003, s. 568). II. Mehmed dönemine kadar Osmanlı sikkelerinde değerli maden olarak sadece gümüş kullanılıyorken, İstanbul'un fethinden sonra Osmanlı'da altın sikke basımına da başlanmıştır. İlk Osmanlı sikkesi olan "sultani" 1479 tarihinde Kostantiniyye'de (İstanbul) darp edilmiştir (Sahillioğlu, 2005, s. 120). Osmanlı altın sikkeleri üzerlerine tuğra konuluncaya kadar bazı değişiklikler dışında aynı şekilde darp edilmeye devam etmiştir (Tekin, 2005, s. 269). Osmanlı sultanları çeşitli türde ve adlarda, zengin kompozisyon özelliklerine sahip altın sikke bastırmışlardır. Osmanlının son zamanlarında ise nikel malzemeden basılmış sikkeler de kullanıma dâhil edilmiştir. Osmanlıda nikelin II. Abdülhamid ve Abdülaziz devrinde sikke metali olarak kullanıldığı bilinmektedir. Ancak asıl ve yoğun kullanımı V. Mehmed döneminde olmuştur (Tekin, 2009, s. 184). Sikkelerin maden içeriğine zaman zaman farklı nedenlerden dolayı müdahalelerde bulunulmuştur. Devletin ekonomik durumunun getirdiği zorunluluktan dolayı yapılan tağşişler ve sikkenin uzun süre piyasadaki dolaşımından kaynaklı yıpranmaları engellemek için sikkenin içine belli miktarlarda farklı madenler katılmıştır (Kemaloğlu, 2024, s. 495).

2. ARAŞTIRMA VE BULGULAR

Geçmişten günümüze doğru bilgiler sunması açısından köprü görevi gören sikkeler son derece değerli, belge niteliğindeki kültür varlıklarıdır. Güçlü ve çok kültürlü bir yapıya sahip Osmanlı İmparatorluğu'nda, sultanların farklı coğrafyalarda bastırdıkları sikkeler Nümismatik bilimi için büyük önem taşımaktadır. Amasya Müzesi Osmanlı sikkeleri açısından oldukça zengin bir müzedir. Çalışmamızda XIX. ve XX. yüzyıllarda darp edilmiş Osmanlı sikkelerinin kompozisyon özellikleri tüm yönleriyle detaylı şekilde incelenip tanıtılacaktır.

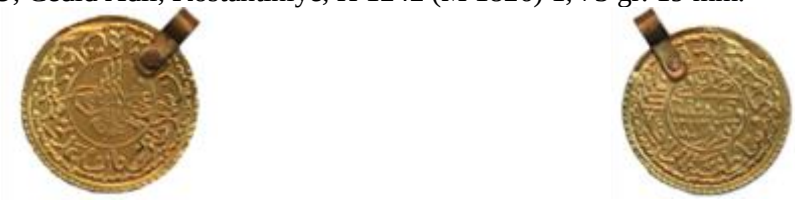
Sikke No: 1 (Envt. S.2020-9)

II. Mahmud, AU, Cedid Mahmudiye, Kostantiniye, H 1250 (M 1834) 1, 570 gr. 20 mm.

Ön Yüz: (Tuğra) "Mahmud Han bin Abdülhamid-El- muzaffer dâimâ, Adli" (Abdülhamid oğlu Mahmud Han-Dâimâ kazanan, Adli)
Arka Yüz: "(27) Duribe fi Kostantiniye 1223" (27) Kostantiniye'de basıldı 1808)

Sikke No: 2 (Envt. S.89.8-1)

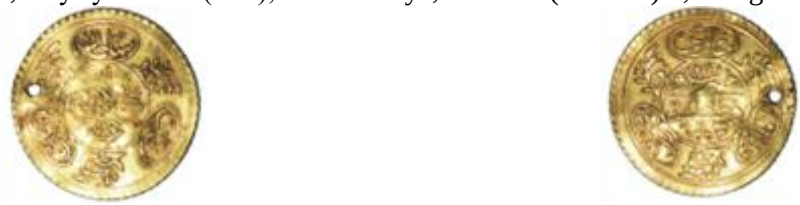
II. Mahmud, AU, Cedid Adli, Kostantiniye, H 1242 (M 1826) 1, 73 gr. 19 mm.



Ön Yüz: (Tuğra) "Mahmud Han bin Abdülhamid-El- muzaffer dâima, Adli (Abdülhamid oğlu Mahmud Han-Dâimâ kazanan, Adli) "Sultan Selatin-i zaman Adli Mahmud Han" (Sultanların sultanı adaletli Mahmud Han)
Arka Yüz: "(19) Duribe fi Kostantiniye El- Mahrusa 1223, Dâme Mülkühû ve Saltanatahû İla Ahirüd-Devran" (19) Büyük şehir İstanbul'da basıldı 1808, Kıyamete kadar devleti ve saltanatı daim olsun)

Sikke No: 3 (Envt. 71-19-2)

II. Mahmud, AU, Hayriye Altını (Tek), Kostantiniye, H 1247 (M 1831) 1, 719 gr. 21 mm.



Ön Yüz: (Tuğra) "Mahmud Han bin Abdülhamid-El- muzaffer dâimâ, Adli" (Abdülhamid oğlu Mahmud Han-Dâimâ kazanan, Adli) "Sultan- Selatin-i- Zaman" (Sultanların Sultanı)
Arka Yüz: "(24) Duribe fi Kostantiniye 1223, Gazi- Mahmud- Han" (24) Kostantiniye'de basıldı 1808, Gazi Mahmud Han)

Sikke No: 4 (Envt. 72-11-2)

II.Mahmud, AU, Dar'ülhilafe Rubiye, Dar'ül Hilafet'ül Elaliye, H 1239 (M 1823) 0, 497 gr. 13 mm.

Ön Yüz: (Tuğra)"Mahmud Han bin Abdülhamid-El- muzaffer dâimâ, Adli" (Abdülhamid oğlu Mahmud Han-Dâimâ kazanan, Adli)
Arka Yüz: "(16) Duribe fi Dar'ül hilafet'ül Elaliye 1223"(16) Yüce hilafetin kentinde basıldı 1808)

Sikke No: 5 (Envt. 78-3-6)

II.Mahmud, AU, Fındık (Çeyrek), Kostantiniye , H 1226 (M 1811) 0, 811 gr. 15 mm.

Ön Yüz: (Tuğra)"Mahmud Han bin Abdülhamid-El- muzaffer dâimâ" (Abdülhamid oğlu Mahmud Han-Dâimâ kazanan)
Arka Yüz: "(3) Duribe fi Kostantiniye 1223" (3) Kostantiniye'de basıldı 1808)

Sikke No: 6 (Envt. 66-2-31)
II.Mahmud, AR, Yeni Kuruş, Kostantiniye, H 1244 (M 1828) 1, 379 gr. 22 mm.

Ön Yüz: (Tuğra)"Mahmud Han bin Abdülhamid-El- muzaffer dâimâ" (Abdülhamid oğlu Mahmud Han-Dâimâ kazanan)
Arka Yüz: "(21) Duribe fi Kostantiniye 1223" (21) Kostantiniye'de basıldı 1808)

Sikke No: 7 (Envt. 31-4-1)
II.Mahmud, AR, Altılık, Kostantiniye, H 1249 (M 1833) 12, 827 gr. 37 mm.

Ön Yüz: (Tuğra)"Mahmud Han bin Abdülhamid-El- muzaffer dâimâ, Adli" (Abdülhamid oğlu Mahmud Han-Dâimâ kazanan, Adli)
Arka Yüz: "(26) Duribe fi Kostantiniye 1223" (26) Kostantiniye'de basıldı 1808)

Sikke No: 8 (Envt.73-7-40)
II.Mahmud, CU, Karabeşlik, Kostantiniye, H 1247 (M 1831) 7, 33 gr. 34 mm.

Ön Yüz: (Tuğra)"Mahmud Han bin Abdülhamid-El- muzaffer dâimâ, Adli" (Abdülhamid oğlu Mahmud Han-Dâimâ kazanan, Adli)
Arka Yüz: "(25) Duribe fi Kostantiniye 1223"(25) Kostantiniye'de basıldı 1808)

Sikke No: 9 (Envt. 50-1-1)

II.Mahmud, AR, Kuruş, Kostantiniye, H 1247 (M 1831) 2, 872 gr. 28 mm.

Ön Yüz: (Tuğra)"Mahmud Han bin Abdülhamid-El- muzaffer dâimâ, Adli" (Abdülhamid oğlu Mahmud Han-Dâimâ kazanan, Adli)
Arka Yüz: "(24) Duribe fi Kostantiniye 1223" (24) Kostantiniye'de basıldı 1808)

Sikke No: 10 (Envt. 73-9-53)
II. Mahmud, AR, Çifte Zolota, Kostantiniye, H 1244 (M 1828), 6,355 gr. 34 mm.

Ön Yüz: "Es –Sultan Mahmud bin Abdülhamid Han Dâme Mülkühû, Duribe fi Kostantiniye 1223" (Abdülhamid Han oğlu Sultan Mahmud Saltanatı daim olsun, Kostantiniye'de basıldı 1808"
Arka Yüz: "Sultanü'l-berreyn ve hakanü'l-bahreyn es-sultan ibn (21) es –sultan" (İki karanın sultanı ve iki denizin hakanı sultan oğlu (21) sultan)

Sikke No: 11 (Envt. 66-2-32)
II. Mahmud, AR, Zolota, Kostantiniye, H 1240 (M 1824) 3, 029 gr. 28 mm.

Ön Yüz: Es –Sultan Mahmud bin Abdülhamid Han Dâme Mülkühû, Duribe fi Kostantiniye 1223" (Abdülhamid Han oğlu Sultan Mahmud Saltanatı daim olsun, Kostantiniye'de basıldı 1808)
Arka Yüz: "Sultanü'l-berreyn ve hakanü'l-bahreyn es-sultan ibn (17) es –sultan" (İki karanın sultanı ve iki denizin hakanı sultan oğlu (17) sultan)

Sikke No: 12 (Envt. 77-13-1)
II. Mahmud, AR, Cihadiye, Kostantiniye, H 1226 (M 1811) 25, 612 gr. 41 mm.

Ön Yüz: (Tuğra)"Mahmud Han bin Abdülhamid-El- muzaffer dâimâ" (Abdülhamid oğlu Mahmud Han-Dâimâ kazanan)
Arka Yüz: "(3) Duribe fi Kostantiniye 1223" (3) Kostantiniye'de basıldı 1808)

Sikke No: 13 (Envt. 70-7-15)

Abdülmecid, AR, Mecidiye, Kostantiniye, H 1261 (M 1845) 23, 715 gr. 37 mm.

Ön Yüz: (Tuğra) "Abdülmecid Han bin Mahmud- El- muzaffer dâimâ, Sene 6" (Mahmud oğlu Abdülmecid Han- Dâimâ kazanan, Sene 6)
Arka Yüz: "Azze Nasruhû Duribe fi Kostantiniye 1255" (Zaferi şerefli olsun, Kostantiniye'de basıldı 1839)

Sikke No: 14 (Envt. S. 94-2-5)

Abdülmecid, AR, Altmış Para, Kostantiniye, H 1257 (M 1841) 3, 025 gr. 26 mm.

Ön Yüz: (Tuğra) "Abdülmecid Han bin Mahmud- El- muzaffer dâimâ" (Mahmud oğlu Abdülmecid Han- Dâimâ kazanan)
Arka Yüz: "(2) Duribe fi Kostantiniye 1255" (2) Kostantiniye'de basıldı 1839)

Sikke No: 15 (Envt. 79-4-595)

Abdülmecid, AR, Yirmi Para, Kostantiniye, H 1258 (M 1842) 1, 357 gr. 20 mm.

Ön Yüz: (Tuğra) "Abdülmecid Han bin Mahmud- El- muzaffer dâimâ" (Mahmud oğlu Abdülmecid Han- Dâimâ kazanan)
Arka Yüz: "(3) Duribe fi Kostantiniye 1255"(3) Kostantiniye'de basıldı 1839)

Sikke No: 16 (Envt. 69-3-1)

Abdülmecid, CU, Kırk Para, Kostantiniye, H. 1274 (M. 1857) 20, 903 gr. 37 mm.

Ön Yüz: (Tuğra)"Abdülmecid Han bin Mahmud- El- muzaffer dâimâ, Sene 19" (Mahmud oğlu Abdülmecid Han- Dâimâ kazanan, Sene 19)
Arka Yüz: "(40) Azze Nasruhû Duribe fi Kostantiniye sene 1255" (40) Zaferi şerefli olsun, Kostantiniye'de basıldı sene 1839)

Sikke No: 17 (Envt. 65-2-4)

Abdülmecid, CU, Yirmi Para, Kostantiniye, H. 1275 (M. 1858) 10, 556 gr. 31 mm.

Ön Yüz: (Tuğra)"Abdülmecid Han bin Mahmud- El- muzaffer dâimâ, Sene 20" (Mahmud oğlu Abdülmecid Han- Dâimâ kazanan, Sene 20)
Arka Yüz: "(20) Azze Nasruhû Duribe fi Kostantiniye sene 1255" (20) Zaferi şerefli olsun Kostantiniye'de basıldı sene 1839)

Sikke No: 18 (Envt. 74-36-26)

Abdülmecid, CU, On Para, Kostantiniye, H. 1272 (M. 1855) 7, 063 gr. 27 mm.

Ön Yüz: (Tuğra)"Abdülmecid Han bin Mahmud- El- muzaffer dâimâ, Sene 17" (Mahmud oğlu Abdülmecid Han- Dâimâ kazanan, Sene 17)
Arka Yüz: "(10) Azze Nasruhû Duribe fi Kostantiniye sene 1255" (10) Zaferi şerefli olsun Kostantiniye'de basıldı sene 1839)

Sikke No: 19 (Envt. 64-2-1)

Abdülmecid, CU, Beş Para, Kostantiniye, H. 1265 (M. 1849) 2, 60 gr. 23 mm.

Ön Yüz: (Tuğra)"Abdülmecid Han bin Mahmud- El- muzaffer dâimâ, Sene 10" (Mahmud oğlu Abdülmecid Han- Dâimâ kazanan, Sene 10)
Arka Yüz: "(5) Azze Nasruhû Duribe fi Kostantiniye sene 1255" (5) Zaferi şerefli olsun Kostantiniye'de basıldı sene 1839)

Sikke No: 20 (Envt. 68-1-2)

Abdülaziz, CU, Yirmi Para, Kostantiniye, H 1281 (M 1864) 10, 798 gr. 32 mm.

Ön Yüz: (Tuğra) "Abdülaziz Han bin Mahmud- El- muzaffer dâimâ, Sene 4" (Mahmud oğlu Abdülaziz Han-Dâimâ kazanan sene 4)

Arka Yüz: "(20) Azze Nasruhû Duribe fi Kostantiniye sene 1277" (20) Zaferi şerefli olsun Kostantiniye'de basıldı sene 1861)

Sikke No: 21 (Envt. 34-15-1)

Abdülaziz, CU, On Para, Kostantiniye, H 1278 (M 1862) 5, 011 gr. 27 mm.

Ön Yüz: (Tuğra) "Abdülaziz Han bin Mahmud-El- muzaffer dâimâ, Sene 1/Dersaadete Mahsus Sikke-i Nuhasiyedir" (Mahmud oğlu Abdülaziz Han-Dâimâ kazanan, Sene 1/Dersaadete ait sikkedir)
Arka Yüz: "(10) Azze Nasruhû Duribe fi Kostantiniye sene 1277" (10) Zaferi şerefli olsun Kostantiniye'de basıldı sene 1861)

Sikke No: 22 (Envt. 68-14-43)

Abdülaziz, CU, Beş Para, Kostantiniye, H. 1281 (M. 1864) 2, 388 gr. 23 mm.

Ön Yüz: (Tuğra) "Abdülaziz Han bin Mahmud- El- muzaffer dâimâ, Sene 4" (Mahmud oğlu Abdülaziz Han-Dâimâ kazanan sene 4)
Arka Yüz: "(5) Azze Nasruhû Duribe fi Kostantiniye sene 1277" (5) Zaferi şerefli olsun Kostantiniye'de basıldı sene 1861)

Sikke No: 23 (Envt. 71-16-4)

II. Abdülhamid, AU, Ziynet Altını, Kostantiniye, H. 1325 (M. 1907) 3, 454 gr. 27 mm.

Ön Yüz: (Tuğra) "Abdülhamid Han bin Abdülmecid-El- muzaffer dâimâ, El Gazi Sene 32/ El-Müstenid Bi-Tevfikatü'l Rabbaniye Melikü'l-Devlet-i Osmaniyye" (Abdülmecid oğlu Abdülhamid Han-Dâimâ kazanan, El Gazi Sene 32/ Allah katından gelen başarılara ve yardımlara dayanan Osmanlı Devleti Meliki)
Arka Yüz: "Azze Nasruhû Duribe fi Kostantiniye 1293, Es-Sultan'ül-Gazi Abdülhamid Han bin Es-Sultan'ül-Gazi Abdülmecid Han Dâme Mülkühû" (Zaferi Şerefli Olsun. Kostantiniye'de basıldı 1876, Sultan Gazi Abdülmecid Han'ın oğlu Sultan Gazi Abdülhamid Han Saltanatı daim olsun)

Sikke No: 24 (Envt. S. 75-13-5)

II. Abdülhamid, AR, Mecidiye, Kostantiniye, H 1295 (M 1878) 23, 700 gr. 37 mm.

Ön Yüz: (Tuğra)"Abdülhamid Han bin Abdülmecid-El- muzaffer dâimâ, Sene 2" (Abdülmecid oğlu Abdülhamid Han-Dâimâ kazanan, Sene 2"
Arka Yüz: "Azze Nasruhû Duribe fi Kostantiniye 1293" (Zaferi şerefli olsun Kostantiniye'de basıldı 1876)

Sikke No: 25 (Envt. 71-20-7)

II. Abdülhamid, AR, Beş Kuruş, Kostantiniye, H 1325 (M 1907) 5, 921 gr. 24 mm.

Ön Yüz: (Tuğra) "Abdülhamid Han bin Abdülmecid-El- muzaffer dâimâ, El Gazi, Sene 32 (Abdülmecid oğlu Abdülhamid Han-Dâimâ kazanan, El Gazi, Sene 32)
Arka Yüz: "Azze Nasruhû Duribe fi Kostantiniye 1293" (Zaferi şerefli olsun Kostantiniye'de basıldı 1876)

Sikke No: 26 (Envt. 73-15-2)

II. Abdülhamid, AR, İki Kuruş, Kostantiniye, H 1304 (M 1886) 2, 325 gr. 18 mm.

Ön Yüz: (Tuğra) "Abdülhamid Han bin Abdülmecid-El- muzaffer dâimâ, El Gazi, Sene 11 (Abdülmecid oğlu Abdülhamid Han-Dâimâ kazanan, El Gazi, Sene 11)
Arka Yüz: "Azze Nasruhû Duribe fi Kostantiniye 1293" (Zaferi şerefli olsun Kostantiniye'de basıldı 1876)

Sikke No: 27 (Envt. 70-7-30)

II. Abdülhamid, AR, Bir Kuruş, Kostantiniye, H. 1322 (M. 1904) 1, 161 gr. 15 mm.

Ön Yüz: (Tuğra) "Abdülhamid Han bin Abdülmecid-El- muzaffer dâimâ, El Gazi, Sene 29 (Abdülmecid oğlu Abdülhamid Han-Dâimâ kazanan, El Gazi, Sene 29)
Arka Yüz: "Azze Nasruhû Duribe fi Kostantiniye 1293" (Zaferi şerefli olsun Kostantiniye'de basıldı 1876)

Sikke No: 28 (Envt. 79-4-663)

II. Abdülhamid, CU, On Para, Kostantiniye, H 1320 (M 1902) 1, 826 gr. 18 mm.

Ön Yüz: (Tuğra) "Abdülhamid Han bin Abdülmecid-El- muzaffer dâimâ, El Gazi, Sene 27 (Abdülmecid oğlu Abdülhamid Han-Dâimâ kazanan, El Gazi, Sene 27)
Arka Yüz: "(10) Azze Nasruhû Duribe fi Kostantiniye 1293" (10) Zaferi şerefli olsun Kostantiniye'de basıldı 1876)

Sikke No: 29 (Envt. 34-18-1)

II. Abdülhamid, CU, Beş Para, Kostantiniye, H 1320 (M 1902) 1, 014 gr. 16 mm.

Ön Yüz: (Tuğra) "Abdülhamid Han bin Abdülmecid-El- muzaffer dâimâ, El Gazi, Sene 27 (Abdülmecid oğlu Abdülhamid Han-Dâimâ kazanan, El Gazi, Sene 27)
Arka Yüz: "(5) Azze Nasruhû Duribe fi Kostantiniye 1293" (5) Zaferi şerefli olsun Kostantiniye'de basıldı 1876)

Sikke No: 30 (Envt. 75-26-4)

V. Mehmet Reşad, AR, Mecidiye, Kostantiniye, H 1335 (M 1917) 24, 142 gr. 37 mm.

Ön Yüz: (Tuğra) "Mehmed Han bin Abdülmecid-El- muzaffer dâimâ, El Gazi, Sene 8" (Abdülmecid oğlu Mehmed Han-Dâimâ kazanan, El Gazi, Sene 8)
Arka Yüz: "Azze Nasruhû Duribe fi Kostantiniye 1327" (Zaferi şerefli olsun Kostantiniye'de basıldı 1909)

Sikke No: 31 (Envt. 70-7-33)

V. Mehmet Reşad, AR, Bir Kuruş, Kostantiniye, H 1329 (M 1911) 1, 172 gr. 15 mm.

Ön Yüz: (Tuğra) "Mehmed Han bin Abdülmecid- El- muzaffer dâimâ, Reşad, Sene 2" (Abdülmecid oğlu Mehmed Han-Dâimâ kazanan, Reşad, Sene 2
Arka Yüz: "Azze Nasruhû Duribe fi Kostantiniye 1327" (Zaferi şerefli olsun Kostantiniye'de basıldı 1909)

Sikke No: 32 (Envt. 77-18-3)

V. Mehmet Reşad, Nİ, Kırk Para, Kostantiniye, H 1331 (M 1913) 5, 956 gr. 24 mm.

Ön Yüz: (Tuğra) "Mehmed Han bin Abdülmecid- El- muzaffer dâimâ, Reşad, Sene 4/ Hürriyet, Müsavat, Adalet" (Abdülmecid oğlu Mehmed Han-Dâimâ kazanan, Reşad, Sene 4/ Özgürlük, Eşitlik, Adalet)
Arka Yüz: (40 Para) "Duribe fi Devlet-i Osmaniye Kostantiniye 1327" (40 Para) Osmanlı Devleti'nde, Kostantiniye'de basıldı 1909)

Sikke No: 33 (Envt. A74-16-159)

V. Mehmet Reşad, Nİ, Yirmi Para, Kostantiniye, H 1330 (M 1912) 3, 835 gr. 21 mm.

Ön Yüz: (Tuğra) "Mehmed Han bin Abdülmecid- El- muzaffer dâimâ, Reşad, Sene 3/ Hürriyet, Müsavat, Adalet" (Abdülmecid oğlu Mehmed Han-Dâimâ kazanan, Reşad, Sene 3/ Özgürlük, Eşitlik, Adalet)
Arka Yüz: (20 Para) "Duribe fi Devlet-i Osmaniye Kostantiniye 1327" (20 Para) Osmanlı Devleti'nde, Kostantiniye'de basıldı 1909)

Sikke No: 34 (Envt. 77-9-91)

V. Mehmet Reşad, Nİ, On Para, Kostantiniye, H 1332 (M 1914) 2, 650 gr. 19 mm.

Ön Yüz: (Tuğra) "Mehmed Han bin Abdülmecid- El- muzaffer dâimâ, Reşad, Sene 5/ Hürriyet, Müsavat, Adalet" (Abdülmecid oğlu Mehmed Han-Dâimâ kazanan, Reşad, Sene 5/ Özgürlük, Eşitlik, Adalet)
Arka Yüz: (10 Para) "Duribe fi Devlet-i Osmaniye Kostantiniye 1327" (10 Para) Osmanlı Devleti'nde, Kostantiniye'de basıldı 1909)

Sikke No: 35 (Envt. 73-14-2)

V. Mehmet Reşad, Nİ, Beş Para, Kostantiniye, H 1331 (M 1913) 1, 732 gr. 16 mm.

Ön Yüz: (Tuğra) "Mehmed Han bin Abdülmecid- El- muzaffer dâimâ, Reşad, Sene 4/ Hürriyet, Müsavat, Adalet" (Abdülmecid oğlu Mehmed Han-Dâimâ kazanan, Reşad, Sene 4/ Özgürlük, Eşitlik, Adalet)
Arka Yüz: (5 Para) "Duribe fi Devlet-i Osmaniye Kostantiniye 1327" (5 Para) Osmanlı Devleti'nde, Kostantiniye'de basıldı 1909)

Osmanlı Devleti'nin kurucusu Osman Bey Dönemi'nde darp edilen sikkelerde darp yeri ve tarihi yer almamaktadır. Oğlu Orhan Bey'e ait ilk sikkenin üzerinde Bursa yazdığı, yine oğlu Süleyman Paşa'nın babasına İpsala'da sikke kestirdiği bilinmektedir. I. Murad ve I. Beyazid dönemlerinde de darp yerleri yer almamakla birlikte, Osmanlı sikkelerinde darp yerinin yazması Fâsıla-yı saltanat adı verilen Fetret Devri ile olmuştur (Hasan Ferid, 2008, s. 90; Pere, 1968, s. 21; Sahillioğlu, 1993, s. 51). Osmanlıda başta İstanbul olmak üzere gerek Anadolu gerekse Balkanlar ve Kuzey Afrika bölgelerinde birçok darphane kurulmuştur. Öyle ki sikkeler üzerinde yüz yirmi yedi farklı darphanenin adı geçmektedir. İstanbul adı sikkelere Kostantiniye, İslambol, Darü's-Saltanatü'l-Aliye, Darü'l-Hilafetü'l-Aliye, Darü'l-Hilafetü's-Seniye isimleriyle beş farklı şekilde işlenmiştir (Damalı, 2014, s. 60). Çalışmamızda ele alınan 35 adet sikke devletin merkezi olan İstanbul'da darp edilmiştir. İstanbul, 34 adet sikkeye Kostantiniye, 1 adet sikkeye Dar'ül Hilafet'ül Elaliye adıyla basılmıştır. Sikkelerden 12'si II. Madmud'a; 7'si Abdülmecid'e; 3'ü Abdülaziz'e; 7'si II. Abdülhamid'e; 6 tanesi V. Mehmed Reşad dönemlerine aittir. İncelenen sikkelere bakıldığında malzeme olarak altın, gümüş, bakır ve nikel malzeme kullanıldığı görülmektedir. Devletin ekonomik durumuna paralel olarak sikkelerde kullanılan madenlerin türü ve değer oranları da değişkenlik gösterebilmektedir. Katalogda 6 adet altın sikke bulunmaktadır. Sikkelerden 5'i II. Mahmud'a (1, 2, 3, 4, 5); 1 tanesi II. Abdülhamid'e (23) aittir. İncelenen sikkeler arasında en çok kullanılan malzeme gümüştür. 15 adet örnekte (6, 7, 9, 10, 11, 12, 13, 14, 24, 25, 26, 27, 30) gümüş malzeme kullanılmıştır. Diğer 10 sikke (8, 16, 17, 18, 19, 20, 21, 22, 28, 29) bakır; 4 sikke ise (32, 33, 34, 35) nikelden darp edilmiştir.

Osmanlı Dönemi sikkelerine bakıldığında altın, gümüş, bakır, nikel farkı olmaksızın kompozisyonun ana unsurunun yazı olduğu anlaşılmaktadır. Diğer süsleme öğeleri ise sikke merkezine yerleştirilen yazı çevresinde şekillenmektedir. Araştırma kapsamında incelenen 35 adet sikke üzerinde sülüs hatla oluşturulmuş yazılar yer almaktadır. Sülüs yazı, yuvarlak hatları ve şekil verilme açısından zengin istif çeşitliliğine olanak sağlamaktadır (Narmanlı, 2023, s. 42). Sikkeler üzerindeki yazıları, sultan ve babasının adları, sultana ait unvanlar, sultanı öven ve yücelten cümleler, dualar ve darp yerleri oluşturmaktadır. Ayrıca yazı paranın değerini gösteren rakamlarla, sultanın cülus tarihini ifade etmek için de kullanılmıştır. Sikkelere yazılar genellikle iki, üç ve dört satır olacak şekilde işlenmiştir. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 24, 25, 26, 27, 30, 31 katalog numaralı örneklerde "fi" harfinin şerit gibi uzatılarak yazı kuşaklarını ayırdığı görülmektedir. 14 adet sikkenin (2, 3, 16, 17, 18, 19, 20, 21, 22, 32, 33, 34, 35) ön ve arka yüzündeki yazılar dairevi, tek sıra olacak şekilde nakşedilmiştir. Sikkeler üzerinde sultan, baba adı, darp yeri dışında "azze nasruhû (zaferi şerefli olsun)", "el- muzaffer dâimâ (dâimâ kazanan)", "dâme mülkühû (saltanatı daim olsun)" ifadeleri sıklıkla kullanılmıştır. 2

numaralı örnekte "dâme mülkühû ve saltanatahû ila ahirüd-devran (kıyamete kadar devleti ve saltanatı daim olsun)"; 23 numaralı örnekte "el-müstenid bi-tevfikatü'l rabbaniye melikü'l-devlet-i osmaniyye (Allah katından gelen başarılara ve yardımlara dayanan Osmanlı Devleti Meliki)", 10 ve 11 numaralı örneklerde "sultanü'l-berreyn ve hakanü'l-bahreyn es-sultan bin es –sultan (İki karanın sultanı ve iki denizin hakanı sultan oğlu sultan)", 2, 3 numaralı örneklerde "sultan selatin-i zaman (sultanların sultanı)" gibi dua ve sultanı yücelten cümlelere yer verilmiştir. 32, 33, 34, 35 numaralı örneklerde ise "hürriyet, müsavat, adalet (özgürlük, eşitlik, adalet)" kelimeleri kullanılmıştır.

İncelenen sikkeler içinde diğer önemli süsleme unsuru tuğralardır. Osmanlılarda zaman içerisinde gelişim gösteren tuğralar bilhassa XIX. yüzyılda özgün halini almıştır (Narmanlı, 2023, s. 49). Hükümdarın yazılı alameti olan tuğralar, sikkelerin ön yüzlerinde merkeze yerleştirilmiştir. Katalogda 10 ve 11 numaralı sikkelerin haricindeki tüm sikkelerde tuğra yer almaktadır. Bazı örneklerde tuğraların sağına mahlaslarının yerleştirildiği görülmektedir. Bazı örneklerde tuğra etrafında kalan boşluklar gerek bitkisel gerek geometrik süslemelerle doldurulmuştur. II. Mahmud Dönemi'ne ait 1, 2, 3, 4, 7, 8, 9 numaralı sikkelerde sultanın adaletini simgeleyen "Adli" mahlası yer almaktadır. II. Abdülhamid'in 23, 25, 26, 27, 28, 29 numaralı sikkelerinde tuğranın sağına, sultanın Plevne Muharebesi'nden sonra aldığı "gazi" unvanıyla "el-gazi" yazısı eklenmiştir. V. Mehmed Reşad'ın 30, 31, 32, 33, 34, 35 numaralı sikkelerinde tuğranın sağında "Reşad" yazmaktadır. Ancak 1915'te Çanakkale Zafer'inden sonra sultana "Gazi" unvanı verilince V. Mehmed Reşad "Reşad" yerine "el-gazi" unvanını yazdırmıştır (Umur, 1980, s. 319).

İncelenen sikkeler üzerinde süsleme unsuru olarak bitkisel, geometrik ve nesneli süslemeler kullanılmıştır. Bu unsurlar yazı aralarında ve çevresinde, tuğra etrafında ya da zemini doldurup kompozisyonu tamamlamak için kullanılmışlardır. Katalogda ele alınan sikkelerde gül, lale, papatya, kıvrık dal üzerinde üsluplaştırılmış çiçekler, natüralist tomurcuklar, buğday başağı ve defne dalları bitkisel bezemeleri meydana getirmektedir. 4 adet sikkede (1, 3, 10, 11) dallar üzerine yerleştirilmiş yaprak ve tomurcuklar bordürü oluşturmaktadır. Sikkelerde papatya (6), gül (8, 9, 15), lale (7) ve natüralist tomurcuk (1, 3) motiflerinin meydana getirdiği dairevi bordür tuğra ve yazı kompozisyonunu çevrelemektedir. Tuğranın sağına işlenmiş olan çiçeklerle kompozisyonun tamamlayıcı öğeleri olarak sikkelerde estetik bir görünüm elde edilmiştir. İncelenen örneklerde tuğranın sağına gül, lale, kıvrık dal arasına yerleştirilmiş çiçek ve üsluplaştırılmış tomurcuk motiflerinin yerleştirildikleri görülmektedir. Gül motifi en çok kullanılan süsleme öğelerinden bir tanesidir. İslam felsefesinde Peygamberimiz Hz. Muhammed (S.A.V) ile özdeşleştirildiğinden ve tasavvuf anlayışında gonca gül birliği, açılmış gül birliğin çokluk içindeki görünümünü temsil ettiğinden İslam sanatında sıkça kullanılan bir motif olmuştur. Ayrıca dallarının ve yapraklarının narin görünümü tercih edilen bir bitkisel unsur olmasını sağlamıştır. İncelenen 7, 13, 16, 17, 18, 19, 24 numaralı örneklerde tuğra etrafında gül motiflerinin serpiştirildiği görülmektedir. Sikkelerde kullanılan diğer önemli bitkisel öğe laledir. Lale de kültür ve sanat çevresinde çokça yer bulmuş çiçeklerden bir tanesidir. Lalenin bir soğandan çıkan çiçek olarak vahdet-i vücudu simgelemesi, ebced hesabıyla Allah" adına karşılık gelmesi bu çiçeğin sevilerek kullanılmasına neden olmuştur. Katalogda 4 ve 5 numaralı örneklerde tuğranın sağına uzun yapraklı ve kıvrımlı lale motifleri işlenmiştir. 3 adet sikkede (6, 14, 15) kıvrık dal arasında üsluplaştırılmış çiçek motifi ve 1 adet sikkede (1) natüralist tomurcuk motifi bulunmaktadır. İncelenen 4 sikkede (32, 33, 34, 35) bitkisel motiflerle oluşturulmuş çelenk bulunmaktadır. Bu motifleri başak ve defne dalları oluşturmaktadır. Başak ve defne dalları tuğranın altında kurdele ile birbirine bağlanmıştır.

Geometrik süslemeler sikkelerde bordürde, tuğra etrafında görülmektedir. Bordürlerde düz bordür, inci dizileri, ay-yıldız motifleri ve testere dişli bordürler, yıldız motifleri ve testere dişli bordürler, zencerek, düğüm motifleri meydana getirmektedir. Katalogda 4, 5, 16, 17, 18, 19, 20, 21, 22, 33, 34, 35 numaralı sikkelerde testere dişi motifli bordür görülmektedir. 13, 24, 25, 30 numaralı örneklerde testere dişi motifi ay yıldız bordürünü sınırlandırmaktadır. Ay- yıldız bordürü on iki adet hilal ve her bir hilalin ortasına denk gelen yıldızlardan oluşmaktadır. Hilaller birbirine bağlıdır ve eklendikleri yerlerde noktalar bulunmaktadır. Hilallerin dış kısımlarına, birleşim yerlerinin üstüne papatya motifleri yerleştirilmiştir. 2 adet sikkede yıldızların oluşturduğu bordürü yine testere dişli bordür çevrelemektedir. Katalogda sadece 12 numaralı sikkede ön ve arka yüzünde yer alan bordür, iki düz silmenin birbirine örülmesinden meydana gelmektedir. Sikkelerden altısında (7, 23, 32, 33, 34, 35) inci dizisi; beşinde (2, 3, 4, 5, 6) düz bordür; dördünde ise zencerek motifli bordürlerin ortasına tuğra ve yazı kompozisyonu yerleştirilmiştir. Bu bordürlerin çoğunda zamanla meydana gelen aşınmadan dolayı bozulmalar oluşmuştur. İki adet sikkede (28, 29) birlikten doğan gücü, saadeti ve mutluluğu simgeleyen saadet düğümü motifli bordür kullanılmıştır (Kemaloğlu, 2025, s. 222). Saadet düğümüne "Türk Düğümü", "Herakles Düğümü", "Sonsuzluk Düğümü" adları da verilmektedir (Aytaç, 2018, s. 41; Çoruhlu, 1995, s. 30). 12 numaralı örnekte ise saadet düğümü motifi farklı formuyla tuğranın sağına yerleştirilmiştir. Küçük yıldız motifleri diğer önemli geometrik süslemeleri oluşturmaktadır. Yıldız motifi 4 adet sikkede (32, 33, 34, 35) dairevi yazı kuşağı arasında; 2 adet sikkenin (28, 29) arka yüzünde hilal formlu bordür arasına yerleştirilmiş yazı kuşağının üzerinde yer almaktadır. Sikkelerdeki nesneli süsleme kurdele motifiyle elde edilmiştir. 8 ve 9 numaralı örneklerin ön ve arka yüz kompozisyonunu zincirlerden oluşan hilal şeklinde bir çelenk meydana getirmektedir. Tuğra ve yazı kuşağı altında, iki ayrı parçadan oluşan hilal motifi birbirine ortadan kurdele ile bağlıdır. Yine 8, 9, 32, 33, 34, 35 numaralı sikkelerde çelenkleri başlamak için kurdele kullanılmıştır.

SONUÇ

Eski çağlardan itibaren insanlar temel ihtiyaçlarını karşılamak için kendilerinde mevcut olmayan şeyleri o dönemin şartları oranında başkalarıyla takas ederek gidermeye çalışmışlardır. Ancak bu durumun zaman alması ve kullanım zorluğundan dolayı sikke adı verilen madeni para ortaya çıkmıştır. Sikkeler başlangıçta tamamen ihtiyaca yönelik ortaya çıkmış olsa da zaman içerisinde gerek üretildiği maden gerekse üzerine işlenmiş olan kompozisyonlarla başlı başına sanat eserine dönüşmüşlerdir. Ayrıca küçük ve dar bir alana darphane çalışanları tarafından ilmek ilmek işlenen bilgileri özgün haliyle günümüze aktarması bakımından da oldukça önemlidir. Sikkeler sayesinde devletin bağımsızlığını, hükümdarının kim olduğunu ve hangi tarihlerde hüküm sürdüğünü, iktisadi yapısını, teknolojik gelişimini, imparatorluğun hangi noktalarının faal olduğunu, yazı çeşitliliğini, dillerini, dinlerini, üsluplarını anlayabilmek mümkün olmaktadır.

Para basma uygulaması antik çağlardan itibaren var olmuştur. Uygarlıklar kendilerine ait yazı ve sembollerle bu paraları özelleştirmişlerdir. Hâkimiyetin göstergesi halini alan para basmak, özellikle İslamiyet'i kabul eden medeniyetlerde hutbe okutmayla birlikte gelenek halini almıştır. Bu gelenek, büyük ve çok uluslu yapıya sahip olan Osmanlı İmparatorluğu'nda da devam etmiştir. Osmanlıda saltanatı devralan her sultan farklı coğrafyalarda farklı malzemelerde ve tiplerde sikke kestirmişlerdir. Bu sikkeler sadece Türk değil, dünya Nümismatik bilimi için büyük önem taşımaktadır.

Amasya, Osmanlı Devleti'nin şehzade sancakları arasında yer almış bir kenttir. Orta Karadeniz'in en eski yerleşimlerinden olan şehirde pek çok medeniyetin izlerini görülmektedir. Mimariden el sanatlarına birçok farklı eserin bulunduğu Amasya, Osmanlı sikkeleri açısından oldukça zengindir. Bu sikkeler

Amasya Müzesi'nde muhafaza edilmektedir. Çalışma kapsamına müzedeki XIX. ve XX. yüzyıla tarihlenen II. Mahmud, Abdülmecid, Abdülaziz, II. Abdülhamid ve V. Mehmed Reşad dönemlerine ait 88 adet sikke içinden seçilen 35 adet Osmanlı sikkesi dâhil edilmiştir. Kataloga alınan sikkelerin transkripsiyonu yapılmış, yazı, malzeme, ölçü ve kompozisyon özellikleri tüm yönleriyle ele alınarak detaylı şekilde incelenmiştir. Sikkeler üzerinde yer alan tüm unsurlar kendi içinde sınıflandırılmış, yazıların ve motiflerin çözümlemeleri yapılmıştır. Sikkelerin kronolojik sıra ile ele alınması hem devletin siyasi, ekonomik ve kültürel değişimini göstermesi hem de malzeme, form ve üslup değişimlerinin somut biçimde algılanmasına imkân tanıması açısından önemlidir.

XIX. ve XX. yüzyıl Osmanlı sikkelerine bakıldığında, sikkelerde görülen metal değişimleri (altından gümüşe, gümüşten de bakır ve nikele olan geçiş süreci), darphane reformları, ayarlarda düşüşler ve yeni para birimlerinin basılıp dolaşıma sokulması ekonomik sıkıntıların sikkelere açıkça sansıma şekli olmuştur. XIX. yüzyılda, özellikle II. Mahmud Dönemi'nde gerek formları ve süsleme özelikleri gerekse birim çeşitliliğiyle dikkat çeken altın sikkeler, XX. yüzyılda tedavülden çekilmeye başlanmıştır. Basılan sikkeler ise daha çok hatıra ve tasarruf amacıyla darp edilmiştir. Gümüş sikkeler hala kullanılmış olsa da ayarlarındaki hızlı düşüşler sebebiyle yerini nikel ve bakır sikkelere bırakmıştır. Özellikle 1910 yılından sonra nikel ve bakır 10, 20 ve 40 paralar yaygınlaşmıştır. XIX. yüzyıl Osmanlı sikkeleri, hem geleneksel Osmanlı estetiğini hem de batı etkisiyle başlayan modernleşme sürecini birlikte yansıtan oldukça karakteristik ve zengin tasarımlara sahip olmuştur. Özellikle II. Mahmud ve Abdülmecid dönemlerinde kıvrımlı hatlar, yoğun bordür desenleri, çiçek ve kıvrımlı motifler belirginleşmiştir. Bu dönem sikkeleri önceki klasik Osmanlı sikkelerine göre daha süslü hale gelmiştir. XIX. yüzyıl ortalarından sonra, Abdülmecid ve Abdülaziz dönemlerinde görülmeye başlayan defne dalı çelenkleri ve yıldız motifleri batı madalya ve nişan estetinden etkilenmiş ve sikkelerde yerini bulmuştur. XX. yüzyıl Osmanlı sikkeleri, özellikle II. Abdülhamid, Mehmed Reşad (V. Mehmed) dönemlerinde basılan sikkeler, hem geleneksel Osmanlı estetik anlayışını hem de modernleşme sürecinin izlerini taşımaktadır. Osmanlı sikkelerinin en karakteristik öğesi olan padişah tuğrası XX. yüzyılda da temel tasarım öğesi olmuştur. Hattatların elinden çıkan tuğralar, estetik bir kaligrafik kompozisyon olarak geleneksel formunu sürdürmüştür. Tuğranın çevresine yerleştirilen defne dalı ve buğday başağından oluşan çelenkler, kurdele formu, hilal ve yıldız motiflerinin kullanımına bu yüzyılda da devam etmiştir.

Sonuç olarak, XIX. ve XX. yüzyıl Osmanlı sikkeleri, hem tarihsel hem ekonomik hem de kültürel açıdan oldukça önemli bir yere sahiptir. Bu dönem, Osmanlı İmparatorluğu'nun son yüzyıllarına denk geldiği için paralar, devletin geçirdiği dönüşümlerin bizzat şahitleri olarak başta sanat tarihi olmak üzere pek çok bilim dalı için önem arz etmektedir.

KAYNAKÇA

Aytaç, İ. (2018). Harput İç Kale Kazılarında Bulunan Artuklu Dönemi Sikkeleri. Fırat Üniversitesi Harput Araştırmaları Dergisi, 5(1), 29-55.

Çoruhlu, T. (1995). Osmanlı Koruyucu Silahlarında Süslemeler ve Teknikler (Askeri Müze'den Örnekler ile). (Yayımlanmamış doktora tezi). İstanbul Üniversitesi, Sosyal Bilimler Enstitüsü, İstanbul.

Damalı, A. (2010). Osmanlı Sikkeleri Tarihi (C. 1-9, C. 1). İstanbul: Nilüfer Damalı Eğitim, Kültür ve Çevre Vakfı Yayınları.

Damalı, A. (2014). A'dan Z'ye Osmanlı Nümismatik El Kitabı. İstanbul: Nilüfer Damalı Eğitim, Kültür ve Çevre Vakfı Yayınları.

Eroğlu, İ. (2020). Sinop Arkeoloji Müzesi'ndeki Bir Grup Osmanlı Dönemi Sikkesi. (Yayımlanmamış yüksek lisans tezi). Ordu Üniversitesi, Sosyal Bilimler Enstitüsü, Ordu.

Hasan Ferid. (2008). Osmanlı'da Para ve Finansal Kredi: Meskûkât. (M. H. Sağlam, Çev.) (C. 1). İstanbul.

Kabaklarlı, N. (1998). Mangır (1299-1808): Osmanlı İmparatorluğu Bakır Paraları. İstanbul: Uşaklılar Eğitim ve Kültür Vakfı Yayınları.

Kemaloğlu, Z. (2023). Amasya Müzesi'nde Bulunan Osmanlı Dönemi Sikkeleri. (Yayımlanmamış doktora tezi). Ondokuz Mayıs Üniversitesi, Lisansüstü Eğitim Enstitüsü, Samsun.

Kemaloğlu, Z. (2024). Tarihin Şahitleri Amasya Müzesi Osmanlı Sikkeleri. Amasya: Amasya Belediyesi Kültür Yayınları.

Kemaloğlu, Z. (2025). Amasya Müzesi'ndeki Saadet Düğümü Motifli Osmanli Sikkeleri (ss. 220-232). 7. Uluslararası Kültür, Sanat ve Edebiyat Kongresi (2 Ağustos 2025), sunulmuş bildiri, Ankara.

Narmanlı, F. (2023). Cumhuriye'e Geçiş Dönemi'nde Hat Sanatı. İstanbul: Kitap Dünyası Yayınları.

Pere, N. (1968). Osmanlılarda Madeni Paralar (Yapı ve Kredi Bankası Osmanlı Madeni Paraları Koleksiyonu),. İstanbul: Doğan Kardeş Matbaacılık.

Sahillioğlu, H. (1965). Bir Asırlık Osmanlı Para Tarihi 1640-1740. (Yayımlanmamış doçentlik tezi). İstanbul Üniversitesi, İktisat Fakültesi, İstanbul.

Sahillioğlu, H. (1993). Darphâne. TDV İslâm Ansiklopedisi. İstanbul: TDV Yayınları.

Sahillioğlu, H. (2005). Osmanlı Para Tarihinde Dünya Para ve Maden Hareketinin Yeri (1300-1750). O. Tekin (Ed.), Altının İktidarı İktidarın Altınları (Yapı Kredi Koleksiyonu) içinde (ss. 115-132). İstanbul: Yapı Kredi Yayınları.

Tekin, O. (2003). Mangır. TDV İslâm Ansiklopedisi. Ankara: TDV Yayınları. https://islamansiklopedisi.org.tr/mangir adresinden erişildi.

Tekin, O. (2005). Devletler, Hükümdarlar ve Sikkeleri. O. Tekin (Ed.), Altının İktidarı İktidarın Altınları (Yapı Kredi Koleksiyonu) içinde (ss. 167-278). İstanbul: Yapı Kredi Yayınları.

Tekin, O. (2009). Sikke. TDV İslâm Ansiklopedisi. İstanbul: TDV Yayınları. https://islamansiklopedisi.org.tr/sikke adresinden erişildi.

Umur, S. (1980). Osmanlı Padişah Tuğraları. İstanbul: Cem Yayınevi.

Uslu, K. (2007). Bir Kitap: Akçe. Anadolu Nümizmatik Bülteni, (1), 10.

Yılmaz, A. (2019). İznik Müzesi'nde Bulunan Osmanlı Dönemi Sikkeleri. (Yayımlanmamış doktora tezi). Yüzüncü Yıl Üniversitesi, Sosyal Bilimler Enstitüsü, Van.

AMASYA BAYEZİD PAŞA CAMİ MİHRABI SÜSLEME PROGRAMI

AMASYA BAYEZID PASA MOSQUE MIHRAB DECORATION PROGRAM

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ÖZET

Süsleme unsurlarının ne zaman ortaya çıktığı konusunda kesin bir bilgi bulunmamakla birlikte, insanlık tarihinin herhangi bir noktasında veya kültürlerde süsleme sayılabilecek formlara rastlamak mümkündür. Ancak bunun bir sanat haline gelip sistematik olarak uygulanması İslam sanatıyla birlikte olmuştur. Emeviler ile başlayıp Abbasi, Karahanlı, Gazneli, Büyük Selçuklu dönemleriyle gelişimini sürdüren kompozisyon anlayışı Anadolu Selçuklu, Beylikler ve Osmanlı İmparatorluğu dönemlerinde özgün bir yapıya kavuşmuş, sanatçılar tarafından farklı coğrafyalarda çeşitli malzemelerle değişik yüzeylere tatbik edilmiştir. Bu alanlardan biri de mihraplardır. Mihrap, cami, mescit, türbe gibi dini yapılarda kıble yönünü gösteren mimari elemandır. Mihraplar başlangıçta tamamen ihtiyaca yönelik sade, süslemesiz bir yapıya sahipken zamanla ibadet mekânlarının en dikkat çeken elemanlarından olmuştur. Çeşitli İslam medeniyetleri tarafından farklı coğrafyalarda form ve süsleme açısından geliştirilip, zenginleştirilen mihraplar, bezeme unsurlarının son sınırlarına kadar denendiği yüzeylerden biri haline gelmiştir. Sanatçılar dönemin zevk ve beğenisine uygun olarak oluşturdukları sanat üsluplarını farklı bölgelere taşımışlardır. Bu izleri ve yansımaları gerek süsleme gerekse yapı elemanlarında Anadolu'nun çeşitli yerlerinde görmek mümkündür. Bu yerlerden biri Amasya'dır. Amasya, Orta Karadeniz'in en eski yerleşim merkezlerinden olup, çok sayıda medeniyete ev sahipliği yapmıştır. Osmanlı Devleti'nin de şehzade sancakları arasında bulunmaktadır. Pek çok medeniyetin izlerini bünyesinde barındıran kentte, özellikle Osmanlı Dönemi'ne ait çok sayıda taşınabilir- taşınamaz eser miras kalmıştır. Eserlerin başında ise camiler gelmektedir. Çalışma kapsamında Amasya il merkezinde yer alan Bayezid Paşa Cami mihrabı konu edilmiştir. Bayezid Paşa Cami mihrabı, süsleme unsurları ve teknik açıdan Türk sanatı içerisinde önemli bir yer teşkil etmektedir. Çalışmamızda mihrap tüm yönleriyle incelenecek ve süsleme unsurları ayrıntılı olarak tanıtılacaktır.
Anahtar Kelimeler: Osmanlı, Amasya, Mimari, Cami, Mihrap, Süsleme.

ABSTRACT

While there is no definitive information regarding the origin of decorative elements, it is possible to encounter forms that can be considered decorative at any point in human history or across cultures. However, its transformation into an art and systematic application began with Islamic art. Beginning with the Umayyads and continuing its development through the Abbasid, Karakhanid, Ghaznavid, and Great Seljuk periods, this understanding of composition attained a unique structure during the Anatolian Seljuk, Beylik, and Ottoman periods, and was applied by artists using various materials and on various surfaces in different geographies. One of these areas is the mihrab. A mihrab is the architectural element that indicates the direction of qibla in religious structures such as mosques, masjids, and mausoleums. While initially a simple, undecorated structure, mihrabs served purely as a necessity, over time they became one of the most striking elements of places of worship. Developed and enriched in terms of form and ornamentation by various Islamic civilizations across different geographies, mihrabs became one of the surfaces where decorative elements were tested to their fullest extent. Artists brought the artistic styles they created to different regions, in line with the tastes and preferences of their time. These traces and reflections can be seen in various parts of Anatolia, both in decorative and structural elements. One such place is Amasya. Amasya is one of the oldest settlements in the Central Black Sea region and has

hosted numerous civilizations. It was also among the Ottoman Empire's sanjaks. The city, which bears the traces of many civilizations, has inherited numerous movable and immovable artifacts, particularly from the Ottoman period. Mosques are among the most prominent of these works. The study focuses on the mihrab of the Bayezid Pasha Mosque, located in the city center of Amasya. The Bayezid Pasha Mosque mihrab holds a significant place in Turkish art in terms of its decorative elements and technical features. In this study, the mihrab will be examined in all its aspects, and its decorative elements will be introduced in detail.
Keywords: Ottoman, Amasya, Architecture, Mosque, Mihrab, Decoration.

1. GİRİŞ

Mihrap, ibadet mekânlarında kıbleyi yani Mekke yönünü tayin eden hücreye denilmektedir (Arseven, 1966, s. 1347). Arapça "saray, harem kısmı, hükümdarın taht bölümü, köşk, yüksekçe yer" gibi karşılıkları olan mihrap, zamanla camilerde imamın önünde durduğu ve cemaate namaz kıldırdığı yer anlamları için kullanılmıştır(Erzincan, 2005, s. 30). Kur'an-ı Kerim'de mihrap, biri çoğulu "meharib" olmak üzere beş ayette geçmektedir: Ali İmran Suresi 37. ve 39. Ayetleri, Meryem Suresi 11. Ayeti, Sâd Suresi 21. Âyeti, Sebe Suresi 13. Ayetleridir (Top, 1997, s. 5). Hz. Muhammed (S.A.V) ve Dört Halife döneminde mescitte mihrap uygulaması görülmemiş, kıble duvarı taş veya bir işaret konularak belirtilmiştir. Bu nedenle Medine'deki ilk cami olma özelliğine sahip Mescidi Nebevi'de, Basra, Kûfe ve Fustat'ta bulunan ilk camilerde niş şeklinde mihraplar yer almamaktadır (Çam, 1994, s. 158). Mihrap zamanla farklı coğrafyalarda farklı medeniyetler aracılığıyla geliştirilerek kendine özgü nitelikleriyle İslam mimarisinde simgesel bir hale dönüşmüştür (Top, 1997, s. 7). Başlangıçta sadece kıbleyi göstermek için kullanılan mihrap, giderek gerek form gerekse süslemeleriyle yapının iç mekânında ilk dikkat çeken elemanı durumuna gelmiştir (Bakırer, 2000, s. 1).

Mihrapların İslam mimarisinde görülmesi Emevi dönemi ile olmuştur. Ardından Abbasiler, Fatımiler, Karahanlılar, Selçuklu (Büyük Selçuklu Atabekler, Zengiler, Anadolu Selçuklu) ve Anadolu Beylikleri gibi devletlerle gelişimine devam etmiştir. İslamiyeti kabul etmiş farklı coğrafyadaki devletler de, gerek sanat gerekse mimaride kendilerine özgü bir yapılanma içerisine girerek plan, kullanılan malzeme ve elemanlar, bezeme öğeleriyle üzerinde yaşadıkları coğrafyanın etkisini sanatçılar vasıtasıyla eserlerine yansıtmışlardır (Kemaloğlu, 2024a, s. 96).

Emevilerde mihraplar, yarım daire planlı ya da at nalı şeklinde uygulanmıştır. Yarım daire şeklindeki ilk Emevi Dönemi mihrabı, Halife I. Velid zamanında (707-709) Vali Ömer b. Abdülaziz'in caminin genişletilmesi sırasında uygulanmış olan Medine Cami mihrabıdır. Ardından Fustat'daki Amr Cami (710-712) ve Şam Emeviyye Cami'nde (706-715) de görülmüştür. Basra Ömer Cami (745-746) mihrabı günümüze gelen en erken tarihli yarım daire planlı mihrap olması sebebiyle oldukça önemlidir. Ummu'l-Velid, Hane'z-Zebib ve Kuseyru'l-Hallabad camilerindeki mihraplar at nalı şeklindedir (Bakırer, 2000, s. 7). Abbasi Dönemi'nde mihraplar basit bir niş olmaktan çıkmış, mihraplara çerçeve, hücre, kavsara, köselik, kitabelik ve sütünce gibi elemanlar eklenmiştir. Bilhassa dikdörtgen plana sahip mihraplar ilk defa Abbasilerde uygulanmıştır (Top, 1997, s. 10). Abbasi dönemine ait ilk mihrap, Bağdat müzesinde muhafaza edilen ve Bağdat Halife Mansur Cami'ne (744) ait olduğu tahmin edilen El-Haseki Cami mihrabıdır. Üzerinde yer alan süslemeleriyle öne çıkan bu mihrap, cephe düzeni incelenebilen en erken mihrap olması bakımından oldukça önemlidir (Kemaloğlu, 2025, s. 207). Yine Ukhaydır Sarayı (778), Cevzak'ül-Hakani Sarayı (836), Samerra Ulu Cami (848-860), Samerra Ebû Dülef Cami (860-861), Nayin Mescidi Cuma (960) ve Nayrız Mescidi Cuma (973) cami mihrapları da dikdörtgen planlı önemli örneklerdir (Bakırer, 2000, s. 16). Fatimi dönemi mihrapları at nalı planlı, yarım kubbe kavsaralı ve cepheden at nalı kemerli özellikleriyle magrib etkisini

yansıtmaktadır. Tolunoğlu Cami'nin esas mihrabı, Kahire El–Ezher Cami (972) esas mihrabı, El-Cuyusi Cami, Seyide Atika Türbesi, İkvat Yusuf Türbesi, Seyyide Mefise Türbesi mihrapları da aynı özellikleri taşımaktadır (Bakırer, 2000, s. 16; Kemaloğlu, 2022, s. 150). Karahanlılar dönemine gelindiğinde mihrapların iyice şekillendiği görülmektedir. Buhara'daki Namazgâh Cami (1119-1120) mihrabı dikdörtgen planlı ve mukarnas kavsaralı nişi, üç yönden çevreleyen bordürü, dışta ve içte zencerek motifleri ile bunların arasındaki yazılarıyla ne derece ileri gittiklerinin göstergesi olmuştur. Selçuklular döneminde tuğla işçiliği ve mukarnas kavsaralı mihraplar ön plana çıkmaktadır. Kazvin Mescid-i Haydariye (1113), Zevvare Cuma Cami (1156), Buzan İmamzade Karrar Türbesi (1134), Hemedan'daki Künbet-i Aleviyan (XII. yy) ve Erdistan Cuma Cami (1158-1160) mihrapları bu dönemin en güzel ve en dikkat çeken süslemelere sahip mihraplarıdır. İran'da çok köşeli niş ve mukarnaslı kavsaraya sahip mihrap düzenini sergileyen en erken tarihli eser IX. yüzyıla ait Demavend Cuma Cami mihrabıdır. İran mihraplarının bir başka özelliği de XIII. yüzyıla ait ve tümüyle perdahlı çiniden yapılmış mihrapların olmasıdır. Meşhed'deki İmam Rıza Türbesi mihrabı günümüze ulaşan en erken örnek olması açısından önem taşımaktadır. Anadolu Beylikler Devri mimarisi ve sanatında büyük oranda Selçuklu özellikleri takip edilmiş, yeni üslup ve anlayışlar denenmiştir. Adeta Selçuklu ile Klasik Osmanlı Sanatı arasında bir geçiş dönemi olmuştur. Bu dönem mihraplarında birtakım değişiklikler olsa da Anadolu Selçuklu mihraplarının devamı oldukları hem malzeme hem de mimari elemanların uygulanışından anlaşılmaktadır (Top, 1997, s. 27). Osmanlı gelişme dönemi mimarisinin temelini oluşturan mukarnaslar, taş malzemeyle inşa edilmiş mihraplarda sade ve zarif bir şekilde uygulanmışlardır. Edirne II. Beyazıt Cami (1484-88) ve Şehzade Cami (1543-48) mihrapları bunun en güzel örnekleridir. XVIII. yüzyılın ilk yarısına tarihlenen mihraplar geleneksel formunu devam ettirirken, önceki yüzyıla oranla taş malzemeden yapılmış süslemelerde aşırı abartı ve yoğun hatlar dikkati çekmektedir. Üsküdar Yeni Valide Cami'nin mihrabı bu tesiri göstermesi açısından önemlidir. XVIII. yüzyılın ortalarında, Osmanlıda batı tesiriyle oluşan barok dönemi mihraplarında da kendini göstermeye başlamıştır. Bunun en karakteristik ve en önemli örneği Nuru Osmaniye Cami mihrabıdır. Üsküdar Ayazma Cami, Laleli Cami, Beylerbeyi Cami, Aydın'da Cihanoğlu Cami, Yozgat'ta Çapanoğlu Cami mihrapları da barok etkiyi yansıtan önemli mihraplardandır. XIX. yüzyılla birlikte başlayan ampir üslubu baroğa göre daha sade bir anlayış sergilemektedir. Bu üslubun en başarılı örneğini Nusretiye Cami'de görmek mümkündür. Aksaray Valide Cami mihrabı ise farklı üslup özelliklerini bünyesinde taşıdığından eklektik üslubu ile dikkati çekmektedir (Erzincan, 2005, s. 36).

Mihraplar, başlangıçta tamamen ihtiyaca yönelik, süslemesiz, sade bir yapıya sahipken, zaman geçtikçe dini yapıların ilk dikkati çeken kısmı haline gelmiştir. Fonksiyonelliğinin dışında sanatçıların maharetlerini sergileyebilecekleri, süsleme unsurlarının uygulanacağı en önemli alanlardan biri olmuştur. Bu sebeple kaliteli malzemeler, yazının farklı formları ve kompozisyonlar burada kullanılmıştır (Çok, 2018, ss. 201-228). Taş, alçı, mermer, ahşap ve çini gibi farklı malzemelerle yapılmış olan mihraplarda uygulanan süsleme programlarına bakıldığında tezyini özellikleri gonca ya da açmış güller, karanfiller ve sümbüller, Türk ve İslam sanatında önemli yeri olan laleler, sarmaşıklar, yapraklar gibi bitkisel öğeler; çeşitli yıldız formları, şekillerin simetrik olarak belli bir düzen içinde sıralanmasıyla oluşan geometrik geçmeler; Kuran-ı Kerim'den ayetler, Kelime-i Tevhid, Allah ve Muhammed ile dört halife adları yazıları; mukarnas bezemeleri, kalemişi tekniğiyle yapılmış süslemeler zengin kompozisyon ağını oluşturmaktadır (Etikan, 2008, s. 547; Kemaloğlu, 2021, s. 1859).

Türk süsleme sanatı farklı kültürleri bünyesinde sentezlemiş, homojen bir yapıya sahiptir. Gerek kendi kültüründen gerekse farklı medeniyetlerin sanatından beslenerek farklı bir sanat anlayışı ortaya çıkarmışlardır. Türk süsleme sanatını şekillendiren ana unsur inanç sistemi olmuştur. İslam dininde yaşayan varlığın tasvir edilmesi hoş karşılanmamıştır. Bu yaklaşımın getirdiği kısıtlamalar İslam sanatında yeni şeyler denenmesine ve Orta Asya'dan beri devam eden hayvani bezemelere mesafeli durulmasına neden olmuştur. Süslemelerde stilize edilmiş desenler uygulanmış, figürler olduğu şekilde değil, yorumlanarak, bitki ya da çizgilerin arasına gizlenerek tasvir edilmeye çalışılmıştır (Çam, 2016, s. 90). Sanatçılar daha çok yazı ve geometrik (hendesi) süslemeleri ön plana çıkararak figürsüz, özellikle bitkisel (nebati) bezemelerden meydan gelen süsleme öğelerini kullanmışlardır (Acar, 2022, s. 1138; Doğanay, 2019, ss. 369-386). Geometrik süslemeler, İslam sanatının en karakteristik süsleme öğesi olmuştur. Her kültürde karşımıza çıkan geometrik şekiller, İslam ülkelerinde zenginleşerek müstakil bir süsleme unsuru halini almıştır. Tasvire karşı durulan mesafe sanatçıyı geometrik formları son sınırlarına kadar denemesine neden olmuştur (Mülayim, 1999, s. 175). Zenginleştirilmiş geometrik şekillerle oluşturulan kompozisyonlar, iki şeritli basit geçmeler, yıldız örnekleri, düzenli ve düzensiz çokgenler, kırık ve düz çizgilerin birleşmesiyle elde edilen çok çeşitli süsleme öğeleri yapıların iç ve dış süslemelerinde kullanılmıştır. Geometrik motifler çoğu zaman tek başına tüm alana tatbik edilmiştir. Bazen desenin simetri ve zenginliği, çiçekler ve yapraklar gibi bitkisel motifler vasıtasıyla ortaya çıkarılmak istenmiştir (Broug, 2016, s. 21; Demiriz, 2004, s. 7). Bezeme öğesi olarak kullanılan bitkisel motifler gerek tabiattan alınmış gerekse üsluplaştırılmış şekilleriyle her dönemde önemini korumuş ve sevilerek kullanılmıştır. Özellikle formlarındaki kıvrımları ve zarif duruşlarıyla sıklıkla kullanılmalarına neden olmuştur (Kemaloğlu, 2024b, s. 476). Mihraplarda bitkisel bezemeler rumiler, palmetler, laleler, kıvrık dallar ve dallar arasına yerleştirilmiş çiçekler, stilize edilmiş çiçek motifleri olarak karşımıza çıkmaktadır. Özellikle XVII. ve XX. yüzyıl mihraplarındaki barok karakterli laleler, iri akant yapraklar, S ve C kıvrımlı yapraklar mihraplarda uygulanmıştır. Rumi motifi, Türk ve İslam sanatlarında mimariden el sanatlarına kadar pek çok alanda, zengin formlarıyla yaygın şekilde kullanılmıştır. Türk Süsleme Sanatı'nda önemli bir yeri olan Rumi motifi, her devirde, farklı üsluplarda çeşitli yüzeylere uygulanmıştır (Ögel, 1987, s. 77).

Yazı, yalnızca bilgi vermesi açısından değil eserlere güzellik katması, bakan kişide hoş bir duygu uyandırması için kullanılan önemli bir süsleme öğesi olmuştur. İslam'ın doğuşundan itibaren çok kısa bir süre içerisinde Müslüman sanatçıların maharetli ellerinde bir sanata dönüşen hat, mihraplarda kartuşlarında, kenar bordürlerinde ve alınlık kısımlarında kullanılmıştır. Yazı içeriklerini ise Kuran-ı Kerim'den alınmış ayetler, Kelime-i Tevhid, Allah ve Muhammed adları oluşturmaktadır. Mukarnas, İslam mimarisinde sık kullanılan dekoratif unsurlarındandır. İslam sanatı motiflerine özgü üç boyutlu dekoratif ya da yapısal bir mimari öğe olan mukarnas, kademeli petek görünümlü niş dizilerinden meydana gelmektedir. Mukarnas bezemeleri kubbeler, sütun başlıkları, nişler, minare şerefesi, kemerler, taçkapılar, mezar taşları, çeşmeler, frizler gibi çeşitli yerlerde geçiş bölgeleri için kullanılmıştır (Dallal ve Yaman, 2019, s. 75). Mihraplarda görülen başka bir süsleme öğesi de kalemişidir. Kalemişi; farklı türden mimari yapıların iç ve dış yüzeylerini süslemek için kalem gibi ince fırçalarla çeşitli yüzeylere renkli boyalarla yapılan süslemeye verilen addır (Can ve Gün, 2018, s. 273). Mihraplarda niş yüzeyinde, kavsarada, nişin alt kısmında, sütuncelerde, köşeliklerde, bordürlerde, alınlıkta ve tepelikte kalemişi tekniğiyle zengin motif repertuvarına sahip süslemeler yapılmıştır (Kemaloğlu, 2021, s. 1863, 2022, s. 148).

Amasya tarihi açıdan Anadolu'nun en eski yerleşim yerlerinden biridir. Orta Karadeniz Bölgesi'nde bulunan kent başta Osmanlı Devleti olmak üzere farklı dönemlerde pek çok medeniyete ev sahipliği

yapmıştır. Amasya'da bu dönemlere ait çok sayıda eser bulunmakta ve şehrin silüetini oluşturmaktadır. Osmanlı Devleti'nin şehzade sancaklarından olan ve sultanların sanat zevkini yansıtan eserlerin süslediği kentte camiler dikkati çekmektedir. Amasya'da, Osmanlının erken tarihlerinden son yüzyılına kadarki süre zarfında farklı mimari ve tezyini özellikler sergileyen camiler inşa edilmiştir. Bunlardan biri de Amasya Bayezid Paşa Cami'dir. Çalışmamızda Bayezid Paşa Cami Mihrabı incelenecek ve kompozisyon özelikleri tanıtılacaktır. Erken Dönem Osmanlı mimarisinde yaygın olan "tabhaneli" ya da "zaviyeli" camilerin önemli örneklerinden olan yapı, üzerinde yer alan detaylarla ünik bir yapı sergilemektedir. Evliya Çelebi'nin 1646 tarihinde geldiği Amasya'daki camiler arasında "bağ-ı İrem-misal" olarak tarif ettiği yapı, Osmanlı devri Türk mimarisinin ilk döneminde eski Orta Asya yapı geleneklerini kendi döneminin sanatıyla sentezleyen, önemli özelliklere sahip bir eserdir (Eyice, 1992, s. 244).

ARAŞTIRMA VE BULGULAR

Bayezid Paşa Cami Genel Tanımı

Bayezıd Paşa, Yıldırım Bayezid'in şehzadesi Çelebi Mehmed'in lalasıdır. 1413 yılında Çelebi Mehmet tarafından vezir tayin edilmiştir. Bayezıd Paşa'nın Amasya'da bir imaret, Bursa'da da bir medrese yaptırdığı bilinmektedir (Mutlu, 2022, s. 17).

Amasya merkezde Beyazıt Paşa Mahallesi'nde bulunan cami, Çelebi Sultan Mehmet zamanında Vezir Bayezid Paşa tarafından H 817 (M 1414) tarihinde inşa ettirilmiştir (Yardım, 2004, s. 67). Yapının mimarları Şam'lı Müşeymeş oğlu Mehmet oğlu Ebu Bekir ve Tughan Abdullah oğlu Fighan'dır (Urak, 1994, s. 261). Yapı, ters "T" tipi plan şemasına sahip, erken devir Osmanlı mimarisinin zaviyeli (tabhaneli) cami plan tipinin önemli örneklerindendir. Caminin kuzeyinde, altı kalın paye üzerinde kalın kemerlerle beş bölüme ayrılmış son cemaat yeri bulunmaktadır. Bölümlerin üzeri kubbelerle örtülüdür. Yapıya giriş bu bölümden yapılmaktadır. Küçük bir geçitten sonra orta eksende ardı ardına gelen ve büyük bir kemerle birbirinden ayrılan iki kubbeli mekâna girilmektedir. Kubbeler yüksek, sekizgen kasnaklara oturmuştur ve her birinde aydınlatma pencereleri bulunmaktadır. Birinci mekân, mihrabın bulunduğu bölümden daha büyüktür. Bu kısmın kubbesinde bir adet aydınlık feneri yer almaktadır. Doğu ve batı bölümde esas ibadet mekânına birer kapı ile açılan, üzeri kubbeli ikişer mekân bulunmaktadır. Yapının üzeri kurşunla kaplıdır. Plan bakımında değişik ve güzel bir şekil ortaya konulduğu gibi caminin yapımında ve süslemesinde de zengin ve özenli bir işçilik görülmektedir.

Mihrap Özellikleri

Caminin mihrabı alçı malzemeden, sütunçeler ise mermerdendir. Üzerinde kalıplama tekniği ile yapılmış süslemeler yer almaktadır. Mihrap güney duvarın ortasına, giriş aksına konumlandırılmıştır. 440 cm. yüksekliğinde, 260 cm. genişliğindeki mihrap 51cm. derinliğinde ve üç köşelidir. Mihrabın nişi duvar kalınlığı içinde kalmakta, beden duvarından dışarıya çıkıntı oluşturmamaktadır. İç mekâna doğru ise 5cm'lik bir çıkıntı meydana getirmektedir. Mihrabın kavsara yuvaları derin ve yayvandır. Beş sıra mukarnas dizisine sahiptir. Kavsaranın birinci sırası dilimli, üçüncü sırası sivri kemerli sağır nişçik şeklinde düzenlenmiştir. İki ve dördüncü sıralar badem ve kanat formlarıyla tertip edilmiştir. Birinci ve ikinci sıraların orta kısmına alttan uyarıya doğru genişleyen konsol öğeleri yerleştirilmiştir. Kavsara en üstte altı dilimli, yarım küre biçiminde bir tepe nişiyle sonlandırılmıştır. Tepe nişinin üzerine bir adet gülbezek motifi yerleştirilmiştir. Bu motif, dört katmandan meydana gelmiş on iki yaprağın sıralandığı penç motifi kompozisyonudur. Mihrabın alınlık kısmında, dikdörtgen pano içerisinde sülüs hatla, Cin suresi 18. ayeti yazılıdır:

“Ve enne-l mesâcide lillâhi felâ ted’û meâllâhi ehadâ

اَحَدًا اللهِ مَعَ تَدْعُوا فَلَا لِلّٰهِ الْمَسَاجِدَ وَاَنَّ

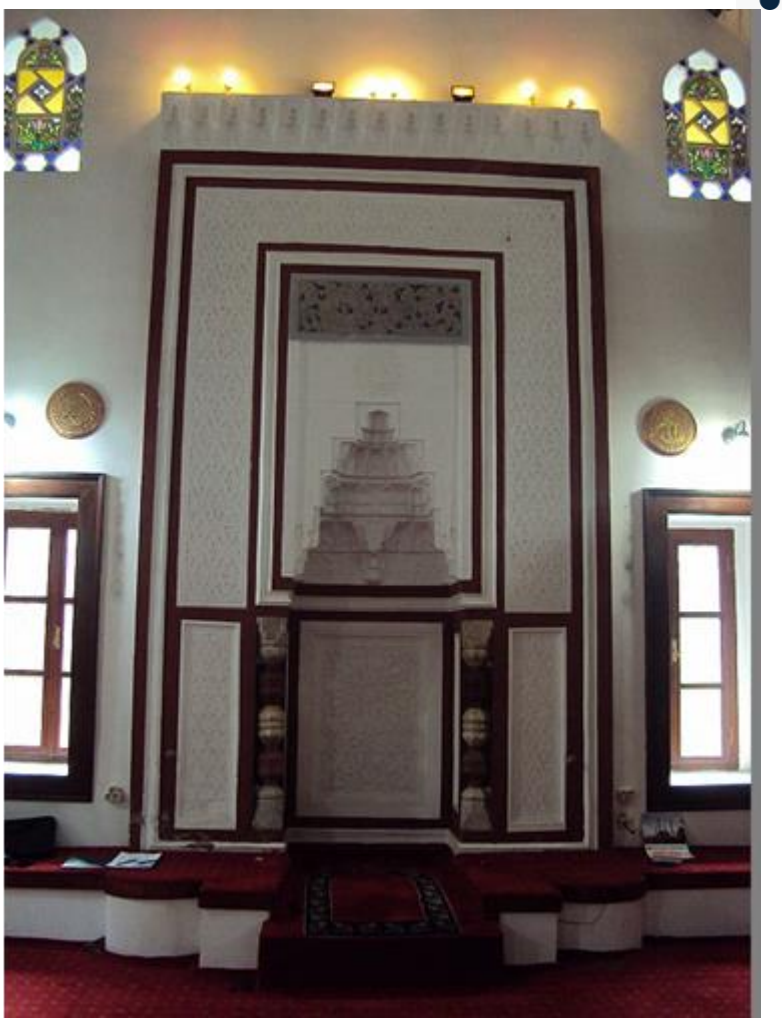
(Şüphesiz mescitler, Allah'ındır. O halde, Allah ile birlikte hiç kimseye kulluk etmeyin)

Yazı kuşağını, siyah dal üzerine koyu yeşil rumilerin yerleştirildiği sarmaşık dolanmaktadır. Mihrap tepeliği, iki sıra mukarnaslı taç olarak mihrap üzerine konumlandırılmıştır. Mukarnasların alt sırasında, aralarına yaprak biçiminde konsol öğeleri yerleştirilmiş dikdörtgen yüzeyler; üst sırasında ise iki kademeli yuvalar yer almaktadır. Mihrapta bir adet bordür ve farklı şekilde düzenlenmiş altı adet silme yer almaktadır. İç kısımdaki üç adet silme nişin alt kısmını kavsaradan ayırmaktadır. Bu bölüm kavsaranın çerçevesi olacak şekilde devam etmektedir. Dış kısımda yer alan üç adet silme de mihrabı dört taraftan çevrelemektedir. Mihrabın bordürünü geometrik ve bitkisel motiflerin bir arada kullanıldığı süsleme unsurları oluşturmaktadır. Bu süslemeleri on iki köşeli geçmeler ve geçmelerin kesiştiği orta bölümlere yerleştirilen altı kollu yıldızlar meydana getirmektedir. Bordürün alt kısmı ince kırmızı bir silme ile çerçeve içine alınarak üst bölümden ayrılmıştır. Pano şeklinde düzenlenen bölümün üst kısmında üstte on iki kollu tam, onun altında altı kollu yarım yıldız motifi dikkati çekmektedir. Bu yıldızların ortalarına da birer adet çarkıfelek motifi işlenmiştir. Mihrap nişin iç kısmında yer alan karşılıklı iki pano, on kollu yarım yıldızlar ve beşgenlerden müteşekkil geometrik geçmelerle doldurulmuştur. Mihrabın sütunçeleri sekiz köşelidir ve mermer malzemeden yapılmıştır. Sütunceler, sekiz köşeli, dört kısa şeritle boğumlara ayrılmıştır. Boğumlar mermer ve kırmızı boyaların dönüşümlü kullanılmasıyla hareketlendirilmiştir. İkinci ve dördüncü sıradaki boğumlar kırmızı renktedir. Boğumların ortasından geçen yatay içbükey şerit bu kısmı ikiye ayırmaktadır. Üçüncü boğumun ortasından geçen şeridin üzeri baklava dilimi motifi ile bezelidir. Kaide ve başlığa birleşik olan yarım boğumlar ise süslemesizdir. Sütun başlıkları mukarnaslı olup, içerisi ortabağdan gelişen ve palmetle nihayetlenen rumi motifleriyle tezyin edilmiştir. Kaide kısmının ön tarafı kademelendirilmiş düz, kenarları ise yivlidir. Sütunçelerin gövdelerindeki boğumlar ilginç bir uygulama olup, dönem içinde başka örneği bulunmamaktadır (Özbek, 2002, s. 530). Mihrap, ikinci ve üçüncü silmelerin nişe doğru 90 derecelik açı yapmasıyla oluşturulmuş oturtmalık kısmı ile son bulmaktadır.

Görsel 1. Bayezid Paşa Cami Genel Görünümü
(Amasya İl Kültür ve Turizm Müdürlüğü Arşivi)

Görsel 2. Bayezid Paşa Cami Harime Giriş Kapısı
(Fotoğraf Yazara Aittir)

Görsel 3. Bayezid Paşa Cami Harim kısmı
(Fotoğraf Yazara Aittir)



Görsel 4. Bayezid Paşa Cami Mihrabı Genel Görünüşü
(Fotoğraf Yazara Aittir)

Görsel 5. Bayezid Paşa Cami Mihrabı Bordür Detayı
(Fotoğraf Yazara Aittir)

Görsel 6. Bayezid Paşa Cami Mihrap Nişi
(Fotoğraf Yazara Aittir)

Görsel 7. Bayezid Paşa Cami Mihrap Kavsarası
(Fotoğraf Yazara Aittir)

Görsel 8. Bayezid Paşa Cami Mihrabı Nişin Alt Kısmında Yer Alan Pano
(Fotoğraf Yazara Aittir)

Görsel 9. Bayezid Paşa Cami Mihrabı Nişin İç Kısmında Yer Alan Pano (Fotoğraf Yazara Aittir)

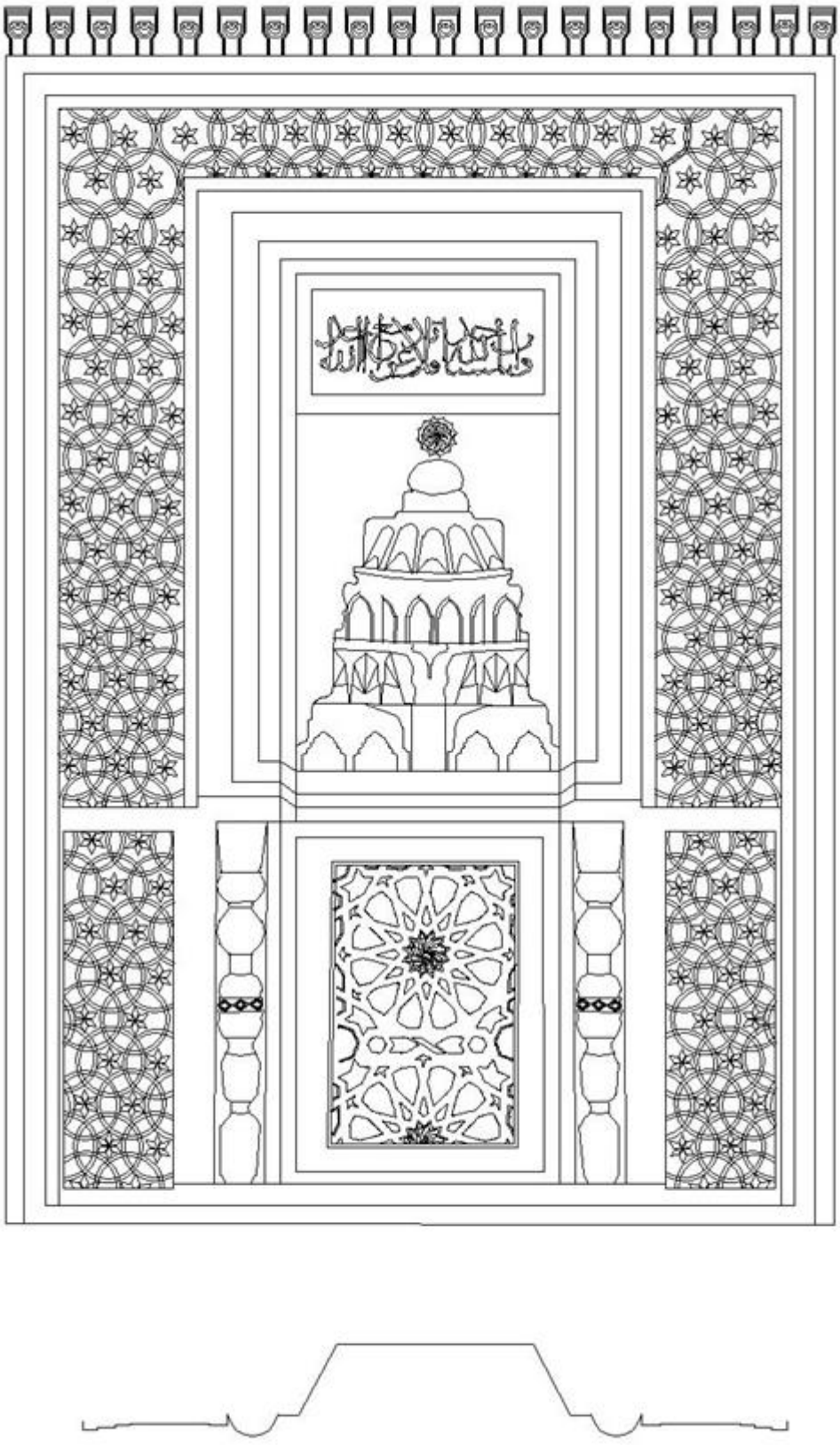
Görsel 10. Bayezid Paşa Cami Mihrap Alınlığı
(Fotoğraf Yazara Aittir)

Görsel 11. Bayezid Paşa Cami Mihrap Tepeliği
(Fotoğraf Yazara Aittir)

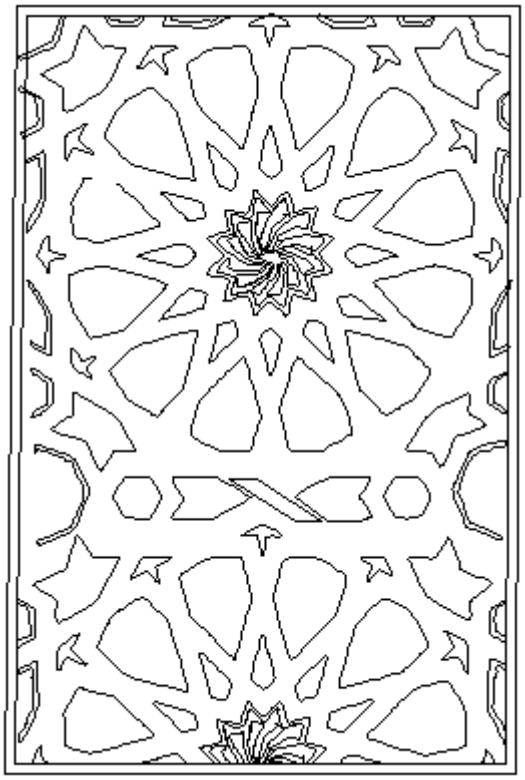
Görsel 12. Bayezid Paşa Cami Mihrap Sütunçesi
(Fotoğraf Yazara Aittir)

Görsel 13. Sütunçe Başlık Detayı
(Fotoğraf Yazara Aittir)

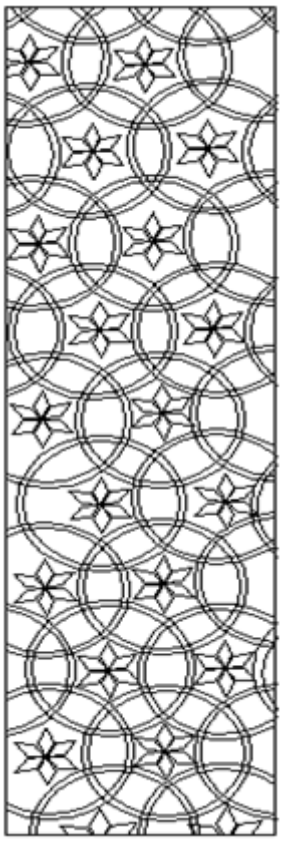
Görsel 14. Sütunçe Kaide Detayı
(Fotoğraf Yazara Aittir)



Çizim 1. Bayezid Paşa Cami Mihrabı Plan ve Kesiti
(Çizim Yazara Aittir)



Çizim 2. Bayezid Paşa Cami Mihrabı Nişin Alt Kısmı Pano Detayı
(Çizim Yazara Aittir)



Çizim 3. Bayezid Paşa Cami Mihrabı Bordür Detayı
(ÇizimY azara Aittir)

3. SONUÇ

Mihrap, başlangıçta tamamen ihtiyaç üzerine, kıble yönünü belirlemek için ortaya çıkmış; ancak zamanla dönemin sanat üslubunu, teknik özelliklerini yansıtan bir ayna olmuştur. Gerek yerli gerekse Anadolu dışından gelen sanatçıların hünerlerini gözler önüne serebilecekleri asıl alanlardan biri olmuştur. Mihrap, gelişimini uzun süre içinde tamamlamıştır. Her bölgenin ve kültürün kendine özgü yapısıyla zenginleşerek şekillenmiştir. Bu özelliğinden dolayı bir mihraba bakıldığında malzeme, teknik ve süsleme özelliklerinden onun hangi kültürün ürünü olduğunu anlamak olanaklı hale gelmiştir.
Amasya tarih boyunca coğrafi ve stratejik açıdan çok önemli bir konumda olmuş, birçok medeniyetin uğrak yeri olmuştur. Araştırmamızda Amasya Bayezid Paşa Cami mihrabı malzeme, teknik ve kompozisyon özellikleri açısından ayrıntılı olarak incelenmiştir. Mihrabın, alçıdan kalıplama tekniğiyle yapıldığı üzerinde geometrik, bitkisel, yazı ve mukarnastan oluşan süslemelerin yer aldığı tespit edilmiştir. Süsleme öğeleri mihrabın bordüründe, nişinde, tepelik, alınlık ve sütunçelerinde dengeli şekilde uygulanmıştır. Kompozisyon özellikleri açısından bakıldığında ağırlıklı olarak geometrik süslemeler kullanılmıştır. Bunları geometrik geçmeler, farklı formlarda yıldızlar, çarkıfelek ve baklava dilimi motifleri oluşturmaktadır. Bitkisel süslemeler mihrapta ana unsur olarak değil, tamamlayıcı unsur olarak kullanılmıştır. Alınlığın alt kısmında görülen gülbezek ile yazı kuşağı aralarında ve sütunçe başlıklarındaki rumi motifleri bitkisel süslemeleri meydana getirmektedir. Yazı, mihrabın sadece alınlık kısmında görülmektedir. Bir başka süsleme öğesi olan mukarnas ise mihrap kavsarasında, tepeliğinde, sütunçelerin başlık ve kaidelerinde görülmektedir. Mihrabın sütunçeleri gerek form gerekse süsleme açısından farklı uygulama olup benzersizdir.
Erken dönem Osmanlı mihrapları, Anadolu Selçuklu ve Beylikler geleneğinin devamı niteliğinde olup, hem teknik hem de süsleme açısından kendine özgü nitelikler taşımaktadır. Amasya Bayezid Paşa Cami, Osmanlı'nın Amasya'daki erken dönem mimarisinin örneklerinden biri olduğu için hem tarihsel hem de kültürel öneme sahiptir. Osmanlı'nın beylikten devlete geçiş dönemi mimarisinin Anadolu'daki temsilcisi olan yapı, malzemesi teknik ve süsleme özellikleri ile Osmanlı klasik döneminden önceki mimari gelişimin anlaşılması açısından oldukça önemlidir.

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KAYNAKÇA

Acar, T. (2022). Uşak Boduroğlu Camii Özelinde Kandil Motifi ve İkonografisi. Ankara Üniversitesi İlahiyat Fakültesi Dergisi, 63(2), 1135-1160. doi:10.33227/auifd.988868

Arseven, C. E. (1966). Mihrap. Sanat Ansiklopedisi. İstanbul: Milli Eğitim Basımevi.

Bakırer, Ö. (2000). XIII. ve XIV. Yüzyıllarda Anadolu Mihrapları. Ankara: Türk Tarih Kurumu Basımevi.

Broug, E. (2016). İslam Sanatında Geometrik Desenler. (Y. Darbaz Karaca, Çev.). İstanbul: Klasik Yayınları.

Can, Y. ve Gün, R. (2018). Ana Hatlarıyla Türk İslâm Sanatları ve Estetiği. İstanbul: Kayıhan Yayınları.

Çam, N. (1994). İslamda Sanat, Resim ve Mimari. Ankara: Elektronik İletişim Ajansı.

Çam, N. (2016). İslâmda Sanat Sanatta İslam İslâm. Ankara: Akçağ Yayınları.

Çok, B. (2018). Anadolu Selçuklu Dönemi (1071-1308) Çinili Mihrap Bordürlerinde Tezyinat. Kilis 7 Aralık Üniversitesi İlahiyat Fakültesi Dergisi, 5(8), 201-228.

Dallal, Y. ve Yaman, B. (2019). Erken Osmanlı Mimarisinde Kullanılan Mukarnas Biçimleri. Süleyman Demirel Üniversitesi İlahiyat Fakültesi Dergisi, (42), 75-91.

Demiriz, Y. (2004). Slam Sanatında Geometrik Süsleme. İstanbul.

Doğanay, A. (2019). Türk Tezyînî Sanatları. Türk İslam Sanatları Tarihi içinde (2. bs., ss. 369-386). Ankara: Grafiker Yayınları.

Erzincan, T. (2005). Mihrap. TDV İslâm Ansiklopedisi. İstanbul: TDV Yayınları.

Etikan, S. (2008). Seccade Halılarda Kullanılan Bazı Motifler ve Bu Motiflerin İslam Sanatında Yeri. Bildiriler, Maddi Kültür içinde (C. 2, ss. 545-564). 38. ICANAS, Uluslararası Asya ve Kuzey Afrika Çalışmaları Kongresi (10-15.09.2007), sunulmuş bildiri, Ankara.

Eyice, S. (1992). Bayezid Paşa Camii. Türkiye Diyanet Vakfı İslam Ansiklopedisi. İstanbul: TDV Yayınları.

Kemaloğlu, Z. (2021). Merzifon Cami Ve Mescit Mihraplarında Tezyinat Unsurları. Akademik Tarih ve Dusunce Dergisi, 8(4). doi:10.46868/atdd.176

Kemaloğlu, Z. (2022). Anadolu'da Kalem İşi Süslemeye Bir Örnek: Amasya Taşova Aşağı Baraklı (Özbaraklı) Camii Mihrabı. AKRA Kültür Sanat ve Edebiyat Dergisi, 10(28), 147-165.

Kemaloğlu, Z. (2024a). Geometrik Tezyinatlı Amasya Camii Mihrapları. AKRA Kültür Sanat ve Edebiyat Dergisi, 12(32), 93-112. doi:10.31126/akrajournal.1365347

Kemaloğlu, Z. (2024b). Tarihin Şahitleri Amasya Müzesi Osmanlı Sikkeleri. Amasya: Amasya Belediyesi Kültür Yayınları.

Kemaloğlu, Z. (2025). Amasya Cami Mihraplarında Süsleme Unsuru Olarak Kandil Motifi (ss. 206-219). 7. Uluslararası Kültür, Sanat ve Edebiyat Kongresi (2 Ağustos 2025), sunulmuş bildiri, Ankara.

Mutlu, İ. (2022). Amasya'da Osmanli Devri Anıtları. (Yayımlanmamış doktora tezi). Erciyes Üniversitesi Sosyal Bilimler Enstitüsü, Kayseri.

Mülayim, S. (1999). Değişimin Tanıkları Ortaçağ Türk Sanatında Süsleme ve İkonografi. İstanbul: Kaknüs Yayınları.

Ögel, S. (1987). Anadolu Selçuklularının Taş Tezyinatı. Ankara: Türk Tarih Kurumu Yayınları.

Özbek, Y. (2002). Osmanlı Beyliği Mimarisinde Taş Süsleme (1300-1453). Ankara: Kültür Bakanlığı Yayınları.

Top, M. (1997). Erken Dönem Osmanlı Mihrapları (XIV-XV. yüzyıl). (Yayımlanmamış doktora tezi). Yüzüncü Yıl Üniversitesi, Sosyal Bilimler Enstitüsü, Van.

Urak, G. (1994). Amasya'nın Türk Devri Şehir Dokusu ve Yapılarının Analiz ve Değerlendirilmesi. (Yayımlanmamış doktora tezi). Gazi Üniversitesi, Fen Bilimleri Enstitüsü, Ankara.

Yardım, A. (2004). Amasya Kaya Kitabesi (Bayezid Paşa İmareti Vakfiyesi). Ankara: Amasya Valiliği Kültür Yayınları.

ASSESSING THE IMPACT OF A GROUP GUIDANCE PROGRAM ON REDUCING DIGITAL ADDICTION AND CYBERBULLYING IN PRIMARY SCHOOL STUDENTS

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ABSTRACT

Technology influences daily life, education, and social interactions. Children need healthy habits to prevent addiction, which can harm school performance, social relationships, and increase cyberbullying. Promoting mindful use is essential. This study examined the effectiveness of a group guidance programme in reducing negative tech behaviours among fourth graders, encouraging proper use and raising awareness of cyberbullying and harassment. Using a quasi-experimental design, the research assessed the impact of the group guidance programme. It involved 235 pupils who completed the Digital Addiction Scale for Children as a pre-test. The scale was administered before and after the five-session programme to track score changes, ranging from 25 to 125, with higher scores indicating a greater risk of digital addiction. The top 15 scorers were invited, but only 12 volunteered. The programme included discussions, videos on cyberbullying, and activities. It addressed tech use, provided real-life examples, and facilitated group discussions. Each session featured interactive games, assignments, and feedback. The series concluded with students reflecting on their experiences and digital awareness habits. Results showed a 91.5% reduction in digital addiction scores and increased awareness of cyberbullying and safe technology use. The study demonstrates that targeted group guidance can significantly decrease digital addiction and raise awareness among young students, emphasising their role in promoting healthier tech habits. It recommends implementing and evaluating similar programmes across various age groups and schools to verify their effectiveness and foster safer digital environments for children.

Key Words: Digital addiction; cyberbullying, safe technology use; digital awareness; group guidance programme; online harassment.

INTRODUCTION

Technology is among the most defining aspects of contemporary life, advancing rapidly and increasingly integrated into everyday routines. The widespread availability of digital devices such as smartphones, tablets, and computers has profoundly transformed children's experiences in learning, communication, and leisure (Çöl,2020). In fact, as digital technology becomes more accessible, according to national statistics (TÜİK, 2016), the increase in internet and device access has been significant, making it nearly impossible to shield children from technological influences completely.

Although the educational benefits of technology are well-documented, its improper or excessive use can lead to a range of negative consequences. These include declines in academic performance, psychosocial issues such as social withdrawal or anxiety, and behavioural addictions that can disrupt daily life (Kenar, 2012). Numerous studies (Peker, 2013; Çakır Balta & Horzum, 2008; Tsai & Lin, 2003; Morahan-Martin & Schumacher, 2000) have shown that excessive use of the internet and digital devices can disrupt sleep patterns, diminish productivity, and hinder school achievement. Additionally, early exposure to uncontrolled digital environments increases the likelihood of encountering online dangers, including cyberbullying, trolling, and exposure to inappropriate content, which can have lasting psychological and emotional effects. Studies (Tekdal & Saygıner, 2016; Willard, 2006) indicate that prolonged exposure to digital environments significantly increases the risk of cyberbullying, underscoring the critical need for early, proactive preventive measures in primary education settings.

When previous studies on changing technology-related negative behaviours are examined, it is observed that most were **not conducted at the primary school level.** Most existing research has focused on **high school students** or has used **qualitative or quantitative surveys administered to teachers**. For example, in a study conducted by Özlü (2020), technology addiction was described as a disorder that needs to be treated rapidly in today's world. It was also emphasised that this addiction is now observed even among family members who serve as primary role models for students. The study highlighted the adverse effects of this situation on students, particularly noting increases in **tendencies toward violence, attention deficits, problems in language development,** and **the use of slang expressions.** Furthermore, it was stated that students' interest in school decreased due to technology addiction, which in turn led them toward academic failure. These studies demonstrate that technology addiction not only affects individuals' own lives but also has profound impacts on the people around them.

It is clear that ss technology becomes integrated into early childhood education, students are increasingly exposed to both the advantages and potential dangers of digital environments. Additionally, technology addiction can disrupt classroom management and diminish students' academic engagement. To address this, the study introduces an intervention model designed to support students in developing self-regulation skills and responsible digital behaviour. The primary aim of this study is to identify technology-related negative behaviours among primary school students and to evaluate the effectiveness of a group guidance programme designed to reduce digital addiction and increase awareness of cyberbullying. The study aims to investigate

1. The common technological devices used by children, their purposes, and the daily time spent on these devices,
2. The current level of technology awareness and cyberbullying among children,
3. The impact of a group guidance program on children's digital addiction levels.

CONCEPTUAL FRAMEWORK

Technology has long been a defining feature of human history, continually evolving to improve our lives through innovation and efficiency. With the rapid advancement of electronic devices and the widespread adoption of the internet, technology has become deeply embedded in our everyday routines. Beyond facilitating communication and providing instant access to information, it now plays a vital role in entertainment, leisure activities, and social interactions, shaping how we connect and engage with the world (Çöl, 2020).

According to data from the Turkish Statistical Institute (TÜİK, 2016), an impressive 96% of households in Türkiye own either mobile phones or smartphones, and 76% of households have internet access. These statistics paint a clear picture: children are growing up in environments where digital technologies are an integral part of daily life, with access to devices and connectivity becoming almost universal.

Given this pervasive digital presence, completely isolating children from technology is neither practical nor sustainable in today's world. Instead, the key focus should be on fostering responsible, conscious technology use and guiding children to develop healthy digital habits.

Technology Use and Digital Addiction in Children

Technology has emerged as an essential element of contemporary life, exerting influence across all age demographics. In recent years, the proliferation of digital devices such as smartphones, tablets, computers, and internet-based applications has significantly increased the utilisation of technology among primary school-aged children. While technology enhances access to information, communication, and educational resources, excessive and uncontrolled usage may lead to behavioural addiction, commonly termed digital addiction.

Digital addiction is characterised by an inability to regulate the use of technological devices, often accompanied by a range of emotional, cognitive, and behavioural symptoms. These can include irritability, reduced performance, withdrawal from social interactions, and dependence on devices. Research indicates that digital addiction is linked to various psychosocial factors and can have a detrimental impact on individuals' academic achievements, social relationships, and family life (Morahan-Martin & Schumacher, 2000; Tsai & Lin, 2003). Also, when children are deprived of digital devices, they may experience heightened feelings of anxiety, frustration, anger, and a noticeable decline in motivation, all of which can significantly interfere with their daily functioning and overall well-being.

Research has demonstrated that increased internet and digital device use among students often correlates with a decline in academic performance, sleep disruptions, and decreased productivity. Anderson (2001) observed that students who devote excessive hours to online activities tend to prioritise their digital pursuits over restorative sleep, which, in turn, hampers their academic progress. Similarly, Çakır Balta and Horzum (2008) noted that problematic internet use can pose significant challenges to students' academic achievement and professional growth.

A study by Nair (2019) found that mobile phone use was highly prevalent among high school students. Although **59.2%** of the participating students stated they were aware that mobile phones negatively and inefficiently affected lesson flow, the majority **(63.3%)** still reported keeping their mobile phones on during class. In addition, **70.7%** of participants reported difficulty following lessons because they checked their phones either occasionally or constantly during class, underscoring the seriousness of the issue.

Similarly, a study by Kuyucu (2017) found that increased smartphone addiction and more extended smartphone use among high school students were associated with lower academic achievement. In another study conducted with high school students in South Korea, a significant positive relationship was found between **internet addiction and interpersonal problems,** as well as between **internet addiction and the number of hours spent playing games** (Yom, 2009). Additionally, it was reported that adolescents with internet addiction exhibited more pronounced interpersonal problems and experienced increased nutritional disorders and cardiac risks as a result of sedentary lifestyles.

In addition to addiction, improper use of technology can lead to various negative behaviours, including exposure to inappropriate content, aggressive language, decreased face-to-face social interaction, and emotional desensitisation (Kowalski et al., 2014; Livingstone & Haddon, 2009). As children spend more time in digital environments, the likelihood of encountering harmful behaviours rises (Livingstone et al., 2011). Studies emphasise that prolonged screen time negatively impacts children's physical and mental health, resulting in attention problems, social withdrawal, and emotional instability (Stiglic & Viner, 2019; Twenge & Campbell, 2018). When technology is not used purposefully and responsibly, it can hinder children's social skill development and interpersonal communication (Subrahmanyam & Šmahel, 2011; Valkenburg & Peter, 2011). The literature (Valkenburg & Peter, 2011; Gentile et al., 2011) stresses that technology itself is not harmful; instead, the manner and duration of its use determine its impact. Consequently, preventive educational interventions focused on awareness, self-regulation, and responsible use are crucial, especially during early schooling years.

The decreasing age at which children are first exposed to technology has heightened concerns about the rise of digital addiction among primary school students. Without proper guidance and supervision, these young children risk developing unhealthy technology habits that could carry over into adolescence and beyond.

Technology plays a vital and transformative role in contemporary education by enhancing students' focus, deepening their understanding, and encouraging active, hands-on participation. Unlike traditional teaching methods, integrating advanced technological tools and digital resources allows students to immerse themselves more fully in the learning process. This integration also helps them cultivate essential skills and competencies, such as critical thinking, problem-solving, and the ability to apply knowledge in diverse real-world contexts (Kenar, 2012).

Despite its numerous advantages, improper and excessive use of technology can give rise to a range of problems, notably digital addiction. As computers and the internet become increasingly integrated into daily life, various forms of technology addiction have surfaced, including internet addiction, computer reliance, social media obsession, video game dependence, smartphone overuse, online shopping compulsions, and the urge for instant messaging (Morahan-Martin & Schumacher, 2000).

Cyberbullying

One of the most notable negative behaviours associated with technology is cyberbullying, a harmful activity that closely resembles traditional bullying but is uniquely characterised by its use of digital communication platforms. Cyberbullying involves the deliberate, repeated, and hostile actions carried out through the internet, social media, mobile phones, and other information and communication technologies, all aimed at causing harm to others. According to Belsey (2006), it is defined as hostile behaviour conducted intentionally and persistently via digital means to inflict emotional pain. Although cyberbullying lacks physical contact between the aggressor and the victim, its psychological impact can be profound, often resulting in severe emotional distress. Research has shown that individuals subjected to cyberbullying frequently suffer from depression, diminished self-esteem, anxiety, sadness, shame, and frustration (Baker & Kavşut, 2007). Children and adolescents, in particular, may perceive these behaviours as playful or harmless, primarily when they act anonymously through fictional characters or virtual avatars within digital environments. This sense of anonymity, coupled with the absence of immediate consequences, can lead perpetrators to feel detached from responsibility, thereby

exacerbating the severity and frequency of cyberbullying incidents (Willard, 2006). This dynamic significantly increases both the prevalence and the devastating impact of cyberbullying on young individuals.

Research indicates that increased exposure to technology correlates with a heightened risk of encountering cyberbullying. Specifically, Tekdal and Saygıner (2016) discovered that individuals who spend between 5 and 10 hours online each day are significantly more prone to experiencing cyberbullying than those whose online activity is under five hours. This evidence suggests that limiting excessive technology use could play a vital role in reducing the likelihood of cyberbullying incidents. Consequently, implementing interventions that focus on encouraging mindful screen time and promoting responsible technology habits among children are essential strategies for preventing cyberbullying.

METHODOLOGY

Research Design

A quasi-experimental single-group pretest–posttest design was employed. This model allows for examining the effect of an intervention when random assignment to control and experimental groups is not feasible.

Participants

The study was conducted during the 2023–2024 academic year with fourth-grade students at a Primary School in Gaziantep, Turkey. Initially, the Children's Digital Addiction Scale was administered to 235 students. Based on the results, 12 students (5 girls and seven boys) with the highest scores were selected for the group guidance programme.

Data Collection Instruments

Data were collected using the Children's Digital Addiction Scale (CDAS) developed by Hawi, Samaha, and Griffiths (2019). The scale consists of 25 items rated on a 5-point Likert scale and measures psychological, social, and behavioural dimensions of digital addiction. The Cronbach's alpha reliability coefficient of the scale is reported as .93. Additionally, a Technology-Related Negative Behaviours Readiness Test was administered to assess students' baseline awareness before the intervention.

Data Analysis

Pretest and posttest scores were compared descriptively to examine changes in digital addiction levels following the group guidance programme.

Group Guidance Programme

The intervention comprised five structured sessions, each approximately 40 minutes in duration, conducted within the school's information technology classroom. Interactive activities, educational games, storytelling, videos, and group discussions were used throughout the sessions to enhance engagement and learning. The program aimed to raise students' awareness of technology and digital devices, promote responsible and appropriate use of technology, reduce negative behaviors related to technology, increase understanding of cyberbullying, and teach effective coping strategies for cyberbullying situations.

1. **Session 1:** Introduction, group rules, and technology awareness
2. **Session 2:** Identification and purposes of technological devices
3. **Session 3:** Correct and incorrect use of technology
4. **Session 4:** Cyberbullying awareness and prevention
5. **Session 5:** Evaluation, reflection, and posttest administration

FINDINGS

The results on Technological Device Usage Patterns:

The study revealed that mobile phones, tablets, and televisions were the most frequently used technological devices among the participants. All students reported daily use of these devices, with most spending over an hour each day on them. Interestingly, the students engaged in both entertainment activities, such as watching videos and playing games, and academic tasks at roughly the same frequency. See Table 1.

Table 1. Technological Device Usage Patterns of Participating Students (N = 12)

Category	Variable	Number of Students
Technological Devices Used	Mobile Phone	10
	Tablet	8
	Television	8
	Computer	4
	Smart Watch	3
	Game Console	2
Daily Time Spent Using Technology	0–1 hour	3
	1–2 hours	4
	2–3 hours	4
	3 hours and above	1
Purposes of Technology Use	Watching videos	10
	Playing games	10
	Doing homework	9
	Conducting research	9
	Spending free time	8
	Solving tests	6
	Reading e-books	1

The current level of technology awareness and cyberbullying among children,

The study results indicate that prior to the intervention, students demonstrated limited awareness regarding technology use and cyberbullying. Specifically, 66.7% of students reported insufficient knowledge about proper technology usage. Half of the participants had experienced online insults or inappropriate language, yet 50% were unsure how to respond in such situations. Additionally,

75% lacked sufficient knowledge about cyberbullying, and 83% did not know the appropriate actions to take when exposed to cyberbullying.

Table 2 Results of students' readiness test prior to the intervention

• **66.7%** of students reported insufficient knowledge about correct technology use.
• **50%** stated that they had been exposed to insults or inappropriate language online.
• **50%** did not know what actions to take in such situations.
• **75%** lacked sufficient knowledge about cyberbullying.
• **83%** did not know what to do when exposed to cyberbullying.

The impact of a group guidance program on children's digital addiction levels.

The **Children's Digital Addiction Scale (CDAS)** was administered before and after the five-session group guidance programme. The comparison of pretest and posttest scores revealed that: The study's results indicate a significant reduction in digital addiction levels among the participants. Specifically, after the intervention, 11 out of 12 students (91.5%) showed a decrease in their CDAS pretest and posttest scores. This finding suggests that the implemented intervention was effective in decreasing digital addiction among the majority of students. See table 2.

Pretest and posttest CDAS scores are presented in Table 5.

Table 3 *Comparison of Students' CDAS Pretest and Posttest Scores*

Student	Pretest Score	Posttest Score	Difference
S1	90	56	-34
S2	82	97	+15
S3	75	34	-41
S4	70	36	-34
S5	70	52	-18
S6	66	57	-9
S7	66	45	-21
S8	63	47	-16
S9	63	38	-25
S10	62	39	-23
S11	61	56	-5
S12	60	53	-7

Following the intervention, **11 out of 12 students (91.5%) demonstrated a decrease in digital addiction scores**, indicating a reduction in digital addiction levels.

Qualitative feedback from the final session supported the quantitative findings. Students reported reduced screen time, greater awareness of appropriate technology use, and a better understanding of cyberbullying and coping strategies. After the fifth session, they wrote reflections evaluating the programme, noting reduced screen time, increased responsible tech use, improved knowledge of cyberbullying, and plans to limit social media use. They also learned to use technology correctly and felt more confident responding to cyberbullying. Their responses are included as direct quotations. The

students' responses offer valuable insights into their understanding and perceptions of technology and cyberbullying.

Transitioning to the behavioral intentions influenced by the program, Student P5 expressed that, after five sessions, they have a clearer understanding of technology's dual nature and intend to limit their usage, particularly restricting apps like TikTok, YouTube, and WhatsApp to avoid negative behaviors and cyberbullying:

> *"During these five sessions, I learned the real face of technology, and from now on I will limit my use of technology. I will definitely apply what I learned in the future and restrict applications such as TikTok, YouTube, and WhatsApp because I may be exposed to behaviours that set bad examples and to cyberbullying."*

Supporting this, Student P6 stated that they learned both the positive and negative uses of technology and plan to use their phone less, showing a conscious effort to moderate their digital activity: *"I learned the good and bad uses of technology, and from now on I will use my phone less."*

Regarding coping strategies and behavioural changes, Student P9 indicated increased confidence in handling future cyberbullying situations and noted a reduction in phone usage, which helped them overcome technology addiction:

> *"If I encounter a cyberbully in the future, I may be able to cope with it. I have information about this, and I reduced my phone usage even further, which was very good. This situation took me out of technology addiction."*

Expanding on practical applications of their learning, Student P10 mentioned acquiring knowledge on appropriate phone use, managing cyberbullying, and understanding responsible technology use after the five-day program:

> *"I learned many things during these five days. Some of them are that I should use my phone for a maximum of one hour, what to do if someone cyberbullies me, and how to use technology properly."*

Likewise, student P1 remarked that they no longer spend much time on the internet and now know how to use it properly, indicating a shift in their digital habits: *"I no longer spend much time on the internet, and I know how to use it properly."*

Building on this, Student P3 shared that they had previously been unaware of cyberbullying but have since learned about it and understand proper technology use: *"I did not know about cyberbullying before, but now I have learned it. I learned how technology should be used."*

Moving further, Student P4 reflected on their comprehension of technology and cyberbullying, noting that their teacher taught them about past and present issues related to technology, complemented by engaging warm-up games, which suggests that the instructional approach was practical in making the concepts accessible: *"I understood technology and learned about cyberbullying. What existed in the past and what exists now were taught to us by our teacher. The warm-up games were very nice."*

Finally, Student P12 summarised their comprehensive understanding of cyberbullying, recognising its causes and manifestations, and emphasised the importance of self-protection. They also noted the duality

of technology as both beneficial and potentially harmful, in addition to forming new friendships during the sessions:

> *"I learned what cyberbullying is and why it happens. I learned what cyberbullying looks like and how I can protect myself from it. I learned that technology is another World, with both useful and harmful aspects. I made new friends."*

The findings indicate that the group guidance programme contributed positively to students' awareness of technology use, reduced digital addiction levels, and increased knowledge about cyberbullying and preventive behaviours. Both quantitative and qualitative results support the effectiveness of the intervention implemented in this study.

CONCLUSION AND DISCUSSION

The results of this study align with existing literature emphasising the effectiveness of preventive, school-based interventions in addressing technology addiction and cyberbullying among children. The structured group guidance approach facilitated peer interaction, self-reflection, and behavioural awareness, contributing to meaningful changes in students' technology use habits.

This study demonstrates that a structured group guidance programme can effectively reduce digital addiction and enhance cyberbullying awareness among primary school students. The findings underscore the importance of early intervention, particularly at the primary education level, where technology habits are still developing.

The literature emphasises the importance of preventive educational interventions in addressing negative behaviours linked to technology (Livingstone & Smith, 2014; Wartella, Rideout, Zupancic, Beaudoin-Ryan, & Lauricella, 2015). Group guidance programmes provide students a space to build awareness, share experiences, and learn coping strategies in a supportive environment (Prout & Brown, 2007; Rose & Steen, 2014). These interventions are especially effective at the primary school level, where behavioural patterns are still forming (Clarke, & Dede, 2014).

Through structured activities, students learn to use technology responsibly, recognise risks such as digital addiction, and develop skills to handle issues like cyberbullying (Kowalski, Giumetti, Schroeder, & Lattanner, 2014; Kuss & Griffiths, 2017). School-based guidance helps foster healthy digital habits and supports students' psychosocial well-being, aiding their overall development and resilience in a digital world (UNESCO, 2019).

By integrating educational guidance with interactive learning methods, schools can play a critical role in promoting healthy and responsible technology use. Future research may expand this model with larger samples and longitudinal designs to further examine its long-term effectiveness. The results of this study are expected to contribute to future research and practical applications in school counselling, educational administration, and preventive guidance services.

REFERENCES

Baker, ÖE., Kavşut, F. *Akran Zorbalığını Yeni Yüzü: Siber Zorbalık*. Eurasian Journal of Educational Research. 2007; 27: 31-42.

Büyüköztürk, Ş., Çakmak, EK., Akgün, ÖE., Karadeniz, Ş., Demirel, F., *Eğitimde Bilimsel Araştırma Yöntemleri,* Pegem Akademi Yayıncılık,2019,Ankara.

Cebeci F., Artan, T., Karaman, M. (2020). *Sosyal hizmet bölümü stajyer öğrencilerinin iş bulma kaygısını azaltmaya yönelik grup çalışması.* Turkish Studies, 15(3), 1721-1738.

Çimen S., Kafkas, A., Gürel, K. (2023). *Lise Öğrencilerinin Olumsuz Davranışlarına Teknolojinin Etkisi ve Öğretmenlerin İstenmeyen Davranışları Yönetme Becerisi.* Disiplinlerarası Eğitim Araştırmaları Dergisi, 7(14), 59-83.

Gentile, D. A., Choo, H., Liau, A., Sim, T., Li, D., Fung, D., & Khoo, A. (2011). Pathological video game use among youths: A two-year longitudinal study. *Pediatrics, 127*(2), e319–e329. https://doi.org/10.1542/peds.2010-1353

Gürcan, N(2010). *Ergenlerin Problemli İnternet Kullanımları İle UyumlarıArasındaki İlişkinin İncelenmesi.* Selçuk Üniversitesi Eğitim Bilimleri Enstitüsü, Konya.

Hawi NS, Samaha M, Griffiths MD. *The digital addiction scale for children: Development and validation*. Cyberpsychol Behav Soc Netw 2019; 22(12): 771-778.

Kaçmaz, C., Cumurcu HB., Çelik, OT., *Çocuklar için Dijital Bağımlılık Ölçeğinin Türkçeye Uyarlanması: Güvenirlik ve Geçerlilik Analizi.* Bağımlılık Dergisi. 2023; 24(4):495-506.

Kalip K, Çöl M. *Teknolojiyle Bağlantılı Yeni Davranışsal Bozukluklar.* ESTÜDAM Halk Sağlığı Dergisi. 2020;5(2):318-33.

Kenar, İ. *Teknoloji ve derslerde teknoloji kullanımına yönelik veli tutum ölçeği geliştirilmesi ve tablet PC uygulaması [Development of parents' attitude scale regarding technology and use of technology in classes and tablet PC application]*. Eğitim Bilimleri Araştırmaları Dergisi - Journal of Educational Sciences Research. 2012: 2 (2); 123–139.

Kowalski, R. M., Giumetti, G. W., Schroeder, A. N., & Lattanner, M. R. (2014). Bullying in the digital age: A critical review and meta-analysis of cyberbullying research among youth. *Psychological Bulletin, 140*(4), 1073–1137. doi:10.1037/a0035618

Livingstone, S., & Haddon, L. (2009). *EU Kids Online: Final report*. London, England: EU Kids Online, London School of Economics and Political Science.

Livingstone, S., & Smith, P. K. (2014). Annual research review: Harms experienced by child users of online and mobile technologies: The nature, prevalence and management of sexual and aggressive risks in the digital age. *Journal of Child Psychology and Psychiatry, 55*(6), 635–654. https://doi.org/10.1111/jcpp.12197

Özlü, Z. (2020). *Teknoloji Bağımlılığının Çocuk ve Gençlerin Davranışları Üzerindeki Etkileri.* Sosyal Bilimler Araştırmaları Dergisi, 5(10), 524-532.

Peker, A. *İnsani Değerler Yönelimli Psiko-Eğitim Programının Problemli İnternet Kullanımı Ve Siber Zorbalık Üzerindeki Etkisi.* Doktora Tezi. Sakarya Üniversitesi, 2013.

Prout, H. T., & Brown, D. T. (2007). *Counseling and psychotherapy with children and adolescents: Theory and practice for school and clinical settings* (4th ed.). Wiley.

Rose, J., & Steen, S. (2014). The Achieving Success Everyday (ASE) group counseling model: Fostering resilience in middle school students. *Professional School Counseling, 18*(1), 28–37. https://doi.org/10.5330/2156-759X-18.1.28

Kowalski, R. M., Giumetti, G. W., Schroeder, A. N., & Lattanner, M. R. (2014). Bullying in the digital age: A critical review and meta-analysis of cyberbullying research among youth. *Psychological Bulletin, 140*(4), 1073–1137. https://doi.org/10.1037/a0035618

Kuss, D. J., & Griffiths, M. D. (2017). Social networking sites and addiction: Ten lessons learned. *International Journal of Environmental Research and Public Health, 14*(3), 311. https://doi.org/10.3390/ijerph14030311

Sözbilir, M., & Atila, ME., (2016). Nitel araştırma desenleri. *Araştırma yöntem ve teknikleri II* Erzurum: Atatürk Üniversitesi Açıköğretim Fakültesi.

Stiglic, N., & Viner, R. M. (2019). Effects of screentime on the health and well-being of children and adolescents: A systematic review of reviews. *BMJ Open, 9*(1), e023191. doi:10.1136/bmjopen-2018-023191

Subrahmanyam, K., & Šmahel, D. (2011). *Digital youth: The role of media in development*. New York, NY: Springer.

Tekdal, M., Saygıner, Ş. Öğrenme ve Öğretme Sürecinde Mobil Teknolojilerin Kullanımı. *4th International Instructional Technologies & Teacher Education Symposium.* Elazığ: Fırat Üniversitesi, 2016.

Türel, YK., Gür, D. *Ebeveynlerin Çocukların Bilgi İletişim Teknolojileri Kullanımına Yönelik Tutumları Üzerine Bir Ölçek Geliştirme Çalışması.* Bursa Uludağ Üniversitesi Eğitim Fakültesi Dergisi. 2019; 32(1): 145-165.23

Türkiye İstatistik Kurumu. (2019). *Hanelerde Bilişim Teknolojileri Sahipliği Oranı.* Türkiye İstatistik Kurumu. http://www.tuik.gov.tr/

Twenge, J. M., & Campbell, W. K. (2018). Associations between screen time and lower psychological well-being among children and adolescents: Evidence from a population-based study. *Preventive Medicine Reports, 12*, 271–283. doi:10.1016/j.pmedr.2018.10.003

UNESCO. (2019). *Behind the numbers: Ending school violence and bullying*. UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000366483

Valkenburg, P. M., & Peter, J. (2011). Online communication among adolescents: An integrated model of its attraction, opportunities, and risks. *Journal of Adolescent Health, 48*(2), 121–127. doi:10.1016/j.jadohealth.2010.08.020

Wartella, E., Rideout, V., Zupancic, H., Beaudoin-Ryan, L., & Lauricella, A. R. (2015). Teens, health and technology: A national survey. *Media and Communication, 3*(3), 13–23. https://doi.org/10.17645/mac.v3i3.416

HUMAN–ROBOT COLLABORATION IN MANUFACTURING: ETHICAL AND OPERATIONAL IMPLICATIONS IN INDUSTRY 5.0

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Abstarct

Human–robot collaboration (HRC) represents the next evolution in industrial automation, redefining how labor, safety, and productivity are structured within manufacturing environments. Unlike traditional automation systems where robots function in isolation, Industry 5.0 emphasizes shared workflows, adaptive decision-making, and cooperative workstations supported by artificial intelligence. This paper explores the operational advantages and ethical challenges associated with HRC deployment across European industrial facilities.

A comparative field study was conducted in German automotive and Scandinavian electronics manufacturing hubs, assessing productivity, worker perception, fatigue reduction, and occupational safety outcomes. Results show that collaborative robots (cobots) increase efficiency metrics by an average of 29%, significantly reduce repetitive strain injuries, and improve workflow consistency. Machine learning-driven systems enable robots to adapt motions based on real-time sensor input, ensuring safer and more intuitive environments.

However, employee sentiment indicates concerns about job displacement, algorithmic control, and data privacy, particularly in systems using biometric monitoring. Ethical evaluation reveals a need for transparency standards, consent frameworks, and strengthened human oversight to prevent dependency or unintended decision automation.

The study proposes a Human-Centered Robotics Governance Model integrating ergonomics, ethics, education, and continuous stakeholder feedback. Training programs for technicians demonstrate that upskilling reduces resistance and increases acceptance of robotic integration.

The paper concludes that Industry 5.0 will succeed only if robotics enhances—not replaces—the human role in manufacturing. The future workplace will likely be a co-evolving environment where creativity, empathy, and human judgment work seamlessly with artificial intelligence and automation.

Anahtar Kelimeler: Robotics, Industry 5.0, Human–Robot Collaboration, Automation, Ethics, Manufacturing

CUMHURİYET BAYRAMI HUTBELERİNDE DİNİ SÖYLEMİN DÖNÜŞÜMÜ: YAYGIN DİN EĞİTİMİ BAĞLAMINDA TEMATİK BİR İNCELEME

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ÖZET

Hutbe, her hafta Cuma günü kılınan Cuma namazının bir rüknü olarak, Müslümanlar için yerine getirilmesi gereken farz ibadetlerden biridir. Hz. Peygamber döneminden itibaren bir irşad vasıtası olan hutbe, cemaatin ihtiyaçlarını göz önünde bulundurarak halkı dini konularda aydınlatma işlevi taşımaktadır. Öte yandan İslam tarihi boyunca hutbelerin yalnızca dini değil, siyasi bir işlevi de bulunmuş; özellikle meşruiyet aracı olarak rol oynamıştır. Bu nedenle bu çalışmada hutbeler, yaygın din eğitiminin etkili bir aracı olarak ele alınmakla birlikte, tarihsel süreçte kazandığı siyasi işlevin eğitsel içeriğe yansımaları da bağlamsal bir unsur olarak dikkate alınmıştır.

Bu bağlamda, Diyanet İşleri Başkanlığı'nın kuruluşundan günümüze kadar Cumhuriyet Bayramı için hazırlanmış hutbeler incelenmiştir. Tarihsel bir izlek sunabilmesi amacıyla, tek bir konu etrafında geniş bir tarih aralığı tercih edilmiş ve böylece veri seti oluşturulmuştur. 1924–2025 yılları arasını kapsayan taramada, Diyanet İşleri Başkanlığı tarafından yayımlanan hutbe kitapları ve süreli yayınlarda yer alan toplam 28 hutbe metnine ulaşılmıştır. Çalışma, nitel araştırma yöntemine dayalı olarak tasarlanmış; Cumhuriyet Bayramı hutbeleri belirli bir olgu olarak ele alınmış ve bu bağlamda durum çalışması deseni benimsenmiştir. Verilerin analizinde ise içerik analizi yöntemi kullanılarak metinlerde öne çıkan temalar sistematik biçimde çözümlenmiştir. Çalışmanın amacı, Cumhuriyet Bayramı hutbelerinin yüz yıllık süre zarfında hangi temalar etrafında şekillendiğini ortaya koymak ve bu veriler üzerinden yaygın din eğitimi açısından anlamlı bir değerlendirme sunmaktır.

Anahtar Kelimeler: Hutbe, din eğitimi, yaygın eğitim, cumhuriyet.

ABSTRACT

As one of the essential components of the Friday prayer performed weekly, the sermon (khutbah) is among the obligatory acts of worship that Muslims are required to observe. Since the time of the Prophet Muhammad, the sermon has functioned as an instrument of religious guidance, illuminating the congregation on religious matters while taking their spiritual and social needs into consideration. Throughout Islamic history, however, sermons have not only carried religious significance but have also fulfilled political functions, particularly serving as instruments of legitimizing political authority. For this reason, while this study approaches sermons as effective tools of popular religious education, it also takes into account the political function they have historically acquired and the ways in which this has been reflected in their educational content.

In this context, sermons prepared for Republic Day from the establishment of the Presidency of Religious Affairs to the present have been examined. In order to present a historical trajectory, a broader time frame centered around a single theme was selected, thereby forming the dataset. Through a survey of materials published between 1924 and 2025, a total of 28 sermons appearing in official sermon collections and periodicals of the Presidency were identified. The study is designed within the framework of qualitative research, treating Republic Day sermons as a specific case and therefore adopting a case study design. The data were analyzed using content analysis, through which the prominent themes in the texts were systematically examined. The aim of the study is to reveal the themes

around which Republic Day sermons have been shaped over the past century and to offer, on the basis of these findings, a meaningful evaluation from the perspective of popular religious education.

Keywords: Sermon, religious education, non-formal education, republic.

GİRİŞ

Cuma ve Bayram namazı gibi ibadetlerin yerine getirilmesi sırasında irad edilen hutbe, ibadet olmasının yanı sıra cemaati bilgilendirme işleviyle yaygın din eğitiminin önemli unsurlarından biri olarak kabul edilmektedir. (Doğan, 1999) Osmanlı Dönemi'nde hutbenin dilinin Arapça olması sebebiyle eğitsel işlevinin sınırlı kaldığı, özellikle II. Meşrutiyet sonrasında hutbelerin diline dair tartışmaların yoğunlaştığı görülmüştür. (Zengin, 2008) Cumhuriyet'in ilanıyla birlikte hutbenin toplumu aydınlatma işlevine daha fazla önem verilmiş ve bu amaç doğrultusunda Diyanet İşleri Başkanlığı'ndan Türkçe hutbeler hazırlaması talep edilmiştir. (Bulut, 2024) Bu bağlamda Arapça dua ve Türkçe nasihat bölümlerinden oluşan hutbeleri içeren ilk hutbe kitabı 1927 yılında yayınlanmıştır. (Diyanet İşleri Reisliği, 1927) Bu tarihten itibaren hutbe hazırlama görevi Diyanet tarafından sürdürülmektedir.

Hutbelerde iman, ibadet, ahlak gibi temel dini esasların yanı sıra toplumsal meselelere de değinilmektedir. Özellikle bayramlar ve kandil geceleri gibi zaman dilimlerine ise hutbelerde özel olarak yer verilmiştir. Hem dini duygunun daha coşkun yaşandığı hem de birlik- beraberlik, kardeşlik mesajlarının yoğun bir şekilde işlendiği bu günlerde irad edilen hutbeler, cemaatin hazır bulunuşluğu ile değerler eğitimi için oldukça uygun bir zemin bulmaktadır. Bu çalışma, Cumhuriyet Bayramı'na özel olarak için hazırlanmış hutbe metinlerini tematik açıdan inceleyerek dönemsel söylem farklılaşmalarını ve bu farklılaşmaya etki eden toplumsal-siyasal dinamikleri ortaya koymayı amaçlamaktadır.

Çalışmanın veri seti, Cumhuriyet'in ilanından 2025 yılına kadar Diyanet İşleri Başkanlığı tarafından yayınlanmış olan Cumhuriyet Bayramı hutbelerinden oluşmaktadır. Verileri toplamak üzere Diyanet'in hutbe yayınladığı kaynakların her birine başvurulmuştur. Bu kaynaklar erken cumhuriyet döneminde hutbe kitaplarından ibaret iken ilerleyen yıllarda süreli yayınlar ve resmî web sitesi de eklenerek hutbe yayınları daha düzenli ve kolay erişilebilir hale getirilmiştir. Tüm kaynaklar tarandıktan sonra toplam 28 Cumhuriyet Bayramı hutbesine ulaşılmıştır.

Çalışma nitel araştırma yöntemlerinden durum çalışması (case study) deseninde yapılandırılmış, veriler içerik analizi yöntemiyle çözümlenmiştir. Bir durumun güncel bağlam veya ortam içinde araştırılmasını gerektiren durum çalışmaları, süreç değerlendirmeleri için uygun görülmüştür. (Creswell, 2021) Yüz yıllık tarihi süreçte Cumhuriyet Bayramı hutbelerinde yer alan ana temalar ve tekrar eden söylem kalıpları dönemsel olarak incelenmiş, bu temaların tarihsel süreçteki süreklilik ve dönüşüm düzeyleri analiz edilmiştir.

ARAŞTIRMA VE BULGULAR

Cumhuriyet Bayramı, hutbelerde dini ve milli kimliğin iç içe geçtiği önemli temalardan biridir. 1925 yılında milli bayram ilan edilmesine rağmen, bu bayrama ilişkin ilk hutbe 1972 yılında yayınlanmış, diğer bayramlara göre hutbe geleneğine daha geç dahil olmuştur. (Cumhuriyet Bayramı Kanunu, 1925) Bu ilk hutbe, dönemin Diyanet İşleri Başkanı Dr. Lütfi Doğan imzasıyla Diyanet Gazetesi'nde yayımlanmıştır. (Doğan, 1972)

1923-2025 yılları arasında yayınlanan hutbeler incelendiğinde, Cumhuriyet Bayramı konulu 28 hutbe tespit edilmiştir. İlk Cumhuriyet Bayramı hutbesi 1972 yılında yayınlanırken son hutbe Cumhuriyet'in yüzüncü yılı olan 2023 yılında yayınlanmıştır. Hutbelerin içerikleri tematik olarak incelendiğinde 2000'li yıllardan sonra belirgin bir farklılaşma olduğu anlaşılmaktadır. Buna göre 1972-2002 yılları arasında tespit edilen 19 hutbenin yalnızca 7'si özgün hutbe metinleridir. Bu tarih aralığında aynı hutbelerin tekrar tekrar okunduğu görülmektedir. Buna karşılık 2002-2025 yılları arasında yayınlanan 9 hutbenin 5'i özgündür. Aşağıdaki tabloda çalışmanın veri setini oluşturan Cumhuriyet Bayramı

hutbelerinin tarih ve tekrar bilgileri sunulmaktadır. Buna göre 2002 yılına kadar özgün hutbe oranı %37 iken, 2002 sonrasında bu oranın %55'e çıktığı görülmektedir.

Belge adı	Hazırlayan	Tarih	Kaynak	Açıklama
Cumhuriyet Bayramı Münasebetiyle	Dr. Lütfi Doğan Diyanet İşleri Başkanı	1972	Diyanet Gazetesi	Özgün Hutbe
İslam'da Cumhuriyet İdaresi	Mustafa Özdamar Erzurum Müftülük Memuru	1973	Diyanet Gazetesi	Özgün Hutbe
İslam'a Göre Cumhuriyet İdaresi	Arif Erkan	1973	Diyanet Gazetesi	Özgün Hutbe
Hakimiyet Milletindir	Dr. Lütfi Doğan	1973	Hutbeler	Özgün Hutbe
Cumhuriyet	Tevfik Ersen	1975	Hutbeler	Özgün Hutbe
İslam'a Göre Cumhuriyet İdaresi	M. Salih Tanrıverdi	1981	Diyanet Gazetesi	3. hutbenin tekrarı
Cumhuriyet	Yazar bilgisi bulunmuyor	1981	Hutbeler	5. hutbenin tekrarı
Cumhuriyet	Mehmet Bulut	1983	Diyanet Gazetesi	3. hutbenin tekrarı
Cumhuriyet	Diyanet	1984	Diyanet Gazetesi	5. hutbenin tekrarı
İslam'da İstişare ve Cumhuriyet	Ebu Hureyre Özdemir	1986	Diyanet Gazetesi	Özgün Hutbe
Milli Günlerimiz ve Cumhuriyet Bayramı	Diyanet	1987	Diyanet Gazetesi	5. hutbenin tekrarı
Cumhuriyet	Yazar bilgisi bulunmuyor	1987	Hutbeler	5. hutbenin tekrarı
Milli Günlerimiz ve Cumhuriyet Bayramı	Diyanet	1988	Diyanet Gazetesi	5. hutbenin tekrarı
Cumhuriyet	Diyanet	1989	Diyanet Gazetesi	5. hutbenin tekrarı
Cumhuriyet	Yazar bilgisi bulunmuyor	1996	Diyanet Aylık Dergi	5. hutbenin tekrarı
Milli Günlerimiz ve Cumhuriyet Bayramı	Yazar bilgisi bulunmuyor	1997	Diyanet Aylık Dergi	5. hutbenin tekrarı
Cumhuriyetimizin Kuruluşu	Yazar bilgisi bulunmuyor	1998	Diyanet Aylık Dergi	Derleme
Cumhuriyet Fazilettir	Yazar bilgisi bulunmuyor	1999	Diyanet Aylık Dergi	Özgün Hutbe
Cumhuriyet	Yazar bilgisi bulunmuyor	2000	Diyanet Aylık Dergi	5. hutbenin tekrarı
Cumhuriyet Bayramı	Yazar bilgisi bulunmuyor	2002	Diyanet Aylık Dergi	Özgün Hutbe
Cumhuriyet Bayramı	Yazar bilgisi bulunmuyor	2003	Diyanet Aylık Dergi	Özgün Hutbe
Toplumsal İradenin Temsili: Cumhuriyet	Yazar bilgisi bulunmuyor	2004	Diyanet Aylık Dergi	Özgün Hutbe
Cumhuriyet	Yazar bilgisi bulunmuyor	2005	Diyanet Aylık Dergi	Özgün Hutbe
Cumhuriyet Bayramı	Prof.Dr. Mustafa Çağrıcı İstanbul Müftüsü	2006	İstanbul Müftülüğü	Özgün Hutbe
Cumhuriyet Fazilettir	İl Müftülüğü Hutbe Komisyonu	2008	Ankara Müftülüğü	18.hutbenin tekrarı
Cumhuriyet Bayramı	Prof.Dr. Mustafa Çağrıcı İstanbul Müftüsü	2010	Ankara Müftülüğü	24. hutbenin tekrarı
Cumhuriyet: Toplumsal İradenin Temsili	Yazar bilgisi bulunmuyor	2019	Minberden Öğütler	22. hutbenin tekrarı
Vatan Millet Sevdasıyla Nice Yüzyıllara	Din Hizmetleri Genel Müdürlüğü	2023	DİB Resmi Web Sitesi	Özgün Hutbe

1972-2002 Yılları Arasında Cumhuriyet Bayramı Hutbeleri

Bu dönemde yayınlanan hutbelere genel bir bakışla bakıldığında, birkaç özgün hutbe denemesinden sonra 1975 yılında yayınlanan hutbe metninin sonraki yıllarda çok defa tekrarlandığı görülmektedir. Hutbelerde cumhuriyeti kazandıran tarihi başarılardan övünçle bahsedildikten sonra cumhuriyetin Müslüman-Türk kimliğine uygun olduğuna dair açıklamalar getirilir. Konu Kur'an ve hadislerden alınan dini referanslarla temellendirilirken, Hz. Peygamber ve dört halife döneminden örneklerle anlatım güçlendirilmektedir. Cumhuriyet ve demokrasi tanımlarında ise millet egemenliği, istiklal, hürriyet gibi temalar öne çıkarılmakta, metnin bu kısımlarında bilgilendirme amacı sezilmektedir.

"Bugünkü devletimiz, milletin kendi iradesiyle kurulmuş olup, bu devlet şeklinin adı Cumhuriyet'tir. Cumhuriyet idaresi, yönetim sistemi bakımından, demokrasi diye adlandırılan idare şekline dahildir. Bu idare şeklinde, hâkimiyet millete ait olup, millet bu hakkını, yasalarda belirtilen yollarla kullanır." (Diyanet İşleri Başkanlığı (DİB), 1975)

Yukarıda ana hatları verilen 1972-2002 yılları arasındaki özgün hutbelere biraz daha yakından bakıldığında, ilk Cumhuriyet Bayramı hutbesi bir prototip olarak dikkate değerdir. Zira sonraki yıllarda bu ilk hutbenin söylem ve tema düzeyinde tekrarlandığı görülmektedir. Cumhuriyetin ilânının

yıldönümüne atıfla başlayan hutbede bayram coşkulu bir dille kutlanmaktadır. Cumhuriyet, maddî ve manevî hayatı aydınlatan bir güneş olarak tasvir edilmiş, ilerleme ve kalkınma ile ilişkilendirilmiştir. Hürriyet, adalet ve fazilet millî kimliğin nitelikleri olarak sunulmakta; meşveret ve danışma ise İslam'ın temel ilkeleri arasında sayılmaktadır. Hutbede bu iki temel üzerinden Cumhuriyet ve demokrasi hem dinî hem millî kimliğe en uygun yönetim biçimi olarak tanımlanmıştır. Millet egemenliği şeklinde tanımlanan Cumhuriyet, İslam'ın meşveret (danışma) ilkesini vurgulayan ayetlerle temellendirilmiştir. (Doğan, 1972)

"Sen onlara sırf Allah'ın lütfettiği merhamet sayesinde yumuşak davrandın. Eğer kaba, katı kalpli olsaydın, hiç şüphesiz etrafından dağılır giderlerdi. Onları affet, onların bağışlanmasını dile, iş hakkında onlara danış, karar verince de Allah'a güven, doğrusu Allah kendisine güvenenleri sever." (Kur'an, Al-i İmran:159)

"Rablerinin çağrısına uyarlar, namazı özenle kılarlar. İşleri de aralarındaki danışma ile yürür. Kendilerine verdiğimiz rızıktan başkaları için harcarlar." (Kur'an, Şura:38)

Cumhuriyet Bayramı hutbelerinin neredeyse tamamında Al-i İmran suresinin 159. ayetine atıf yapılmaktadır. Hz. Peygamber'in özellikle savaşlarla ilgili konularda ashabıyla istişare etmesinin örnekleri verildikten sonra, Cumhuriyetin ruhunun da danışma olduğu açıklanmış böylece Kuran ve sünnetten dayanak sağlanmıştır.

Cumhuriyet, hutbede karşı anlatıyla da açıklanmıştır. "Bir kişinin kendi arzusuna göre mutlak iradesi" cumhuriyetin tam tersi olarak açıklanırken, bu yönetim biçimi için istibdat ve zorbalık gibi tanımlamalar kullanılmıştır. Hutbede tanımlanan mümin, danışma ruhunu benimsemiş, hürriyet ve istiklal uğruna fedakarlıktan çekinmeyen, istibdada karşı duran bir şahsiyettir.

"Bu yönden mümin keyfiliği ve istibdadı sevmez. O hürriyete aşıktır, daima, cumhuriyet yaşayışlıdır. İman kalesi Türkün kalbinde yaşayan ve yaşayacak olan hürriyeti, istiklali ve onu yaşatacak Cumhuriyettir." (Doğan, 1973)

Cumhuriyet, bir yönetim biçimi olmanın ötesinde bir yaşam tarzı olarak sunulmuş; toplumsal huzur ve selamet için hayatın her alanında Cumhuriyet ve demokrasiye uygun yaşamanın gerekliliği vurgulanmıştır. Dinî ve millî vurguların iç içe geçtiği, birbirinden ayrı düşünülmediği hutbede iman, hürriyet, Cumhuriyet, vatan ve millet değer olarak sıralanmış ve bu yüce değerlerin selametine dua edilerek hutbe sonlandırılmıştır.

1924'te halifeliğin kaldırılmasının ardından Diyanet'e gönderilen tebliğde hutbelerde artık millet ve cumhuriyetin saadet ve selametine dua edilmesi yönünde bir yönlendirme yapılmıştır. (BCA, 1924) Dolayısıyla Doğan'ın hutbesinin bu talebe uygun şekilde sonlandırılması tarihsel sürekliliğe işaret etmektedir. Öte yandan başkanlığı döneminde laik söylemleriyle dikkat çeken Doğan'ın, 1973 seçimlerinin ardından değişen siyasi iklim ve artan MSP etkisiyle görevden alınması, söz konusu hutbeyi değerlendirirken siyasi bağlamı göz ardı etmemeyi gerekli kılmaktadır. (Kara, 2016) Bu bağlamda Cumhuriyet şemsiyesi altında öne çıkarılan değerlerin ve ideal mümin profilinin söz konusu etkilerden bağımsız olmadığı anlaşılmaktadır.

İlk hutbenin yayınlanmasının ardından 1973 yılında Cumhuriyetin 50. Yılı münasebetiyle "İslam Açısından Cumhuriyet İdaresi" konulu hutbe yarışması düzenlenmiş ve birinci olan hutbenin 50. Yıldönümü haftasına denk gelen cuma günü tüm camilerde okunacağı bildirilmiştir. (Kepir, 2024) Her ayın birinci ve on beşinci günlerinde yayınlanan Diyanet Gazetesi'nin 79. Sayısı, 1 Kasım yerine 29 Ekim tarihinde yayınlanmış ve yarışmada birinci olan hutbeye bu sayıda yer verilmiştir. İlk hutbede yer alan Cumhuriyet'in dini referansları bu hutbede detaylandırılmış ve anlatım uzun yıllar tekrar edilmiştir. İlk hutbede görülen dini ve milli kimliğe en uygun idare şekli tanımlaması bu hutbede de vurgulanmıştır. (Erkan, 1973)

50. yıl hutbesinde cumhuriyet, nev zuhur bir vakıa olarak değil, tarihi ve dini temellere dayanan köklü ve meşru bir yönetim biçimi olarak takdim edilmektedir.

"Tarihin çok eski devirlerinden beri bilinen ve İslamiyette en güzel şeklini bulan Cumhuriyet, Türk milletinin fıtratına ve İslamiyetin ruhuna uyan güzel bir idare tarzıdır." (Erkan, 1973)

Meselenin dini temellendirmesi, Hz. Peygamber'in sağlığında meşvereti esas alarak ashabı ile istişare etmesine, vefatından sonrası için de vekil bırakmamış olmasına dayandırılmaktadır. Hz. Peygamber'in vekil bırakmaması hutbede seçim yolunu işaret ettiği şeklinde yorumlanmıştır. Dini bir meşruiyet zemini sağlamak amacıyla yapılan bu yorumlar, modern siyasetin kavramları olan demokrasi ve cumhuriyeti İslam Devleti'nin ilk yıllarına taşıyarak anakronik bir bakış açısı ortaya koymaktadır. Hazreti Peygamber'in uygulamalarından örneklerle desteklenen bu söylemde, ilk İslam Devleti'nin meşveret esasına dayalı bir cumhuriyet olduğu, dört halife döneminin ise seçimle işbaşına gelmeleri sebebiyle "cumhuriyet devri" olarak nitelenebileceği ileri sürülmektedir. Yine adalet, eşitlik, hürriyet gibi kavramlar dört halife devrini tanımlamak için kullanılarak demokratik bir devir olduğu savunulmuştur. (Erkan, 1973)

Millet egemenliği, hürriyet, eşitlik, birlik, beraberlik, dayanışma ve kardeşlik Cumhuriyet ruhunun öne çıkan özellikleri olarak açıklanmıştır. Yine milletçe kalkınmanın önkoşulu da bu ruhu kavramaktır.

"Şu halde, müslümanlığımızı ve vatan-perverliğimizi tamamlamak için bu idareye sadık kalmak ve bu idarenin istediği ve aynı zamanda Müslümanlığın emrettiği gibi, birbirimizi kardeş gibi sevmek, danışmak, küçük kusurlarımızı affetmek, kin ve garazdan uzak kalarak birlik ve beraberlik içinde yaşamak zorundayız." (Erkan, 1973)

Cumhuriyete sadık kalmak hutbelerde hem dini hem milli bir görev olarak tanımlanmıştır. Dini ve milli vurgunun birlikteliği, özellikle 1970'li yıllarda yaşanan toplumsal çatışmalara karşı geliştirilen birlik ve beraberlik söylemi ile Türk-İslam sentezi düşüncesi bağlamında anlam kazanmaktadır. (Bora, 1998) 1973 yılında düzenlenen hutbe yarışmasında birinci ve üçüncü olan hutbeler karşılaştırıldığında, her iki metinde de Cumhuriyetin İslamiyet'e uygunluğuna dair benzer dini referansların olduğu görülmektedir. Ancak üçüncü olan hutbede daha ziyade insan hak ve hürriyetleri, eşitlik gibi evrensel ilkeler vurgulanırken birinci olan hutbede dini ve milli değerlerin birlikteliği öne çıkmaktadır. (Özdamar, 1973) Bu durum Diyanet'in 1970'li yıllarda evrensel değerlerden ziyade, dini ve milli kimliğin bir bütün olarak sunulmasını tercih ettiğini göstermektedir.

1973 yılı cumhuriyetin 50. Yılı olmasının yanı sıra, Ramazan Bayramı ve Cumhuriyet Bayramı aynı güne tekabül etmiştir. Diyanet bu durumu "Mutlu Tesadüf Cumhuriyetimizin 50. Yılında Cumhuriyet ve Ramazan Bayramı'nı Aynı Günlerde Kutluyoruz" başlığı ile Diyanet Gazetesi'nin manşetine taşımıştır. Aynı sayıda yer alan "Bayramlarımız" başlıklı yazıda Ramazan Bayramı, insanın Allah'tan başkasına kul olmamayı öğrenerek insanlık şeref ve haysiyetini yeniden kazandığı bir bayram olarak tanımlanırken; Cumhuriyet Bayramı da benzer kazanımlar üzerinden açıklanmıştır. Zira cumhuriyette de "ne kul vardır ne köle." Dolayısıyla "hem Müslüman hem de Türk olarak" bu iki bayramın kazandırdığı ortak insanlık değerlerini birlikte kutlamak, Diyanet tarafından özel olarak vurgulanmıştır. (Koçyiğit, 1973)

1973 yılının bir diğer özgün hutbesi ise Hutbeler kitabında yayınlanan cumhuriyet konulu metindir. Hutbe, "Müslüman-Türk" vurgusu ile başlamakta; hürriyet ve istiklal gibi değerler hem dini hem milli kimliğin gereği olarak açıklanmaktadır. Türk milletinin tarih boyunca bu değerlere bağlı yaşadığı ve gelecekte de aynı ilkeler doğrultusunda varlığını sürdüreceği ifade edilmektedir. Millet egemenliğinin İslam'a uygunluğu ve istibdadın kabul edilemezliği bu hutbede de önceki metinlerde olduğu gibi vurgulanmaktadır. (Hutbeler, 1973)

1975 yılı hutbeler kitabında yayınlanan özgün hutbe ise, sonraki yıllarda en çok tekrar edilen metin olarak öne çıkar ve adeta resmî Cumhuriyet söylemini şekillendirir. Bu hutbe ile kurulan söylemin uzun

yıllar boyunca tekrarlandığı ve kurumsal olarak benimsendiği anlaşılmaktadır. Metinde millet egemenliği, dini ve milli vurgunun güçlü beraberliği, Millî Mücadele'nin destansı bir dille anlatımı dikkat çekmektedir. Dini temellendirme İslam'ın istişare prensibi üzerinden yapılırken dikkati çeken diğer husus, milli vurgu güç kaybetmezken dini söylemin görece zayıflamış olmasıdır. Öte yandan Cumhuriyetin kurucusu Gazi Mustafa Kemal'in ilk defa bu hutbe ile hutbe sonunda anıldığı görülmektedir. (Hutbeler, 1975)

2002-2025 Yılları Arasında Cumhuriyet Bayramı Hutbeleri

2002 yılı hutbesi ile, metinlerde alışılagelen Cumhuriyet Bayramı temalarının yanı sıra yeni temalar dikkati çekmektedir. Müslüman-Türk vurgusu, vatan, millet egemenliği, istiklal ve hürriyet, istişare temalarının tekrar edilmesi, ataların ve Gazi Mustafa Kemal'in minnetle yad edilmesi önceki yıllarda benimsenen dilin devam ettiğini göstermektedir. Bununla birlikte vatanın ve cumhuriyetin bir emanet olarak tanımlanması önceki hutbelerde görmediğimiz bir vurgudur. Cumhuriyet tanımında ise milli egemenlik yerini milli irade ifadesine bırakmıştır. Bir diğer yenilik cumhuriyetin bireyin gelişimine katkıları üzerinden açıklanmasıdır. Buna göre insanın potansiyelini gerçekleştirebilmesi, düşünce ve inanç özgürlüğü gibi bireysel faydalar cumhuriyet idaresiyle ve dolayısıyla istişare ile mümkün olmaktadır. Bu yönleriyle 2002 yılı hutbesi, bir geçiş hutbesi gibi yorumlanabilir. (Diyanet İşleri Başkanlığı, 2002)

2004 yılı hutbesi ise geçişten ziyade yepyeni bir dil sunmaktadır. Bu tarihe kadar Cumhuriyet Bayramı hutbelerinin girişinde Türk milletinin nasıl zorluklarla ve kahramanca bir mücadeleyle cumhuriyeti kazandığı vurgulanarak övünç mesajı öne çıkmıştır. Ancak "Toplumsal İradenin Temsili: Cumhuriyet" başlıklı 2004 yılı hutbesinde Cumhuriyet, halkın istiklal mücadelesinden ziyade ideal bir toplum inşası ile ilişkilendirilmektedir. Bu ideal toplum ise temel hak ve hürriyetlerde eşitlik, sevgi, saygı, kardeşlik gibi değerlerle tanımlanmaktadır. Cumhuriyet tanımında halk egemenliği ifadesine yer verilse de vurgunun millet iradesi üzerinden seçimlere aktarıldığı görülmektedir. (Diyanet İşleri Başkanlığı (DİB), 2004)

"*Cumhuriyet; halkın egemenliği elinde tuttuğu ve bunu belli süreler için seçtiği temsilcileri aracılığıyla kullandığı yönetim biçimidir. Cumhuriyet, toplumun, kendi kendisini idaresi, başka bir ifadeyle her bireyin iradesinin idareye yansımasıdır." (DİB, 2004)*

Cumhuriyet birlikte yaşama ve sorumluluk alma gibi değerlerle tanımlanırken cumhuriyetle gelen özgürlük artık yeni bir anlam kazanmıştır. Önceki yıllarda düşman işgalinden kurtularak bağımsızlığı kazanma anlamında hürriyet, cumhuriyetle ilişkili bir değer olarak açıklanırken artık bireyin özgürleşmesi cumhuriyetin çıktılarından biri olarak sunulur. İlerleme ve çağdaş medeniyetler seviyesine çıkma hedefi ise hala hutbelerde önemini koruyan bir konu olarak ele alınmaktadır. Cumhuriyetin dini referansı olan istişare ve danışma prensipleri bu hutbede "ortak akıl" ifadesiyle kavramlaştırılmış yine birlikte yaşama değeri ile benzer bir çizgide anlatım devam etmiştir. Hz. Peygamberin istişare ile ilgili uygulamaları ve dört halife döneminde yöneticilerin seçimle iş başına gelmesi cumhuriyetin dini temellendirmesi olarak anılmaya devam etmektedir. Gazi Mustafa Kemal'in minnetle anılması sürekliliğe işaret ederken dini ve milli değerlere vurgu yapılarak bitirilmesi cumhuriyetin 2002 sonrası hutbelerde artık bir değerler bütünü olarak ele alındığını göstermektedir. (DİB, 2004)

2005 yılı hutbesinde yine değerler üzerinden cumhuriyet anlatısı karşımıza çıkmaktadır. Bu hutbede İslam dininin ilkeleri ile evrensel insan hak ve özgürlükleri örtüşmesi anlatılmış, ardından bu kesişim kümesinde yer alan adalet, eşitlik, inanç ve düşünce özgürlüğü cumhuriyet idaresiyle kendisine zemin bulan değerler olarak açıklanmıştır. Yine insanın yeteneklerini ortaya koymasına imkan tanıyan da cumhuriyet idaresidir. (DİB, 2005)

2002 yılı sonrasında hutbelerde vurgunun toplumsal hayat üzerine olması ve evrensel insan haklarının hutbede yer bulması dönemin siyasi aktörlerinin Avrupa Birliği uyum süreci politikaları bağlamında düşünülebilir. (Aydın, Taşkın, 2002) Ayrıca özgürlük teması, 2002 öncesinde düşman işgalinden kurtulma veya millet egemenliği anlamlarında hutbede yer bulurken 2002 sonrasında bireyin

özgürleşmesi şeklinde dönüşmesi de dikkat çekicidir. Cumhuriyetin yüklendiği anlamların dönemin değerleriyle ilgili olarak değişkenlik gösterdiği anlaşılmaktadır.

2006 yılı hutbesinde de 2002 sonrasındaki eğilime uygun olarak vurgu toplumsal hayat ve insan hakları üzerindedir. Toplumsal hayatın selameti için İslam'ın despotizmi reddettiği, Allah-kul ilişkisinde dahi insanın özgür bırakıldığı anlatılmaktadır. Bireyleri özgür olmayan toplumların gelişemeyeceği ileri sürülürken Hz. Peygamber'in istişareye örnek olan uygulamaları, O'nun toplum vicdanına olan güveni bağlamında ele alınmaktadır.

Hutbelerde karşılaşılan insan hakları vurgusunu 1990'lı yıllardan itibaren ortaya çıkan ulusal ve uluslararası gelişmeler bağlamında değerlendirmek mümkündür. 1990 yılında İnsan Hakları Derneği ve Türkiye İnsan Hakları Vakfı'nın faaliyete geçmesi, TBMM'de İnsan Hakları Komisyonu kurulması gibi gelişmeler, Türkiye'nin insan haklarına dair yolculuğuna ışık tutmaktadır. Öte yandan Birleşmiş Milletler tarafından 1995-2004 yıllarının İnsan Hakları Eğitimi On Yılı ilan edilmesi ve bu on yıl için eylem planı hazırlanması, konunun uluslararası düzlemdeki gelişmesini göstermektedir. Ülkemizde vatandaşlık eğitimine doğrudan etkisi olan bu gelişmelere bağlı olarak 1998-99 eğitim öğretim yılında Vatandaşlık dersinin adı Vatandaşlık ve İnsan Hakları Eğitimi olarak değiştirilerek 7. Ve 8. Sınıfta zorunlu ders olarak okutulmuştur. Ortaöğretimde ise Demokrasi ve İnsan Hakları, seçmeli dersler arasında yer almıştır. (Üstel, 2021) Dolayısıyla örgün eğitime 1990'lı yılların sonuna doğru dahil edilen insan haklarının hutbeler aracılığıyla yaygın eğitimde de 2002 yılından sonra yoğunlaştığı düşünülebilir.

2006 hutbesinde dikkati çeken bir diğer husus şudur; 1972-2002 yılları arasında hutbelerde cumhuriyet yönetimi ve istibdat karşıt bir anlatımla yer bulmaktaydı. Ancak 2006 hutbesinde despotizmden, baskıcı yönetimlerin İslam'a uygun olmadığından bahsedildikten sonra cumhuriyet öncesi dönem için bir açıklama eklenerek o dönemin de kendi koşulları içinde insan hak ve özgürlüklerine saygılı bir toplum modeli geliştirdiği anlatılmıştır. Cumhuriyet Bayramı hutbelerinde görülen; cumhuriyet idaresinin fazileti, bir kişinin mutlak iradesine dayanan yönetimlerin ise istibdat ve zorbalığı ifade etmesi şeklindeki zıtlık üzerinden kurulan anlatımın aksine bu hutbede Türklerin cumhuriyetten önce de baskıcı bir toplum düzeninde yaşamadıkları ileri sürülmektedir.

"Bizim ecdadımız da, dünyanın başka toplumlarında olduğu gibi saltanatı despotizme çevirmemiş; o çağların şartlarının elverdiği ölçüde, insan hak ve hürriyetlerine saygılı olmaya özen göstermişlerdir; hatta bazı bakımlardan bugünün gelişmiş toplumlarına bile örnek olacak uygulamaları başarmışlardır. Sadece, çok dinli ve çok kültürlü bir şehir olan Kudüs'teki yüzlerce yıllık uygulama bile, bırakın Müslümanları, insanlık için dahi onur verici örneklerle doludur." (Çağrıcı, 2016)

Hem cumhuriyet öncesini hem Kurtuluş Mücadelesi'ni yücelten bu hutbede, cumhuriyetin mimarı olan Gazi Mustafa Kemal Paşa'yı anarak hutbe sonlandırılmıştır.

Son olarak yüzüncü yıl hutbesi ele alındığında oldukça coşkulu bir dile sahip olduğu görülmektedir. "Vatan Millet Sevdasıyla Nice Yüzyıllara" başlığı taşıyan hutbe, başlığın da hissettirdiği gibi vatan temasını öne çıkarmaktadır. Vatan, Milli Mücadele döneminde uğruna yapılan fedakarlıklar hatırlatılarak "yüce bir emanet" olarak tanımlanmıştır. Öte yandan birlik beraberlik kardeşlik temaları, güçlü devlet olma hedefi bağlamında öne çıkarılmıştır. Cumhuriyetin yüzüncü yılına ulaşmak, Allah'ın yardımı ve kardeşlik bilinci ile mümkün olmuştur. Kardeşlik ve milli mücadele hatırlatmalarından sonra hutbe Filistin'de yaşanan zulme dikkat çekmek üzere cemaati yardıma davet etmektedir. Hiçbir Cumhuriyet Bayramı hutbesinde gündeme dair mesajlar olmamasına rağmen, yüzüncü yıl hutbesinde Filistin'de yaşanan zulüm hutbede geniş bir yer tutmuştur. Hutbede Filistin'in konu edilmesi Ekim 2023 tarihinden itibaren yoğun bir şekilde görülmüş, özellikle ekim ayının her haftasında bu konuya geniş yer verilmiştir. Takip eden aylarda da hutbede Gazze'nin anılması sürdürülmüştür. Tüm dünyada yankı bulan Filistin konusu hutbelerde de karşılık bulmuş, o tarihlere denk gelen Cumhuriyet Bayramı hutbesi de kardeşlik teması üzerinden Filistin'e bağlantı kurularak açıklanmıştır. Yüzüncü yıl hutbesinde güçlü devlet, vatan, birlik beraberlik vurgularının yer alması da yine dünyadaki savaş ortamı ile açıklanabilir. Aynı zamanda bu hutbede önceki hutbelere kıyasla çok fazla ayet bulunmaktadır. Her Cumhuriyet

Bayramı hutbesinde Al-i İmran 159. Ayet zikredilirken yüzüncü yıl hutbesinde kardeşlik, Allah'tan ümit kesmemek, zulme karşı durabilmek gibi konularla ilişkili ayetlere yer verilmiştir. Ancak hemen her Cumhuriyet Bayramı hutbesinde yer alan cumhuriyet tanımlarına yer verilmemiştir. Ayrıca cumhuriyetin dini temellendirmesi ve istişare prensibinden de bu hutbede bahsedilmemiştir. Bu durum hutbenin önemli bir kısmının Filistin konusuna ayrılmış olmasıyla açıklanabileceği gibi cumhuriyetin yüzüncü yılı itibariyle artık gerekçelendirmeye ihtiyaç kalmayacak kadar benimsendiği de düşünülebilir. Öte yandan yüzüncü yıl hutbesinde şehitler ve devlet büyükleri yad edilirken Gazi Mustafa Kemal Paşa ismen anılmamıştır. (Diyanet İşleri Başkanlığı, 2023)

2025 yılında Cumhuriyet Bayramı hutbesi yayınlanmamakla birlikte 29 Ekim tarihinde Diyanet İşleri Başkanlığı tarafından kutlama mesajı yayınlanmıştır. Bu mesajda Millî Mücadele destansı bir kahramanlık çerçevesinde anılmış, hürriyet, vatan sevgisi ve birlik-beraberlik gibi değerler öne çıkarılmıştır. Cumhuriyetin kurucusu Gazi Mustafa Kemal Atatürk, şehit ve gaziler minnetle anılırken mesajda yer alan değerler birer emanet olarak kabul edilmiştir.

SONUÇ

Cumhuriyet Bayramı hutbelerinin din eğitimi açısından değerlendirilmesine baktığımızda, cumhuriyetin değer yüklü bir anlatımı olduğu görülmektedir. Bu değerler, 2002 yılı öncesinde daha ziyade vatan sevgisi, hürriyet, istiklal gibi temalarla öne çıkarılırken 2002 sonrasında evrensel insan hak ve özgürlükleri, bireyin özgürleşmesi ve gelişimi, düşünce ve inanç özgürlüğü gibi değerlerin cumhuriyetle ilişkilendirildiği görülmektedir. Hutbenin dönemin etkilerine göre değişkenlik göstermesinin bir diğer bulgusu da 2002 öncesinde millet egemenliğinin cumhuriyeti tanımlarken mutlaka vurgulandığı ancak 2002 sonrasında milli irade ifadesinin tercih edildiğidir. 2002 yılında iktidar olan AKP, tek başına iktidar olmasının ardından seçimle elde ettiği bu başarının herhangi bir vesayetin gölgesinde kalmaması adına "milli irade" ifadesini sıklıkla vurgulamıştır. (Üşenmez, 2012) 2002 sonrası hutbelerde görülen "milli irade" ifadesi, iktidarın söylemlerinin hutbelere yansıması olarak değerlendirilebilir.

2002 öncesinde aynı hutbe metninin yıllarca tekrar edilmesi, bu dönemde Diyanet'in mesajının daha temkinli, istikrarlı ve kurumsal sürekliliğe dayalı bir anlatı çerçevesinde şekillendiğini göstermektedir. Buna karşın 2002 sonrasında özgün hutbe metinleriyle birlikte Cumhuriyet'e yeni değerler ve anlamlar yüklendiği anlaşılmaktadır. Bu değerlerden biri olan düşünce ve inanç özgürlüğünün Cumhuriyet'in bir kazanımı olarak hutbede yer bulması, özellikle başörtüsü yasağı gibi kamusal alanda dinî görünürlüğe dair bazı uygulamaların değiştirilmesine zemin oluşturma çabası olarak okunabilir. Benzer şekilde hutbelerde giderek daha fazla yer bulan insan hakları vurgusu, ulusal ve uluslararası düzeyde bu kavrama yönelik artan duyarlılığın Diyanet söylemine yansıması olarak düşünülebilir. Dolayısıyla yaygın din eğitimi aracı olarak hutbelerin söylem ve temalarının toplumsal dönüşümlerle birlikte şekillendiği gözlemlenmektedir.

KAYNAKÇA

Aydın. Suavi, Taşkın. Yüksel. (2002) *1960'tan Günümüze Türkiye Tarihi*. İstanbul: İletişim Yayınları. 8.Baskı

BCA 1924. Halife ve Hilafet Mevcut Olmadığından Hutbelerde Millet ve Cumhuriyetin Selamet ve Saadetine Dua Edilmesinin İlgililere Tebliği. Fon no.51 Yer no.2.12.8.

Bora. Tanıl. (1998). *Türk Sağının Üç Hali Milliyetçilik Muhafazakarlık İslamcılık*. İstanbul: Birikim Yayınları.

Bulut. Mehmet. (2024) *Tarihimizde Din Hizmetleri Teşkilatları ve Diyanet İşleri Reisliği (1924-1950)* Ankara: Diyanet İşleri Başkanlığı Yayınları.

Creswll. John. (2021) *Nitel Araştırma Yöntemleri Beş Yaklaşıma Göre Nitel Araştırma ve Araştırma Deseni*. Ankara: Siyasal Kitabevi.

Cumhuriyetin İlanına Müsadif 29 Teşrinievvel Gününün Millî Bayram Addi Hakkında Kanun. (1925). T.C. Resmî Gazete, (96), 23 Nisan 1341.

Çağrıcı. Mustafa. (2006). "Cumhuriyet Bayramı", İstanbul Müftülüğü.

Diyanet İşleri Başkanlığı (1973) *Hutbeler*. Ankara: Diyanet İşleri Başkanlığı Yayınları.

Diyanet İşleri Başkanlığı (1975) *Hutbeler*. Ankara: Diyanet İşleri Başkanlığı Yayınları.

Diyanet İşleri Başkanlığı (2009). *Kur'an-ı Kerim Meali*. Ankara: Diyanet İşleri Başkanlığı Yayınları.

Diyanet İşleri Başkanlığı (DİB) 2002, "Cumhuriyet Bayramı" Diyanet Aylık Dergi sayı 42.

Diyanet İşleri Başkanlığı (DİB) 2004, "Toplumsal İradenin Temsili: Cumhuriyet" Diyanet Aylık Dergi sayı:166.

Diyanet İşleri Başkanlığı (DİB) 2005, "Cumhuriyet" Diyanet Aylık Dergi sayı.178

Diyanet İşleri Reisliği (1927). *Türkçe Hutbe*. İstanbul: Şehzadebaşı Evkaf Matbaası.

Doğan. Lütfi. (1972, 15 Ekim), "Cumhuriyet Bayramı Münasebetiyle", Diyanet Gazetesi:5.

Doğan. Recai. (1999) "Cumhuriyet Öncesi Dönemde Yaygın Din Eğitimi Açısından Hutbeler" Ankara Üniversitesi İlahiyat Fakültesi Dergisi. cilt: XXXIX. s. 491-533

Erkan. Arif. (1973, 29 Ekim), "İslam'a Göre Cumhuriyet İdaresi", Diyanet Gazetesi: 3.

Kara. İsmail. (2016) *Cumhuriyet Türkiye'sinde Bir Mesele Olarak İslam 1*. İstanbul: Dergah Yayınları.

Kepir. Aytaç (2024). Cumhuriyetin 50. Yıldönümü Kutlamaları, Yüksek Lisans Tezi. Ankara, Hacettepe Üniversitesi Atatürk İlke ve İnkılapları Enstitüsü.

Koçyiğit, Talat. (1973, 15 Ekim). "Bayramlarımız" Diyanet Gazetesi: 3.

Özdamar. Mustafa. (1973, 15 Ağustos), "İslam'da Cumhuriyet İdaresi", Diyanet Gazetesi: 10.

Üstel. Füsun. (2021). Makbul Vatandaşın Peşinde II. Meşrutiyet'ten Bugüne Vatandaşlık Eğitimi. İstanbul: İletişim Yayınları.

Üşenmez. Özgür. (2012) "Türkiye'de Siyasal İslam ve AKP'nin Hegemonya Sorunu". S.Gülden Ayman (derl.) *Mekan, Kimlik, Güç ve Dış Politika.* İstanbul: Yalın Yayıncılık ss.323-343.

Zengin. Zeki Salih (2008) "Osmanlılar Döneminde Yaygın Din Eğitimi Faaliyeti Olarak Hutbeler" Çukurova Üniversitesi Sosyal Bilimler Enstitüsü Dergisi. sayı:1. s. 379-398

THE IMPACT OF THE GREEN ECONOMY ON THE LABOR SECTOR

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Summary - The development of the green economy leads to significant structural changes in the labor sector. The expansion of areas such as renewable energy, energy efficiency, waste management and eco-innovation stimulates the creation of new jobs. This process accelerates the formation of "green skills", which require particularly high qualifications, and leads to a restructuring of the occupational composition of the labor market. At the same time, a decrease in jobs may be observed in carbon-intensive sectors, which increases the importance of socio-economic measures such as professional transition, retraining and worker adaptation. Overall, the green economy promotes sustainable employment in the labor sector, improves the quality of human capital and strengthens the competitiveness of the economy.

Keywords – green economy, green transition, labor sector, green skills, green transformation

The green economy aims to reduce environmental risks and promote sustainable development while protecting the environment. In contrast to standard economic models, it emphasizes the intrinsic value of natural capital and environmental services and requires full cost accounting to hold those responsible for environmental damage accountable. The 2011 UN Environment Programme Green Economy Report highlights the role of equity in the transition to low-carbon, resource-efficient economies. Green stickers and eco-labels have emerged as consumer indicators of environmental responsibility and have encouraged companies to adhere to sustainability standards aimed at limiting negative impacts on ecosystems and protecting social protection. However, barriers such as inconsistent enforcement and insufficient compliance incentives hinder their effectiveness and require a concerted effort to standardize methods across sectors such as forestry, agriculture and mining while focusing on environmental protection. Labor market transformation and the relevance of the impact of new economic models on the workforce – The technological, economic and social changes that have occurred globally in recent decades have not spared the labor market. Against the background of these changes, an increase in labor productivity, a decrease in production costs and an increase in economic efficiency are supported and bring to the fore the adaptability of the workforce and social sustainability. The increase in digitalization, the development of artificial intelligence and the resulting formation of new work models (freelance, remote work, etc.) are reshaping the essence of the labor market. The development of the green economy also affects the emergence of new professions and the formation of the labor market as a result of the development of the renewable energy sector. As a result, new concepts such as "green professions" and "green skills" are being formed. This change is not only an economic, but also a social process. Investigating the impact of these innovations on the labor market is important in terms of determining state policy, determining the development directions of human capital, and building a sustainable and competitive economy.

The structural changes taking place in the global labor market and the formation of new economic models are also among the main issues on the agenda of international organizations. The UN assesses this entire labor market transformation process in the context of its Sustainable Development Goals. In this context, the UN has 17 goals. Sustainable Development Goal 8 - Decent Work and Economic Growth (SDG 8), Sustainable Development Goal 9 - Industry, Innovation and Infrastructure (SDG 9) and Sustainable Development Goal 13 - Climate Action (SDG 13) are concepts that cover these issues. If we summarize these 3 goals, we can say that the UN's goal is to protect decent work standards against the backdrop of digitalization, to ensure the development of infrastructure for the implementation of innovative economic models, and to combat climate change in an equitable manner. (United Nations, 2015)

The Organization for Economic Co-operation and Development – assesses these processes within the framework of economic efficiency. The main issues on the agenda of this organization include the impact of artificial intelligence and automation on employment, the rapidly changing problem of new skills and social security issues OECD (2023). The OECD examines the impact of the transition to a green economic model on employment within the framework of its "Green growth Strategy". (Organization For Economic Co-Operation And Development, 2011)

The International Labor Organization – its main goal is labor rights, decent work and social justice. Rapid economic change requires the reshaping of labor relations. The exclusion of some workers from social security is one of the main issues of focus. The report of the International Labor Organization "Work for a brighter future" is related to future forecasts in the labor market. (International Labor Organization, 2019)

The purpose of this article is to study the impact of green economy elements on the labor market at the global and regional levels. To analyze the impact of the development of renewable energy sources on employment. To measure the relationship between the development of the green economy and the level of unemployment in the world. The main research question is - does the development of the green economy increase or decrease people's security in the labor market? Can it become a key tool in ensuring employment of the population?

The concept of a green economy is a model aimed at ensuring economic development without harming ecosystems and nature. It focuses on environmental protection and the sustainable use of natural resources, gaining importance in the context of environmental disasters, climate change and resource depletion. In line with the UN Sustainable Development Goals, the green economy seeks to balance economic growth with ecology and responds to the following key challenges: protection of natural resources, mitigation of the effects of climate change, social justice. Health, justice, planetary boundaries, efficiency and sufficiency are important among the main principles of the green economy. These principles promote human well-being, fair distribution, care for nature, efficient use of resources and sustainable development. At the same time, the green economy creates new job opportunities by highlighting innovation and technological development, especially in the field of renewable energy and environmentally friendly technologies. In addition, public policies, economic incentives, education and awareness also support the development of a green economy. These approaches allow society to understand and support this model, increase the development of new skills and economic participation. Thus, the green economy is a model aimed at ensuring both social and ecological equality by providing a sustainable environment and economic opportunities for future generations.

Elements of the green economy have the power to influence all areas of the traditional economy. It is possible to see elements of the green economy in almost all areas. Radical changes are observed in the energy sector. The world has already changed its perspective on renewable energy sources in fossil fuels. In order to reduce greenhouse gas emissions, the use of oil, gas and coal fuels is abandoned. A transition to fuels such as solar, wind, hydropower is being made. A transition to hybrid and electric vehicles is being made in transport. Projects are being implemented to decarbonize transport systems. (see: IRU Green compact). Technologies are being applied in agriculture to increase efficiency and reduce emissions. New research is being conducted in the scientific sphere and new technologies are being applied to grow biological and climate-resistant plants. Waste-free technologies are being applied in industry. Waste recycling technologies and a transition to green energy are being provided.

Global supply-demand shifts, new occupational groups, technological changes - Green jobs, also known as green-collar jobs, ecological jobs or environmental jobs, are defined by the United Nations Environment Programme as employment in a variety of sectors - including agriculture, manufacturing, research and development, management and services - that significantly contribute to the protection or restoration of the quality of the environment. These roles play a crucial role in protecting ecosystems and biodiversity, improving resource efficiency (e.g. energy, materials and water), decarbonising the economy and reducing waste and pollution. The environmental sector not only addresses environmental issues but also promotes economic growth, thereby demonstrating a double benefit. Specifically, the US Bureau of Labor Statistics describes green jobs as jobs in businesses that produce environmentally beneficial goods or services or that involve environmentally friendly production processes. They classify green jobs into categories such as water conservation, sustainable forestry, biofuels, geothermal energy, environmental restoration, sustainability initiatives, energy auditing, recycling, electric vehicle manufacturing, and solar and wind power generation. These classifications highlight the diverse opportunities available in the green jobs sector and demonstrate its important role in advancing sustainability and environmental management. Examples of emerging occupations include climate change scientists, ecologist, electric vehicle engineer, environmental engineer, green building designer, marine biologist, recycling engineer, and solar and wind energy technician. (Wikipedia Green job (2023)

The Green Job Initiative promotes opportunities, equity and a just transition to a green economy, as well as addressing specific challenges such as sustainable development and climate change. It encourages governments, employers and workers to collaborate on relevant policies and programmes to achieve a sustainable and just transition to green jobs and decent work for all. (Green Job Initiatives, UNEP)

As new professions emerge, traditional professions are also beginning to disappear. Of course, the most notable of these are the fossil fuel - oil, natural gas, coal industry, metallurgy industry. Manufacturing plants based on old technologies produce high levels of emissions. This also causes them to disappear over time in the green transition process.

The transition to decarbonised and resource-efficient economies is having a significant impact on labour markets, creating new jobs but also causing job losses and changing skill requirements across sectors. The International Labour Organization (ILO) stresses that successful job creation during this transition depends on having a workforce equipped with a balanced mix of basic, technical and soft skills. To ensure that the green transition is just, it is important to offer proactive training and support to those at risk of unemployment, in particular vulnerable groups such as women, young people, older workers and people with disabilities. According to a 2019 ILO study, the transition could potentially create around

103 million jobs, but around 78 million jobs could be lost by 2030 under two scenarios focusing on energy sustainability and circular economy practices. The impact of the green transition varies by skill level and gender, suggesting that while there is demand for jobs across all skill levels, those requiring higher skill levels are not expected to grow significantly. Research shows that demand for specialized occupations will increase, requiring cutting-edge expertise in research, innovation and technology in green areas. In addition, there is a growing need for mid-skilled workers in positions such as technicians in renewable energy systems and sustainable agriculture. However, net gains in employment are not shared equally between men and women. Data from OECD countries show that women are underrepresented in green jobs compared to men. Barriers stemming from historical gender stereotypes, unequal educational opportunities – particularly in STEM fields – and insufficiently supportive work environments hinder women's entry and advancement into green occupations and create challenges for the equitable distribution of opportunities in the labor market. The skills considered necessary to support the greening of economies and societies are often categorized under different terms, such as "green skills", "green life skills", "green work skills" and "skills for the green transition", each with its own definition.

The document describes the key soft skills needed to facilitate the green transition, classified by the skill level of the professions. The following skills are essential for medium and high-skilled positions:

1. Analytical Thinking: This includes risk and systems analysis to understand and assess the need for environmental change, along with the necessary measures.

2. Coordination and Management: Skills that promote a holistic, interdisciplinary approach that integrates economic, social and environmental objectives.

3. Innovation Skills: The ability to identify new opportunities and develop innovative strategies to address green challenges.

4. Marketing Skills: The ability to effectively promote greener products and services.

5. Consulting Skills: Experience in advising consumers on green solutions and increasing the adoption of green technologies.

6. Networking, IT and Language Skills: Essential for effective participation in global markets.

7. Strategic and Leadership Skills: Enabling policymakers and business leaders to create the right incentives and a supportive environment for cleaner production and transport.

The document highlights the skills required for the entire workforce:

1. Environmental Protection: A fundamental respect for sustainability and a commitment to continuous learning about sustainable development.

2. Adaptation and Transfer Skills: Enabling workforce members to learn and apply new technologies and processes necessary to green their roles.

3. Teamwork Skills: Recognizing the importance of collaborative efforts in reducing the organizational environmental footprint.

4. Sustainability: The ability to manage and tolerate the changes necessary for environmental sustainability.

5. Communication and Negotiation Skills: Essential for advocating for change among colleagues and customers.

6. Entrepreneurial Skills: The ability to seize opportunities related to low-carbon technologies and environmental adaptation.

7. Occupational Safety and Health Awareness: Understanding health regulations related to environmental practices.

8. Basic Digital Skills: Competence that enables the use of technologies that help reduce environmental impacts.

These soft skills are considered essential to enhance the ability of individuals and organizations to effectively engage with and respond to challenges such as promoting sustainability and achieving a green transition.

France has implemented various initiatives to enhance environmental sustainability, implement climate action and create green jobs, which have facilitated cooperation between key stakeholders. The Grenelle de l'environnement was created in 2007 to link the public sector with civil society, social partners and local authorities, while annual national climate conferences, held since 2012, aim to stimulate participation in multilevel governance. The National Observatory on Jobs and Occupations in the Green Economy (Onemev) was created in 2010 to analyse job changes in the green economy and to develop relevant methodologies and statistics, bringing together key national ministries, public employment services and research institutes. In India, the Skills Council for Green Jobs (SCGJ) was established in 2015 under the National Skill Development Mission to coordinate skills development in the green sector. It is an industry-focused society that identifies skills needs and implements training programs in partnership with government and industry representatives, certifying over 536,000 candidates by 2023.

Founded in 2013, Canada's Women in Renewable Energy (WiRE) promotes women's participation in renewable energy, supporting mentoring, networking and education initiatives. The organization endorses the Gender Diversity Leadership Agreement, which aims to increase women's representation in the electricity sector, and offers scholarships for women pursuing related studies.

Singapore's "skills future loan" scheme provides funding for individual skills development, encourages lifelong learning and employers' involvement in workforce training. Similarly, Guyana offers green financing options and skills training for green businesses through its Micro and Small Enterprise Development Program, which facilitates the development of sustainable enterprises.

In Denmark, in addition to a trade union-led retraining programme, the Lindø Industrial Park was established after 2012 to support the maritime and heavy industries, resulting in the Lindø Marine Renewable Energy Centre. Effective labour market information systems and skills anticipation mechanisms are essential for understanding employment changes during the green structural transformation and enable the formulation of appropriate policies for the green transition and the integration of relevant skills into education and training systems. (ILO Research Repository, Kyeung Chun Hae, 2024)

The processes taking place in the green economy affect labor productivity. Technological innovation and automation have a positive effect on labor productivity. At the same time, the transition to a green economy forces companies to invest in new technologies. This creates conditions for more efficient use of human labor. The application of green energy technologies reduces costs, uses less energy, reduces raw material losses, and further optimizes the production process. The creation of a healthier working environment in clean workplaces in the green economy creates conditions for employees to work in a healthier environment. As a result, employee well-being increases and occupational diseases decrease. In the green transition process, employees gain new skills, which makes them more competitive. In the long term, saving resources and having a recycling process brings profits to companies and creates a sustainable and efficient environment.

The transformation of the green economy will also lead to the transformation of workplaces in the regions. The creation of new jobs is inevitable. The initiative of state institutions in this area is important. The State Employment Agency implements training and educational programs in this area. Private companies should also work in this area. The implementation of new projects on renewable energy projects creates a demand for new jobs and also leads to the creation of new jobs. New specialties are also emerging in this transition process. This also creates the need for higher education institutions to adapt their curricula to this. We observe that old professions are gradually decreasing, becoming obsolete and being replaced by new professions. For example, the demand for oil and gas engineers in the fuel energy sector is predicted to decrease and be replaced by engineers working in the field of solar and wind energy. Of course, this transition process also contains risks. Especially in the first stages, mass unemployment associated with this process may be observed. We can observe this more in the regions, especially. At this time, the employment potential of the regions should also be taken into account.

Conclusion - The impact of the green economy on the labor sector can be assessed both positively and negatively. However, the main point here is to ensure sustainability in the labor market. It is necessary to apply a flexible approach to emerging problems. It is important to create new jobs for sustainable development. For this, as we have noted, it is necessary to strive to create a new qualified workforce. New employment programs related to the transition to green energy should be created in the public sector. Private companies, corporations, holdings should organize training for employees. Specialists themselves should be open to new knowledge and devote time to personal development. It is necessary to strive to train educated personnel in new specialties in accordance with the labor market in educational institutions. Acquiring new skills is a difficult and time-consuming process. Therefore, new programs should be created. It would be appropriate for the International Labor Organization to establish green occupational standards, as in other professional fields. It would be more correct for states to apply the green transition strategy in the labor market fairly.

List of references

United Nations. (2015). The 17 sustainable development goals. United Nations. https://sdgs.un.org/goals

Wikipedia . (2023, September 14). Green job. Wikipedia. https://en.wikipedia.org/wiki/Green_job

International Labour Organization. (2019, January 22). Work for a brighter future | International Labour Organization. Www.ilo.org. https://www.ilo.org/publications/work-brighter-future

Organisation For Economic Co-Operation And Development. (2011). Towards Green Growth. Oecd Publishing.

OECD. (2023). OECD.org - OECD. Oecd.org. https://www.oecd.org/

https://energypedia.info/images/f/fc/Green_Jobs_-_Impacts_of_a_Green_Economy_on_Employment.pdf

https://www.itf-oecd.org/sites/default/files/docs/azrbaycanda-nqliyyat-sisteminin-dekarbonizasiyasi.pdf

https://esri.gov.az/uploads/files/Sayta%20%C9%99lav%C9%99%20toplu(2).pdf#page=182

https://sdgs.un.org/partnerships/green-compact.

AN EDUCATIONAL GAME DESIGN FOR TEACHING THE TOPIC OF 'COMPARISON SPEED AND VELOCITY'

'SÜRAT VE HIZIN KARŞILAŞTIRILMASI' KONUSUNUN ÖĞRETİMİNE YÖNELİK BİR EĞİTSEL OYUN TASARIMI

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ÖZET

Öğrenciler, oyun ortamlarında doğal meraklarını ortaya koyar, deneme-yanılma ve uğraş yoluyla öğrenmeye daha istekli hale gelirler. Oyun, onların karar verme, problem çözme ve iş birliği becerilerini destekleyen güçlü bir öğrenme aracıdır. Oyun fen öğretimiyle birleştiğinde ise, soyut kavramların somut deneyimlere dönüşmesini ve birbirine karıştırılan kavramların kolay anlaşılmasına katkı sağlar. Diğer bir deyişle, oyunla iç içe olan öğrenciler bilginin pasif alıcısı olmaktan çıkarak sürecin aktif keşfedicisi olur. Bu nedenle gerçekleştirilen çalışmada, literatürden birbirine karıştırıldığı bilinen sürat ve hız kavramlarına odaklanılmıştır.

Çalışma kapsamında, 6. sınıf Fen Bilimleri dersi "Sürat ve Hızın Karşılaştırılması" konusunun öğretimi için "Asfaltın Efendileri" adlı bir eğitsel oyun tasarlanmıştır. Tasarım tabanlı araştırma yöntemiyle oluşturularak sunulan bu oyun tasarımında, öğrencilerin ilgili kavramları etkileşimli ve keyifli bir öğrenme süreci içinde daha kalıcı ve anlamlı biçimde öğrenmeleri amaçlanmıştır. Bu amaç doğrultusunda geliştirilen tasarımın, öğrencilerin konuyu hem daha kolay kavramalarını hem de öğrenme sürecine etkin bir biçimde katılarak öğrenmeyi zevkli bir deneyime dönüştürmelerini destekleyeceği öngörülmektedir. Çalışma sonunda, tasarım sürecindeki deneyimlere de dayalı olarak ilgililere gerekli önerilerde bulunulmuştur.

Anahtar Kelimeler: Eğitsel oyun tasarımı, Fen öğretimi, Sürat, Hız

ABSTRACT

Students express their natural curiosity in game environments and become more eager to learn through trial and error and effort. Games are a powerful learning tool that supports their decision-making, problem-solving, and collaboration skills. When combined with science teaching, games help transform abstract concepts into concrete experiences and contribute to the easy understanding of concepts that are often confused. In other words, students who are immersed in play cease to be passive recipients of information and become active explorers of the process. For this reason, the study focused on the concepts of speed and velocity, which are known to be confused with each other in literature.

Within the scope of this study, an educational game titled "Masters of Asphalt" was designed for teaching the topic "Comparison of Speed and Velocity" in the 6th grade Science course. Created using a

design-based research method, this game design aims to help students learn the relevant concepts in a more lasting and meaningful way through an interactive and enjoyable learning process. It is anticipated that the design developed for this purpose will support students in both grasping the subject more easily and transforming learning into an enjoyable experience by actively participating in the learning process. At the end of the study, recommendations were made to relevant parties based on the experiences gained during the design process.

Key Words: Educational game design, Science teaching, Speed, Velocity

GİRİŞ

Değişen ve gelişen toplumumuzda ihtiyaçlar doğrultusunda yenilikler ortaya çıkar. Bu yeniliklerle sürekli, güncel ve insanlığa fayda sağlama amacı güdülür. Eğitimdeki değişimler ise güncel olmak ve bireyleri topluma en iyi şekilde kazandırmak gayesiyle belirli zamanlarda eğitim sistemlerinin, öğretim programlarının, öğretim yöntem ve tekniklerinin ayrıca değerlendirme aşamasında kullanılan ölçme araçlarının da değişime uğradığı bilinmektedir (Özgürlük vd., 2015). Son zamanlarda bu değişim hareketlerinin içerisinde öğretimde oyunlara da yer verilmektedir.

Oyun, çocukluk döneminin vazgeçilmez bir parçası olmanın ötesinde, çocuğun sosyal çevresiyle uyum kurmasında önemli bir rol üstlenir. Çocuk, oyun aracılığıyla yalnızca eğlenmez; aynı zamanda kendisini ifade etmenin, çevresiyle etkileşime geçmenin ve dünyayı anlamlandırmanın yollarını da keşfeder. Oyun, çocuk için bir tür iletişim dili gibidir; duygularını, düşüncelerini ve ihtiyaçlarını sözcüklere dökmeden anlatabilmesini sağlar. Bu süreçte çocuk, hem kendi duygusal dünyasını düzenlemeyi öğrenir hem de çevresiyle sağlıklı ilişkiler kurmanın temellerini atar. Böylece oyun, çocuğun bireysel gelişiminin yanı sıra sosyal ve toplumsal kimliğinin oluşumuna da katkı sunan temel bir yaşam pratiği haline gelir (Aytekin, 2001). Dolayısıyla eğitim-öğretim uygulama ve etkinliklerinde oyunlara yer vermek çocukların ilgisini çekecek ve öğrenme süreçlerine olumlu katkı sağlayacaktır.

Fen bilimleri dersi, soyut kavramlar içermesi nedeniyle öğrenciler tarafından çoğu zaman anlaşılması güç bir alan olarak görülmektedir. Oysa fen bilimleri, günlük yaşamın farklı yönlerinde ve çeşitli biçimlerde karşımıza çıkmaktadır. Ancak öğrencilerin sahip oldukları ön bilgiler ya da kişisel gözlemler, kimi zaman bilimsel gerçeklerle örtüşmemekte ve fen öğreniminde güçlüklere neden olabilmektedir (Palmer, 1999). Yapılan çalışmalarda sürat ve hız kavramının onu takiben alınan yol ve yer değiştirmenin öğrencilerin kazanım boyutunda kavramalarında eksiklikler olduğu görülmüştür (Yıldız vd., 2007). Hız ve sürat kavramları, çoğu zaman aynı anlamda kullanılsalar da aslında birbirinden farklı fiziksel büyüklükleri temsil etmektedir. Kavramsal açıdan bakıldığında, sürat yalnızca bir cismin hareket büyüklüğünü ifade eden skaler bir niceliktir; buna karşın hız, hareketin hem büyüklüğünü hem de yönünü belirten vektörel bir kavramdır. Hız, bir cismin konumunun zamanla nasıl değiştiğini ve bu değişimin hangi yönde gerçekleştiğini tanımlarken; sürat, yalnızca hareketin büyüklüğünü dikkate alır ve yön bilgisi içermez (Young & Freedman, 2008). Bu doğrultuda, öğrencilerin hız ve sürat kavramlarını derinlemesine kavramaları, bu iki kavram arasındaki farkı ve ilişkiyi doğru biçimde ifade edebilmeleri büyük önem taşımaktadır. Ayrıca, bu kavramları doğru şekilde öğrenen ve içselleştiren öğrenciler, öğretmenlerinin açıklamalarını daha kolay anlayacak ve günlük yaşamda sıkça karşılaşılan kavram yanılgılarını azaltacaklardır (Balbağ, 2018).

Eğitim ortamlarında uygulanan oyunlarla da derse ilgisi olmayan, dersi dinlerken zorluk yaşayan çocukların öğrenmesini kolaylaştırmak bir yandan da sınıf içi birlik beraberliği artırmak amaçlanır (Yazıcıoğlu & Çavuş-Güngören 2019). Öğretimde kazanımların en doğru ve en kolay şekilde verilebilmesi, çocukların sevdiği ve zamanını eğlenerek geçirdiği oyunu öğretimle birleştirmekle daha kolay olacaktır (Kaytez & Durualp, 2014). Bu çerçevede gerçekleştirilen çalışmada, hız ve sürat kavramlarının öğrenciler için daha kolay ve anlaşılır olması amacıyla bir eğitsel oyun tasarlanması amaçlanmıştır. Bu amaç doğrultusunda geliştirilen oyun tasarımının, öğrencilerin konuyu hem daha kolay kavramalarını hem de öğrenme sürecine etkin bir biçimde katılarak öğrenmeyi zevkli bir deneyime dönüştürmelerini destekleyeceği öngörülmektedir.

YÖNTEM

Araştırmada 6. sınıf fen bilimleri dersi Kuvvetin Etkisinde Hareket ünitesinde yer alan Sürat ve Hızın karşılaştırılması konusuna yönelik bir oyun tasarımı oluşturmak amacıyla tasarım tabanlı araştırma yöntemi temel alınmıştır. Tasarım araştırmaları, bireylerin nasıl davrandığını kavramaya ve mevcut sorunlara yönelik yenilikçi çözüm yolları geliştirmeye odaklanan sistemli incelemelerdir (Büyüköztürk vd., 2016). Tasarım tabanlı araştırma yaklaşımında, belirli bir duruma ilişkin ayrıntılı çözümleme yapılır ve bu analiz doğrultusunda araştırmanın yapısı planlanır (Özmen & Karamustafaoğlu, 2019). Tasarım içeriğinde Maarif Modeli 6. sınıf fen bilimleri dersi öğretim programından yararlanılmıştır (MEB, 2024). Tasarlanan eğitsel oyuna, bir fen bilgisi öğretmeni ve alan eğitiminde uzman iki öğretim üyesi tarafından incelenip gerekli dönütler alınarak son hali verilmiştir. Tasarlanan Asfaltın Efendileri isimli oyun bulgular başlığı adı altında sunulmuştur.

BULGULAR

Tasarlanan Oyun

Dersin Adı: Fen bilimleri

Sınıf: 6. sınıf

Ünitenin Adı: Kuvvetin Etkisinde Hareket

Konu: Sürat ve Hızın Karşılaştırılması

Kavramlar: Büyüklük, Yön, Doğrultu, Uygulama Noktası, Bileşke Kuvvet, Dengelenmiş ve Dengelenmemiş Kuvvet, Dengeleyici Kuvvet, Sürat-Hız, Alınan Yol-Yer Değiştirme, Zaman

Kazanımlar: 2. Bölüm Sabit Süratli ve Sabit Hızlı Hareket

FB.6.2.2.1. Sürat ve hız kavramlarını karşılaştırabilme

a) Sürat ve hız kavramlarına ilişkin özellikleri belirler.

b) Sürat ve hız kavramlarına ilişkin benzerlikleri listeler.

c) Sürat ve hız kavramlarına ilişkin farklılıkları listeler.

Oyunun Uygulanması

Oyunun Adı: Asfaltın Efendileri

Oyunun oynandığı yer: Okulun Bahçesi

Oyun Türü- Öğrenci Sayısı: Bahçe oyunu**,** Grup Oyunu 16 kişi (4+4+4+4)

Kullanılan Malzemeler: Tebeşir, 2 kutu, Kronometre, Not defteri, Kalem, Üzerinde 4 faklı yol krokisi olan kağıtlar. Üzerinde süratin ve hızın tanımı-formül olan 4 adet kağıt.

Oyunun Amacı: Öğrencilerin sürat ve hız kavramlarını anlayarak aralarındaki farkı görebilmesidir.

Oyunun Kuralları:

1. Oyun okul bahçesinde oynanacaktır
2. Bahçede işaretlenen bir A noktası oyunun başlangıç noktasıdır.
3. A noktasının olduğu yerde 1 ve 2 nolu olmak üzere iki kutu vardır. 1 nolu kutuda dört farklı güzergahın olduğunu belirten dört kâğıt, 2 nolu kutuda ise dördü de aynı içerikli hız ve süratin tanım ve eşitliklerinin yazıldığı kağıtlar vardır.
4. Sınıftaki 16 öğrenci 4'er olmak üzere 4 gruba ayrılır. İstenirse gruplara isimler verilebilir.

5. Her grup; 1. kutudan rastgele kâğıt seçecek öğrenciyi, Yol güzergahını takip edecek öğrenciyi, Kronometreyi tutacak öğrenciyi, Bunları not alacak öğrenciyi kendi aralarında belirlerler.

6. Daha sonra oyun öğretmenin işareti ile başlar.

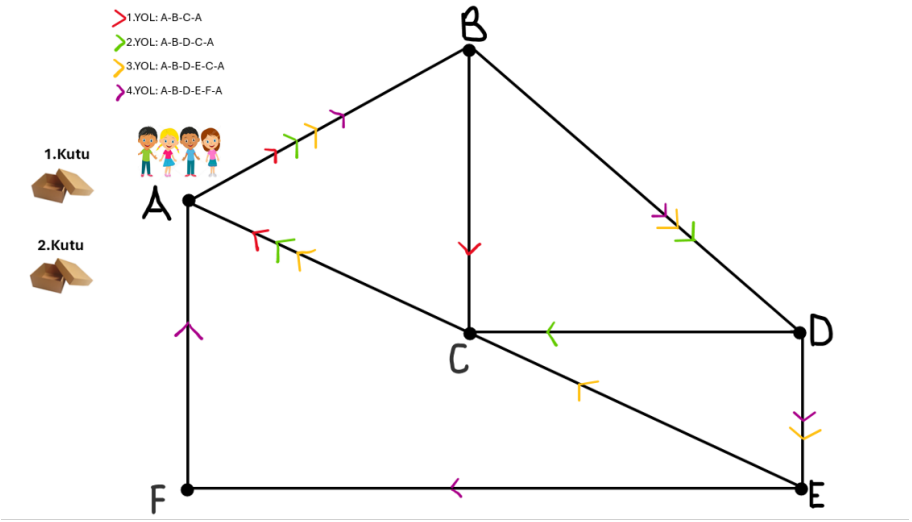
7. Her grup seçtiği kağıttaki güzergaha göre grubu eşliğinde depar hattını takip ederek tamamlar.

8. A noktasından başlayan ve tekrar A noktasına gelen her grubun öğrencisi bu sefer 2. nolu kutudan yeni bir kâğıt çeker. O sırada kronometre durdurulur.

9. Kronometredeki zamanı ve yol birimlerini not alan her grubun öğrencisi, gruptaki arkadaşları ile birlikte tanımı okurlar ve verileri formül yardımıyla çözümlerler. Sürati en fazla olan gruba en yüksek puan olmak şartıyla öğretmen sırasıyla 40, 30, 20 ve 10 puan verir. Ayrıca, hız ve sürat değerlerini doğru hesaplayabilen gruplara öğretmen her ikisi de doğru ise 40, biri doğru ise 20 puan verir.

10. En yüksek puanı alan grup birinci olur.

Oyunun Krokisi



Oyunun Oynanışı:

1. Öğrenciler bahçedeki oyun alanına geçerler. Her grup A noktasının çevresinde birbirlerinden biraz uzak bir şekilde dururlar. Örneğin Akıllılar grubundan kâğıt seçecek olan öğrenci, kutudan rastgele seçtiği güzergâh (1.yol, 2.yol vb.) kağıdını alarak yolu takip edecek olan öğrenciye verir ve bu öğrenci başlangıç noktası olan A noktasına geçer. Kronometreden sorumlu öğrenci de A noktasındadır. Kronometreyi başlattığı anda yolu gidecek olan öğrenci elindeki yol güzergahını en kısa zamanda bitirmek için hareket eder. Yol güzergahının tamamlanması esnasında zamanı ve yolların birimlerini not alan öğrenci eksiksiz bir şekilde bilgileri not eder. Yol bittiği anda kronometre durdurulur. A noktasından başlayan ve A noktasına dönen öğrenci 2. kutudan bir kâğıt çeker. Bu kâğıtta yazan tanımı sesli bir şekilde grup arkadaşlarına okur ve topladıkları verileri formülde yerlerine yazıp tartışma ortamı oluştururlar.

2. Diğer gruplar da bu şekilde oyunu tamamlarlar.

TARTIŞMA ve SONUÇ

Bu araştırma kapsamında, ortaokul 6. sınıf fen bilimleri dersinde yer alan "sürat ve hızın karşılaştırılması" konusuna yönelik özgün bir eğitsel oyun tasarlanmıştır. Tasarım sürecinde, konunun soyut yapısı ve bu doğrultuda öğrencilerde sıkça rastlanan kavram yanılgıları dikkate alınarak, öğrencinin öğrenme sürecine aktif biçimde katılımını merkeze alan bir yaklaşım benimsenmiştir. Geliştirilen eğitsel oyunun, öğrencilerin fen bilimleri dersine yönelik ilgisini ve motivasyonunu

artıracağı; sürat ve hız kavramlarını somutlaştırarak anlamalarını kolaylaştıracağı ve mevcut kavram yanılgılarının giderilmesine katkı sağlayacağı düşünülmektedir.

Bu çalışma kapsamında geliştirilen oyun, öğrencilerin sürat ve hız kavramlarını deneyimleyerek anlamalarını destekleyen bir başlangıç etkinliği olarak tasarlanmıştır. Oyun temelli öğrenme, özellikle ilköğretim düzeyindeki çocuklarda soyut kavramların somutlaştırılmasına katkı sağladığı için öğrenme sürecine doğal bir motive edici unsur eklemektedir. Çocukların hareket ederek, deneme-yanılma yoluyla ve akranlarıyla etkileşim içinde öğrenmesi, sürat ile hız arasındaki farkı sezgisel olarak kavramalarını kolaylaştırmıştır. Bu durum, eğitsel oyunların bilimsel kavramların anlaşılmasına katkı sağladığını bildiren araştırmalarla da uyumludur (Can & Yıldırım, 2017).

Bu kavramsal katkıların yanı sıra, oyunda kullanılan hız temelli mekaniklerin öğrencilerin bilişsel ve psikomotor becerilerini de destekleyebileceği değerlendirilmektedir. Literatür incelemelerine göre hız ve sürat odaklı oyun dinamikleri, öğrencilerin tepki verme becerilerini, karar alma hızlarını ve hareket kontrolünü geliştirme potansiyeline sahiptir (Demirbaş, 2019). Anlık olarak değişen durumlara uyum gerektiren oyun yapılarının, öğrencilerin refleks gelişimine ve zaman baskısı altında hızlı karar verebilme becerilerine katkı sağlayabileceği belirtilmektedir (Sürer, Yılmaz & Aksoy, 2021). Ayrıca görsel geri bildirimlerin ve akıcı oyun yapısının, çocukların oyuna yönelik ilgisini artırarak öğrenme sürecine olumlu yansıyabileceği literatür tarafından desteklenmektedir. Bu bulgular, hız ve sürat kavramlarının oyun tasarımındaki işlevsel rolüne yönelik teorik tartışmalarla da ilişkilidir. Oyun tasarımında hız ve sürat kavramlarının ele alınışı, oyuncu deneyimini yapılandıran temel unsurlardan biridir. Hız unsuru, çoğu oyunda oyuncunun reflekslerini, strateji kurma becerilerini ve karar verme hızını sınayan bir mekanizma olarak öne çıkmaktadır. Bu bağlamda oyun mekaniği ile oyuncu arasındaki etkileşim, deneyimin niteliğini belirleyen kritik bir etmen hâline gelmektedir (Demirbaş, 2019). Dolayısıyla hız ve sürat mekaniklerinin oyunun türüne göre farklı biçimlerde yapılandırılması gerekmektedir.

Sonuç olarak, geliştirilen eğitsel oyun yalnızca soyut kavramların somutlaştırılmasını sağlayan bir öğretim aracı olmakla kalmayıp, öğrenme sürecine öğrenci katılımını artıran ve motivasyonu destekleyen etkili bir materyal olarak değerlendirilebilir. Özellikle fen bilimleri gibi kavramsal yoğunluğa sahip derslerde eğitsel oyunların hem akademik başarıyı hem de derse yönelik olumlu tutumu desteklediği çeşitli araştırmalarla ortaya konmuştur (Ivgin & Akçay, 2020). Bu bulgular doğrultusunda, geliştirilen oyun tasarımının hem kavram öğretimi hem de öğrenme motivasyonu açısından güçlü bir temel sunduğu söylenebilir. Gelecekte yapılacak çalışmaların, farklı yaş gruplarında uygulanarak uzun vadeli öğrenme çıktılarının incelenmesi yararlı olacaktır. Ayrıca, farklı yaş gruplarında oyunun etkililiğini inceleyen çalışmalar yapılması, oyunun uzun vadeli öğrenme kalıcılığına etkisinin araştırılması, tasarımın dijital ortama uyarlanarak etkileşim düzeyinin karşılaştırılması, oyun içi geri bildirim türlerinin öğrenme çıktıları üzerindeki etkisinin incelenmesi, oyunun farklı fen konularına uyarlanabilirliğinin değerlendirilmesi, büyük örneklem gruplarıyla nicel etki analizlerinin yapılması ve öğretmen görüşleri doğrultusunda oyunun sınıf içi uygulanabilirliğinin test edilmesi gibi öneriler ileride benzer çalışma yapacaklara ufuk açabilir.

KAYNAKÇA

Aytekin, H. (2001). *Okul öncesi eğitim programları içinde oyunun çocuğun gelişimine olan etkileri*. Yüksek Lisans Tezi, Dumlupınar Üniversitesi Sosyal Bilimler Enstitüsü, Kütahya.

Balbağ, M.Z. (2018). Fen bilgisi öğretmen adaylarının hız ve sürat kavramlarına ilişkin bilişsel yapıları: kelime ilişkilendirme testi (kit) uygulaması. *Dicle Üniversitesi Ziya Gökalp Eğitim Fakültesi Dergisi, (*33), 38-47. https://doi.org/10.14582/DUZGEF.1875

Büyüköztürk, Ş., Kılıç Çakmak, E., Akgün, Ö.E., Karadeniz, Ş. & Demirel, F. (2016). *Bilimsel araştırma yöntemleri.* Ankara: Pegem Akademi.

Demirbaş, A. (2019). Oyun temelli öğrenmenin bilişsel süreçlere etkisi. *Eğitim ve Teknoloji Dergisi, 5*(2), 45–60.

Ivgin, A. B., & Akçay, H. (2024). The Impact of Using Educational and Digital Games on Middle School Students' Science Achievement. *International Journal of Technology in Education, 7*(3), 386–416.

Kaytez, N. & Durualp, E. (2014). Türkiye'de okul öncesinde oyun ile ilgili yapılan lisansüstü tezlerin incelenmesi. *Uluslararası Türk Eğitim Bilimleri Dergisi, 2*(2), 110-122.

MEB (Millî Eğitim Bakanlığı) (2024). *Fen bilimleri dersi öğretim programı (öğretim programı 3,4,5,6,7 ve 8. sınıflar).* Ankara: MEB Yayınları.

Özgürlük, B., Ozarkan, H. B., Arıcı, Ö., & Taş, U. E. (2015). *PISA 2015 ulusal raporu*. Ankara: M.E.B. Ölçme, Değerlendirme ve Sınav Hizmetleri Genel Müdürlüğü.

Özmen, H. & Karamustafaoğlu, O. (2019). *Eğitimde araştırma yöntemleri.* Ankara: Pegem Akademi.

Palmer, D.H. (1999). Exploring the between students' scientific and nonscientific conceptions. *Science Education, 83*,639-653. http://dx.doi.org/10.1002/(SICI)1098-237X(199911)

Sürer, M., Yılmaz, G. & Aksoy, T. (2021). Dijital oyunlarda hız, tepki süresi ve performans ilişkisi. *Bilgisayar ve Eğitim Araştırmaları Dergisi, 9*(1), 25–39.

Yazıcıoğlu, S. ve Çavuş-Güngören, S. (2019). Oyun temelli etkinliklerin ortaokul öğrencilerinin fen öğrenmesine olan etkisini başarı, motivasyon, tutum ve cinsiyet değişkenlerine göre incelenmesi. *Necatibey Eğitim Fakültesi Elektronik Fen ve Matematik Eğitimi Dergisi, 13*(1), 389-413. http://doi.org/10.17522/balikesirnef.584673

Can, S., & Yıldırım, M. (2017). Eğitsel oyunlarla fen dersine 'var mısın yok musun'? *Atatürk Üniversitesi Kazım Karabekir Eğitim Fakültesi Dergisi,* (35), 14-30.

Yıldız, A., Büyükkasap, E., Erkol, M., & Dikel, S. (2007). Fen bilgisi öğrencilerinin, hız, sabit hız, sürat ve yer değiştirme kavramlarını anlama düzeyleri. *Erzincan Eğitim Fakültesi Dergisi*, *9*(2), 1-12.

Young, H. D., & Freeman, R. A. (2008). *Sears and Zemansk's university physics with modern physics*, 12th Edition, Pearson Addison Wesley.

STRUCTURAL PERFORMANCE OF A 40-TON TRAVERSE: STATIC ANALYSIS RESULTS AND SAFETY ASSESSMENT

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ABSTRACT

The aim of this study is to design a 40-ton Safe Working Load (SWL) lifting traverse (spreader beam) for use at Tersan Shipyard and to evaluate the structural safety of this design by performing static analyses using the finite element method (FEM). The traverse was modeled at full scale in the 3D CAD software Rhinoceros, and static analyses were carried out on the modeled geometry using Rhinoceros' Scan&Solve finite element solver. Appropriate material properties were defined, boundary conditions (points of restraint) were specified, and the 40-ton load was applied to the structure under two different loading scenarios. In the first loading scenario the maximum von Mises stress is 1.99×10^2MPa and the maximum displacement is 4.86mm; in the second loading scenario the maximum von Mises stress is 2.16×10^2MPa and the maximum displacement is 3.49mm. The resulting stress and displacement values are reported, and the final safety assessment of the structure is made by comparing these values with the mechanical properties of the selected material and the applicable safety criteria.

***Keywords**: Spreader beam (lifting traverse), Finite element method (FEM), Static analysis, St37/St52 structural steel*

1. INTRODUCTION

The lifting traverse is an auxiliary lifting device used together with cranes, gantry cranes or similar lifting equipment to enable the balanced and safe hoisting of heavy or bulky loads. It is typically manufactured from high-strength materials such as steel and allows the operator to attach the load at multiple points, securing and controlling its movement. Traverses can be produced in various shapes and sizes depending on the load geometry, weight and lifting requirements.

Lifting traverses have a wide range of applications, from heavy industrial plants and shipyards to logistics centers and the construction sector. They are especially used for transporting long, large or delicate components and loads that cannot be handled by a single crane—often moved with the assistance of two cranes (for example, steel girders, containers, wind-turbine blades, and machine parts). Therefore, when designing a traverse, criteria such as the load's weight and shape, the locations of lifting points, the capacity of the crane(s) to be used, and the working environment must be analyzed carefully.

One of the main advantages of lifting traverses is that they reduce localized stresses on the load and minimize the risk of deformation. When lifted from a single point, a load may experience bending, buckling or structural damage; a traverse prevents these issues by enabling a balanced lift from multiple points. In addition, traverses maintain the angle of slings or chains attached to the crane hook, thereby improving the safety of the lifting operation.

To distribute the tensile/compressive force from the crane equally and in a controlled manner to multiple points of the load. Thus, bending, flexure or deformation that would occur from suspending the load from a single connection point is prevented. Long or delicate components such as ship blocks, modules, engines, or propeller shafts can be damaged if lifted from a single point; a spreader/traverse carries these parts in a balanced manner. By using multiple slings/ropes, it enables the load to be held at the desired angle or position and assists in achieving correct alignment during assembly. It reduces stress on the load and prevents excessive localized stresses; by design, spreader beams/traverses are certified for SWL (Safe Working Load) in accordance with relevant standards [1][2][3]. Therefore, the SWL value of every designed traverse must be explicitly defined; separate SWL tables and labels should be provided for each configuration and detail, the manufacturer must perform a proof-load test, and service standards and user instructions must be supplied together with the test reports.

Types of lifting traverses

Traverses are classified into various types according to their construction and intended use. Five types are examined in this study.

1.1.1. Fixed Spreader Beam

Beams with a fixed length and attachment points. They are simple in construction and low cost. Suitable for lifting applications where loads have fixed dimensions.

1.1.2. Adjustable Spreader Beam

Beams with adjustable suspension points or arms. They provide flexibility for lifting loads of different sizes and weights. More complex but versatile.

1.1.3. Telescopic Spreader

Can extend and retract using mechanical or hydraulic systems. Used especially in shipbuilding and the power sector for lifting long components.

1.1.4. Lifting Frame

Typically has four or more suspension points. Provides support from four corners; used for lifting box-type loads such as containers and generators.

1.1.5. C-Hook Spreader

Used for lifting coiled, rolled or cable-type rotating loads. Allows side-loading of the load.

2. DESIGN STUDIES

Main Constraints and Challenges in this Design

There are specific and significant constraints and challenges in traverse design. These include low stiffness or capacity, wear and jamming in guide/shaft mechanisms, fatigue and local stresses at connection regions, dynamic impacts, eccentricity and imbalance, among other effects. These issues should be prioritized and both mechanical and operational countermeasures implemented.
For this purpose, the design should be performed within the applicable standards considering measures such as: separate SWL tables for each configuration, sizing or extension limits according to worst-case scenarios, redundant (dual) mechanical locks/manual safety latches, position pins, sufficient bearing length, surface hardening, fillets and radii, load cell/balancing according to span range, equalizing bars or adjustable attachment points, etc. [1][4][5].

Material Selection and Design

ST37 and ST52 structural steels, commonly used in shipbuilding, are used as materials in the analysis. These steels are selected for this design due to their high ductility.

The mechanical properties of the materials used are presented below in Tables 1 and 2.

Table-1. Mechanical values of St37 material

Materia used	St37
Density	7.8E-09 $\frac{(Mg}{mm^3)}$
Poisson ratio	0.3
Tensile yield strength	241.68 (MPa)
Elastic modulus	200000 (MPa)

Table-2. Mechanical values of St52 material

Materia used	St52
Density	7.85E-09 $\frac{(Mg}{mm^3)}$
Poisson ratio	0.3
Tensile yield strength	355 (MPa)
Elastic modulus	210000 (MPa)

Within the scope of this study, the traverse designed is an adjustable lifting beam. The implemented design is presented in Figure 1 below.

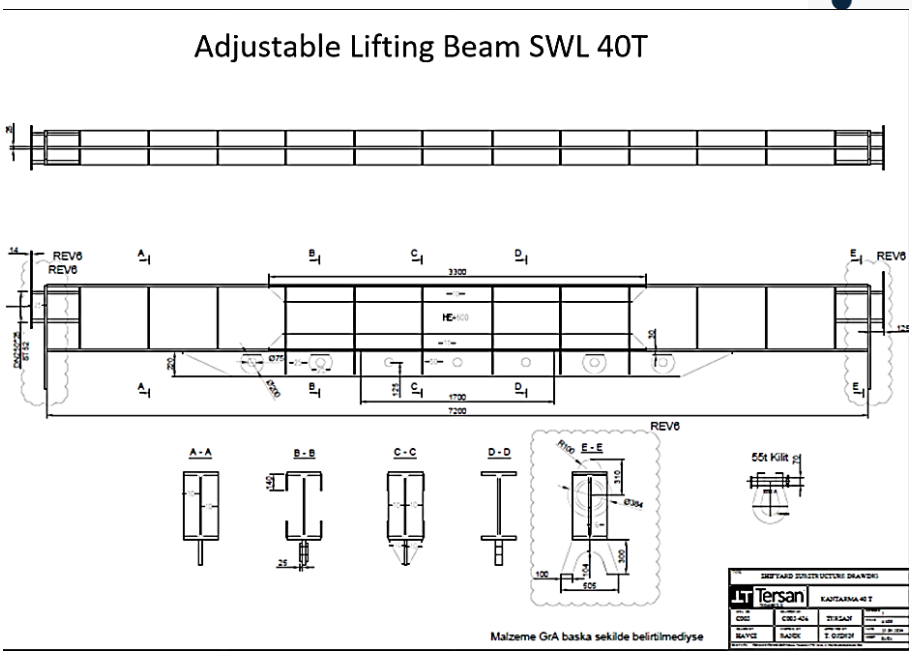

Figure 1. *Technical drawing of the adjustable lifting beam design.*

The adjustable lifting beam with a load carrying capacity of 40 tons, which is the subject of the study, is modeled in three dimensions in real size with the design software Rhinoceros.

The 3D modeled design is shared below in Figure 2.

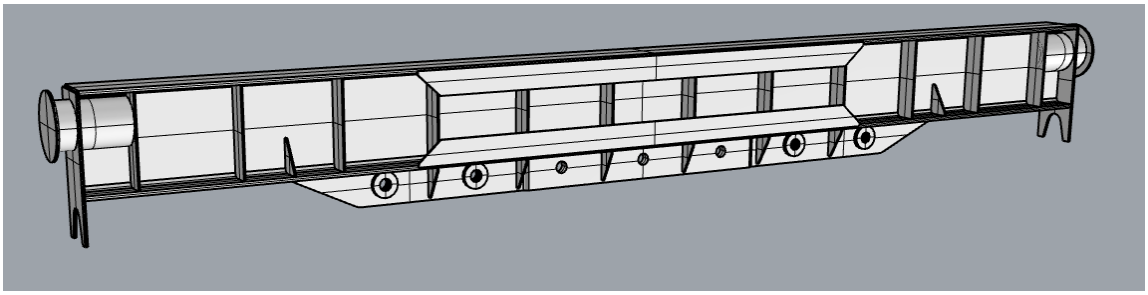

Figure 2. *3D modeled adjustable lifting beam*

St52 structural steel is selected for the areas where the lifting beam connects to the crane, while St37 structural steel is used for the remaining components. These two materials are shown in different colors in Figure 3 below.

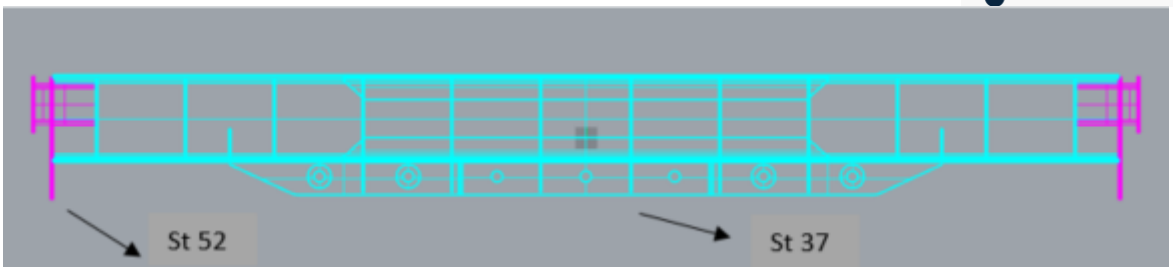

Figure 3. *Two different materials preferred*

The designed adjustable lifting beam has a span of 7200 mm. It is designed within the scope of EN ISO13001 (Cranes — General design — General principles and requirements) and EN 1993 (Design of steel structures) standards, and the design verification is evaluated and studied within the scope of EN 13557 (Cranes — Safety — Non fixed load lifting attachments) standard.

In the design of the adjustable lifting beam, an allowable displacement limit for the component is specified; due to the vibration sensitivity required for this study, an L/600 limit is adopted.

In this study, static analyses are conducted using the finite element method (FEM) to assess the structural strength of a 40-ton SWL lifting beam model in the Rhinoceros environment.

3. DESIGN VERIFICATION STUDIES

Static Analysis

Static analysis is a widely used method in many industries; aviation, robotics, vehicles, construction, machinery and shipbuilding that examines the effects of applied loads or external actions on a structure's behavior and evaluates whether the design is safe. Therefore, static analyses are performed under predefined loading conditions to determine the safety of structures to be built.

The design of the 40-ton SWL lifting traverse discussed in this study is evaluated through static analysis using the finite element method (FEM). The analyses are performed using the Scan&Solve finite element module of Rhinoceros software, which provides reliable solutions to engineering problems.

Within the scope of the study, two primary loading conditions are defined on the design geometry. The behavior of the lifting beam under different loading scenarios corresponding to these two conditions is investigated. The objective of the analysis is to quantitatively determine the structural displacements and the stresses induced by gravity and external loads.

As performance acceptance criteria, it is required that the maximum von Mises stress remain below the yield strength of the respective materials when an appropriate safety factor is applied, that displacement values stay within functional limits, and that bearing stresses in critical pin/hole regions remain at acceptable levels [6,7,8]. After completing the design and material selection, the boundary conditions where the structure will be fixed and the magnitudes and directions of the applied forces are defined [9]. The defined conditions are described below.

Loading Condition-1:

In the first loading condition, a symmetric case is intended to be simulated in which a 40-ton load is suspended at the midpoint of the beam and is transmitted evenly to both ends of the beam. This condition is shown in Figure 4 below.

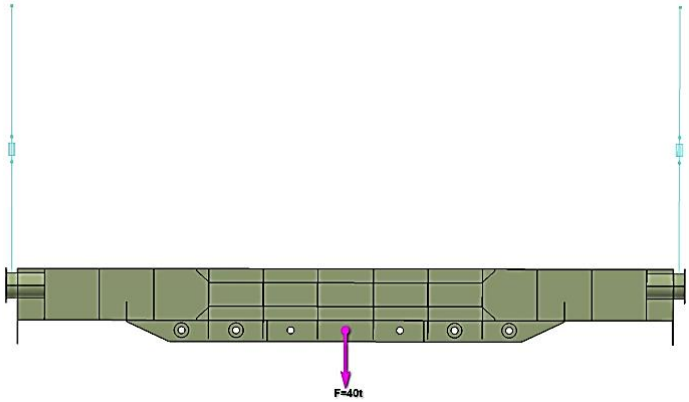

Figure 4. *Loading condition -1*

Loading Condition-2:

The second loading condition is aimed at simulating asymmetric loading scenarios for the 40-ton load. In this scenario, the load is concentrated more on one side, representing an unbalanced lifting condition. This case is shown in Figure 5 below.

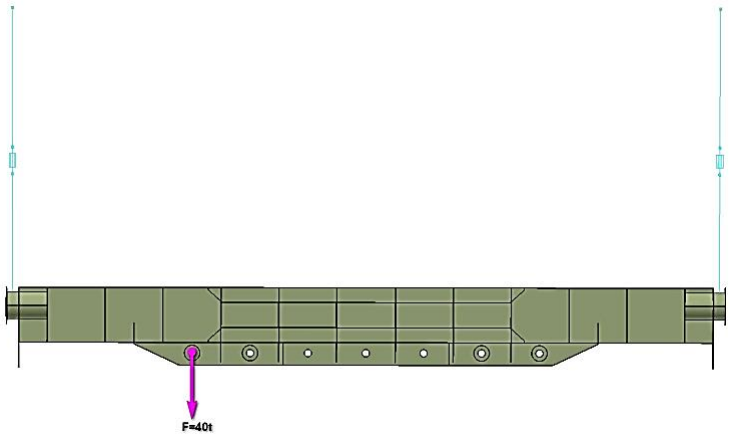

Figure 5. *Loading condition -2*

4. ANALYSIS RESULTS OF THE STUDY

The study provides a practical analysis framework to evaluate the strength and deformation performance of the lifting beam under static and axial loading. The work is carried out to investigate the static behavior of the designed beam under two primary loading configurations [9,10].

Static analyses under the defined load transfer and boundary conditions are performed using the finite element method (FEM). The Rhinoceros Scan&Solve module is employed for the analyses; this tool facilitates largely automated preprocessing (including meshing and simplification) and permits running stability and deformation analyses on multiple solids, extrusions and meshes with minimal manual pre-processing. In the present study, a 40-ton load is applied to the structure in two different loading conditions, and the resulting maximum von Mises stress and maximum displacement values are obtained [11,12].

Examining Loading Condition-1

In the first loading condition, a symmetric scenario is modelled in which the total 40-ton load is applied equally to the two ends of the beam. Consequently, each end is subjected to a 20-ton force, producing stress distributions and structural deformations along the beam. The analysis results showed stress concentrations primarily at the load application points and at welded joint regions; the maximum equivalent von Mises stress is 199MPa and the maximum deformation (displacement) is 4.86 mm. The details of the analysis results are presented in Figures 6 and 7 below.

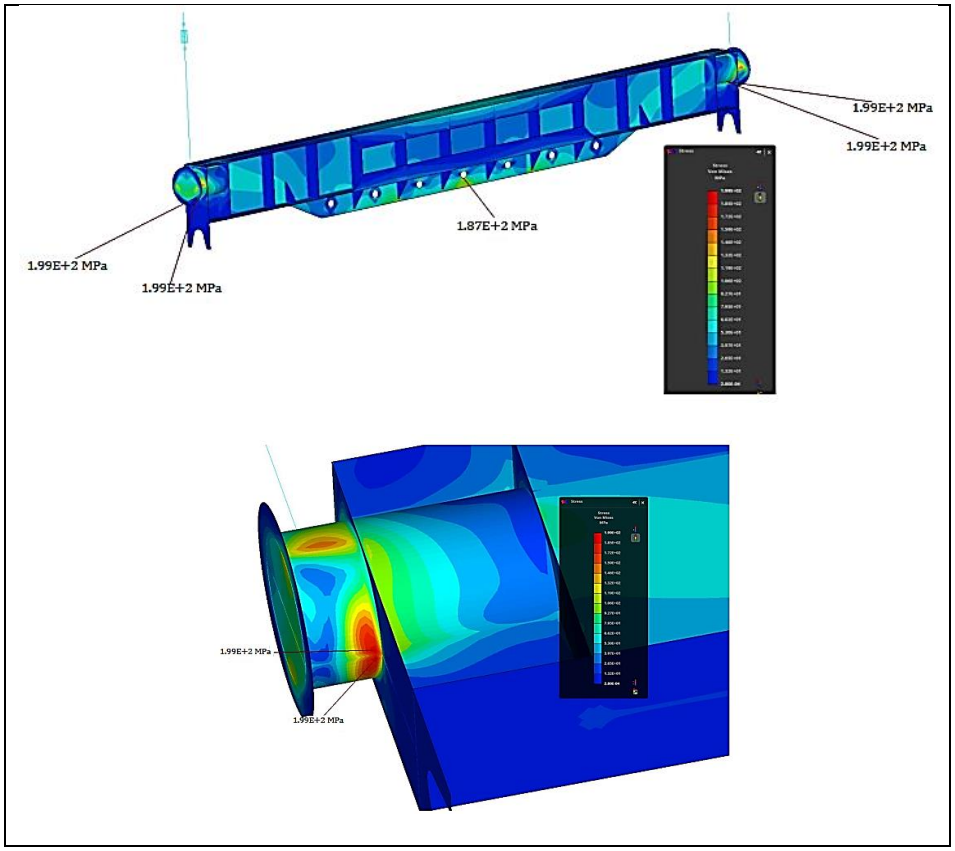

Figure 6. *Stress for loading condition-1*

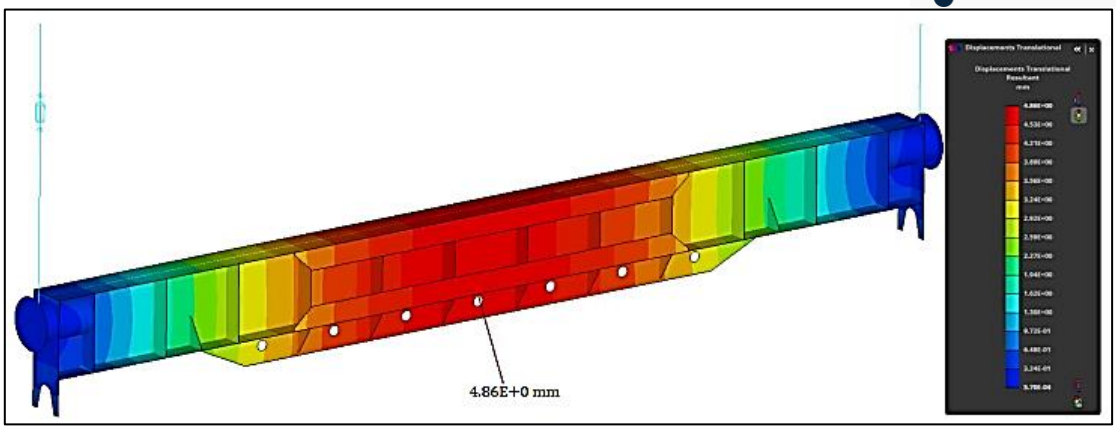

Figure 7. *Displacement obtained for Loading Condition-1*

Examining Loading Condition-2

The second loading condition represents an asymmetric loading scenario; in this case the 40-ton load is concentrated on one side (an unbalanced lift). Under this loading, stress concentrations occur at the loaded end and connection regions, and the maximum equivalent von Mises stress is determined to be 216MPa (Figure 8). The maximum deformation of the structure is found to be 3.49mm. The analysis details are presented in Figures 8 and 9 below.

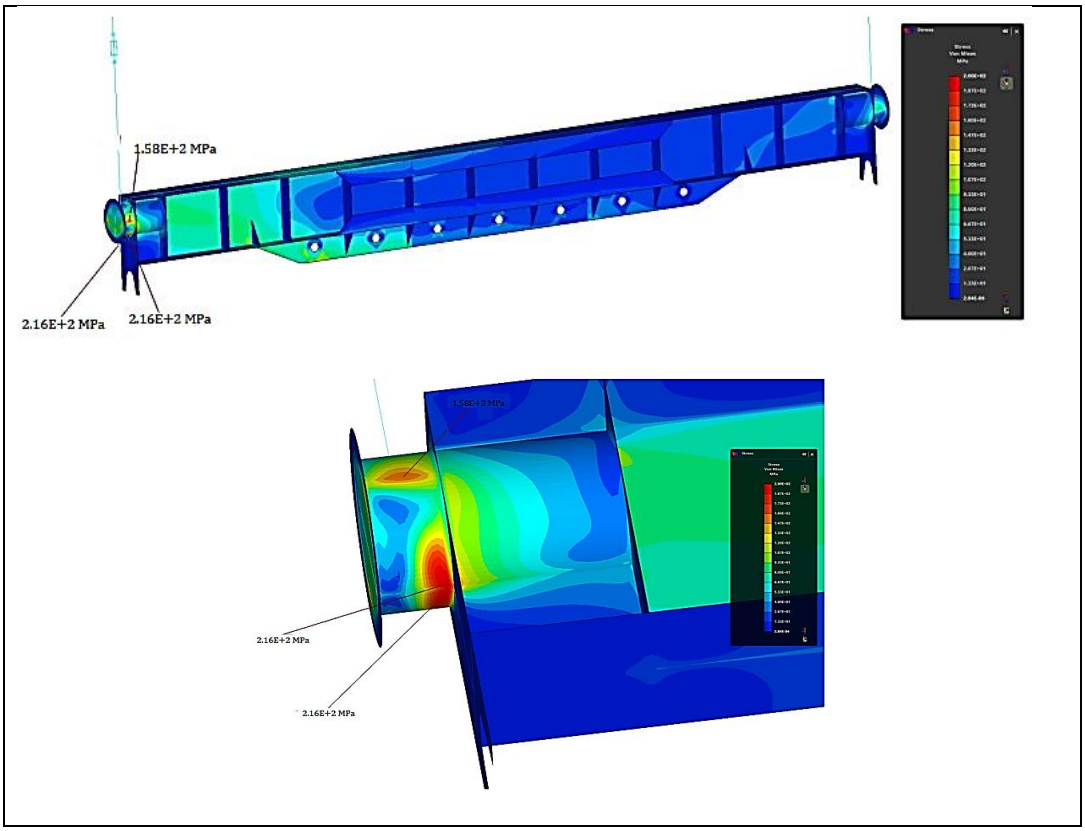

Figure 7. *Stress for loading condition-2*

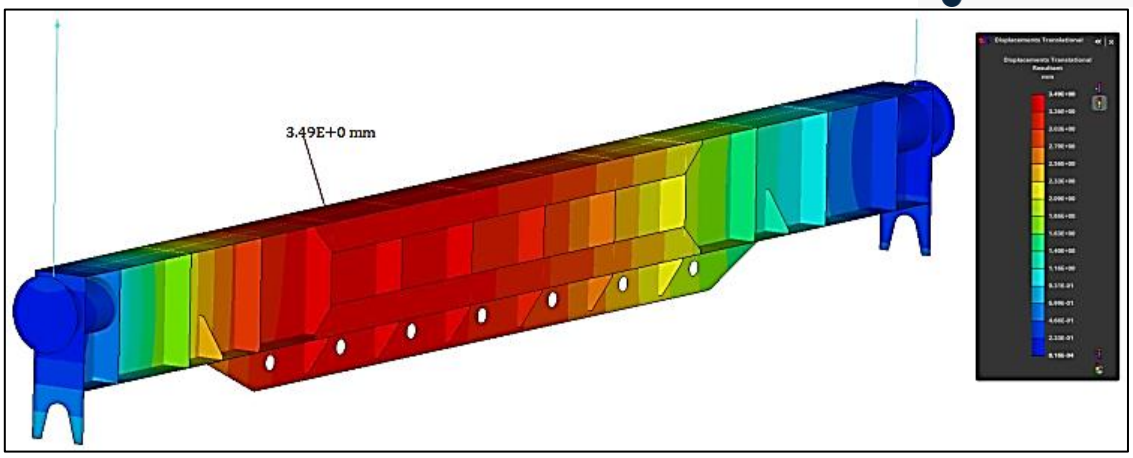

Figure 7. *Displacement obtained for Loading Condition-2*

he results obtained in this study present the maximum von Mises stresses and maximum displacements for the two loading configurations of the lifting beam, and they provide input for guiding safety and design decisions.

5. CONCLUSION

The purpose of the force calculations and finite element analyses conducted in this work is to evaluate whether the designed lifting beam with a 40 t SWL capacity is safe. For the structure to be considered safe, the calculated maximum stress values must be lower than the yield strength of the materials used. The analysis results indicate that maximum stresses are concentrated in regions where the crane and connection elements are attached, which are made from ST52; the yield strength used for ST52 is taken as 355MPa. The obtained maximum von Mises stresses are 1.99E+002MPa (symmetric loading) and 2.16E+002MPa (asymmetric loading), respectively; both values are below the yield strength of ST52. Consequently, the structural strength of the beam under the considered static loading scenarios is judged to be adequate. The maximum deformations are found to be 4.86mm and 3.49mm. Since the safety displacement limit is 12mm, the values obtained as a result of the analysis are within the accepted safety limit since they are below the limit value.

According to the analysis results, the beam remains below the yield stress for the two principal loading conditions considered and therefore meets static lifting safety requirements in this context. The resulting safety factors (yield strength / maximum stress) are approximately 1.78 (for 1.99E+002MPa) and 1.64 (for 2.16E+002MPa); although these values are favorable for a basic static assessment, they may not be sufficient alone for the final safety verification of the design [13,14,15,16]. In particular, given that stresses concentrate at welded joints and load application points, the following additional evaluations are recommended:

- Review of weld details and local geometric transitions; improve weld design or add reinforcements where necessary [16,17].

- Perform fatigue analyses to more comprehensively assess material safety (especially if the structure will experience repeated loading or vibration) [18].

- Conduct additional analyses for dynamic effects, impact loads and possible collision scenarios.

- Improve analysis fidelity by locally refining the mesh, modelling connection details in greater detail, and, if required, performing experimental validation tests (prototype testing).

6. REFERENCES

[1] European Committee for Standardization. (2009). EN 13155:2003 + A2:2009 — Cranes — Safety — Non-fixed load lifting attachments. CEN.

[2] European Committee for Standardization. (2015). EN 13001-1:2015 — Cranes — General design — General principles and requirements. CEN.

[3] European Committee for Standardization. (2005). EN 1993-1-1:2005 — Eurocode 3: Design of steel structures — General rules and rules for buildings. CEN.

[4] American Society of Mechanical Engineers. (2014). ASME BTH-1-2014: Design of Below-the-Hook Lifting Devices. ASME.

[5] Health and Safety Executive. (1998). Lifting Operations and Lifting Equipment Regulations 1998 (LOLER). HSE

[6] Genç, İ.,(2007), "Designing and Analysis Phases of Four Elements (Master's Thesis)", Atatürk Üniversitesi

[7] Young, W. C., Roark, R. J., & Budynas, R. G. (2011). Roark's Formulas for Stress and Strain (7th ed.). McGraw-Hill.

[8] Timoshenko, S. P., & Gere, J. M. (1961). Theory of Elastic Stability. McGraw-Hill.

[9] Brush, D. O., & Almroth, B. O. (1975). Buckling of Bars, Plates, and Shells. McGraw-Hill.

[10] The Steel Construction Institute. (2010). Steel Designer's Manual (5th ed.). Wiley-Blackwell.

[11] Zienkiewicz, O. C., & Taylor, R. L. (2000). The Finite Element Method (5th ed.). Butterworth-Heinemann.

[12] Bathe, K. J. (1996). Finite Element Procedures. Prentice Hall.

[13] American Welding Society. (2015). AWS D1.1/D1.1M:2015 — Structural Welding Code — Steel. AWS.

[14] International Institute of Welding. (2016). IIW Recommendations for Fatigue Design of Welded Joints and Components (2nd ed.). IIW.

[15] Suresh, S. (1998). Fatigue of Materials. Cambridge University Press.

[16] Stephens, R. I., Fatemi, A., Stephens, R. R., & Fuchs, H. O. (2000). Metal Fatigue in Engineering (2nd ed.). John Wiley & Sons.

[17] The Steel Construction Institute. (2010). Steel Designer's Manual (5th ed.). Wiley-Blackwell.

[18] Roark, W. C., Young, W. C., & Budynas, R. G. (2011). Roark's Formulas for Stress and Strain (7th ed.). McGraw-Hill.

SAFE DRIVING IN LOGISTICS AND THE DESIGN OF A GPS-BASED RISK-ORIENTED WARNING SYSTEM

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Abstract

Safe driving in the logistics sector is a critical process that encompasses the technical and behavioral rules to be applied during driving in order to protect vehicles, drivers, and the cargo being transported. This study addresses an advanced warning system developed to enhance driving safety using GPS-based location data. The system analyzes vehicles' stopping behavior in real time by polygon-based designation of risky areas, safe stopping zones, and customer locations, and automatically sends notifications to relevant units according to the assessed risk level. Moving beyond basic location tracking offered by GPS service providers, an integrated monitoring approach that enhances operational safety is proposed.

As a result of implementing the developed system, vehicle-tracking processes became automated and drivers' stopping behaviors were standardized, transforming into a more orderly operational model. In addition, by classifying risky areas using spatial data and continuously monitoring stopping durations, the level of operational control increased significantly. These improvements contributed both to increased efficiency in logistics processes and to a marked improvement in customer satisfaction.

Keywords: Safe driving, GPS, risk analysis, logistics management, notification systems.

1. Introduction

Ensuring uninterrupted, safe, and efficient logistics operations depends on the systematic provision of driving safety. Safe driving is not only about complying with traffic rules; it also encompasses multidimensional components such as regular vehicle maintenance, proper transportation of the cargo, the driver adopting a defensive driving approach, and the effective use of technological support systems. According to studies, globally about 75% of transportation accidents are caused by human errors, and in Turkey, 88% of road transport accidents are caused by driver errors (Emniyet Genel Müdürlüğü,

2024; World Health Organization [WHO], 2023). These data clearly reveal the decisive role of the human factor in logistics safety.

In recent years, digital solutions such as GPS-based tracking systems, IoT (Internet of Things) sensors, AI-supported driver behavior analysis systems, and semi-autonomous driving technologies have emerged as innovative tools to enhance driving safety. These technologies increase the effectiveness of risk-based warning systems by collecting and analyzing real-time data to evaluate variables such as speed, braking, steering, and fatigue (Lee et al., 2021; Zhang & Wang, 2020; Miller&Johnson,2019; Chen&Lee,2021).

Theoretically, a "risk-based approach" is a proactive model in safety management aimed at identifying hazards before they occur and taking preventive measures (Hale&Borys, 2013; Zang&Wang,2020). Correspondingly, the concept of "predictive maintenance" aims to detect potential faults in advance by monitoring vehicle performance data via sensors (Jardine et al., 2006; Zang&Wang,2020;European Logistics Association,2022). The integration of these two concepts contributes to the systematic management of risks in the logistics sector and to enhancing operational continuity.

Moreover, safe driving not only prevents accidents but also serves to reduce carbon emissions by increasing fuel efficiency. Balanced speed management, avoidance of abrupt braking, and route optimization contribute to reducing environmental impacts within sustainable logistics practices (European Environment Agency [EEA], 2022). Thus, safe driving holds strategic importance for both human safety and environmental sustainability.

2. METHOD USED

In this study, a system is designed to analyze vehicle stoppage, route, and risk-area behaviors using location and speed data obtained from a GPS service provider. The method consists of three main stages:

2.1. Classification of locations and polygon definitions

Locations such as customer facilities, transfer centers, fuel stations, rest areas, and similar safe zones are defined on the map in polygon form. Likewise, risk points identified by security units and areas where stopping is not allowed are categorized and fed into the system.

Below, polygon-based location boundary visualization and technical polygon map diagram examples are shared in Figures 1 and 2.

Figure 1. Example polygon-based location boundary image.

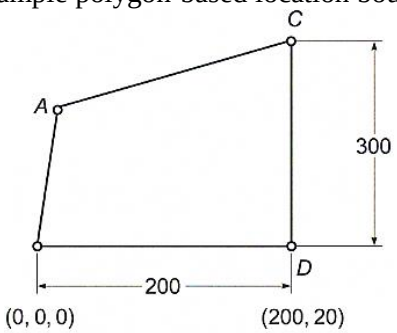

Figure 2. Technical CAD diagram of polygon ABCD

2.2. Processing Real-Time GPS Data

Latitude, longitude, and speed data from vehicles at specific intervals were stored on SQL Server; each data point was matched with defined fields using geometry and polygon algorithms. When the vehicle speed was zero, the data was interpreted as a stop, and the risk level of the stopped point was automatically analyzed. A sample data snapshot of the locations defined in the system database is shared in Table 1 below.

Table 1. Sample data view of locations defined in the system database.

	GPS_AREA_ID	AREA_NAME	AREA_TYPE	AREA_FULL_NAME	COORDINATES	USER_ID	INSERT_DATE	UPDUSER_ID	UPDATE_DA
1	16		Su	S	(40.70 28683 29.861	901,40.70904170056...	1	2025-01-29 11:20:00.000	1	2025-01-29 1
2	17		Su	C	(40.72 55968 29.843	8695,40.7215467866...	1	2025-01-29 11:20:00.000	1	2025-01-29 1
3	18		Su	F	(40.70 77691 29.862	247,40.70622555322...	1	2025-01-29 11:20:00.000	1	2025-01-29 1
4	19		Su	B	(40.71 29748 29.856	5311,40.7097374696...	1	2025-01-29 11:20:00.000	1	2025-01-29 1
5	20		Su	Y	(40.71 76828 29.855	3487,40.7160166579...	1	2025-01-29 11:20:00.000	1	2025-01-29 1
6	21		Su	F	(40.72 50553 29.843	7325,40.7238916673...	1	2025-01-29 11:20:00.000	1	2025-01-29 1
7	22		Su	S	(40.70 62017 29.859	3986,40.7089674397...	1	2025-01-29 11:20:00.000	1	2025-01-29 1
8	23		Su	M	(40.71 53907 29.867	5995,40.7127731431...	1	2025-01-29 11:20:00.000	1	2025-01-29 1
9	24		Pa	F	(40.71 86988 29.854	1486,40.7187926514...	1	2025-01-29 11:20:00.000	1	2025-01-29 1
10	26		TI	C	(40.71 36944 29.866	4919,40.7188007424...	1	2025-01-30 11:15:00.000	1	2025-01-30 1
11	27		Pa	F	(40.71 65681 29.855	4053,40.7188317754...	1	2025-01-30 11:17:00.000	1	2025-01-30 1
12	30		Pa	F	(40.71 86119 29.861	9722,40.7188494677...	1	2025-01-30 13:36:00.000	1	2025-01-30 1

An example showing the last known location of a vehicle on the road is shared in Figure 3.

Figure 3. Last known location of the vehicle on the road

2.3. Risk-Based Notification Mechanism

The system informs the relevant customer or facility manager in case of stops at defined locations, and first the vehicle supervisor and then the security department in case of waits in risky areas. It is configured to use SMS notifications at high risk levels and email notifications at medium and low risk levels.

3. ALGORITHMS TESTED

3.1. Data acquisition and preprocessing

It is used to clean, align, and convert raw sensor/GPS/telemetry data into a format suitable for modeling. It provides the basis for feature extraction.

Sensor fusion and filtering: Kalman filter, particle filter (for aligning GPS/IMU/OBD data and reducing noise)

Signal processing: Low-pass filters, motion segmentation (for sudden acceleration/jamming support)

Missing data filling/cleaning: k-NN imputation, MICE (to correct missing records)

Map-matching and time synchronization

3.2. Risk assessment & feature Engineering

It determines risk levels based on location or driving behavior; it is used to classify events such as stopping, accelerating, and braking as risky/normal.

Clustering: DBSCAN, K-means (for grouping risky areas or similar driving patterns)

Statistical/rule-based scores: Weighted risk scores, kernel density estimation (thermal map) (to identify hotspots)

Dimensionality reduction/feature selection: PCA, mutual information (to select the most meaningful indicators)

3.3. Prediction, anomaly detection & intervention

Early prediction of risky events, automatic detection of anomalies, and real-time warning/operational response have been researched and studied. This will shorten response time, improving performance and customer satisfaction. Furthermore, it will ensure that outputs consistent with the results in the document are obtained.

Supervised classification: Random Forest, XGBoost, SVM, logistic regression (for classifying driver behavior (aggressive/normal))

Time series/sequence models: LSTM, GRU, Hidden Markov Models (for predicting future risky events or vehicle failures)

Anomaly detection: Isolation Forest, autoencoder-based approaches, change-point detection (for automatic notification of unexpected behaviors/events)

Rotation/optimization: Dijkstra, A*, genetic algorithms or optimization libraries (for dynamic route and response planning)

Predictive maintenance: Remaining Useful Life (RUL) models, survival analysis, regression-based models.

4. SYSTEM DESIGN

The system is designed not just to display location information from GPS data, but as a decision-making mechanism that interprets this data. In this study;

- Vehicle locations are instantly identified by comparing defined polygon areas with vehicle locations.
- For stops in undefined areas, the system automatically creates a risk analysis and detects patterns by examining past vehicle movements.
- If the stop duration exceeds the limits defined in the system, a notification stream is triggered to investigate the cause of the delay.
- Thanks to the algorithms built on SQL Server, evaluation is performed at the moment the data is processed without the need for an additional application.
- Alternatively, it has been evaluated that the same algorithms can be applied with MongoDB and Python-based open-source structures.

The designed system is a decision support mechanism that interprets GPS data not only as location information but also according to the operational context. The basic components of the system are summarized below;

- Polygon-location matching algorithm
- Defined/undefined area detection module
- Stop duration analysis engine
- Automatic risk assessment module
- Notification trigger stream

The GPS risk system diagram created in the study is shared below in Figure 4.

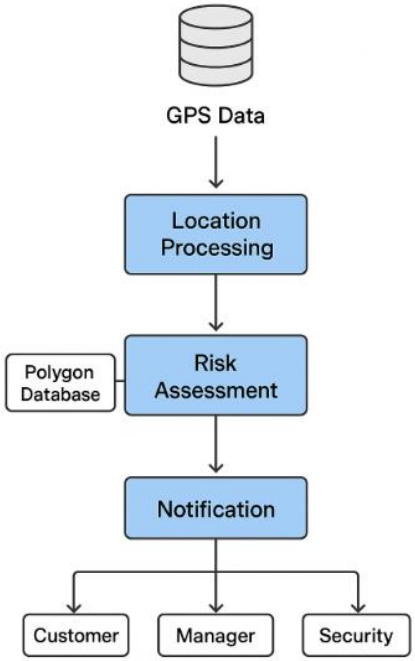

Figure 4. The generated GPS risk system diagram.

This design offers a fully automated, real-time security approach that is not dependent on monitoring users.

5. CONCLUSIONS

The results obtained in operations where the developed system was implemented can be summarized as follows:

- Vehicle tracking has become automated, eliminating user dependency.
- Driver stopping behavior has become more disciplined.
- Accurate classification of risky areas has been achieved.
- Intervention time in stopping timeouts has been shortened.
- Measurable increase in customer satisfaction has been achieved.

With the implementation of the system, vehicle tracking and driver management processes have significantly improved. Suggestions for future study;

- Machine learning-based driver behavior prediction
- Dynamic route-based risk scoring
- Integration of predictive analysis and anomaly detection models

The system has gone beyond being just a vehicle tracking solution and has become a risk-focused safety management tool for logistics companies. It is recommended that machine learning-based driver behavior prediction and route-based risk scoring be added as part of future work.

6. REFERENCES

[1] Emniyet Genel Müdürlüğü. (2024). Karayolu Trafik Kaza İstatistikleri Raporu 2024. Ankara: EGM Yayınları.

[2] European Environment Agency (EEA). (2022). Transport and environment report 2022: Reducing transport emissions. https://www.eea.europa.eu

[3] Hale, A., & Borys, D. (2013). Working to rule, or working safely? Part 2: The management of safety rules and procedures. Safety Science, 55, 222–231. https://doi.org/10.1016/j.ssci.2013.02.013

[4] Jardine, A. K. S., Lin, D., & Banjevic, D. (2006). A review on machinery diagnostics and prognostics implementing condition-based maintenance. Mechanical Systems and Signal Processing, 20(7), 1483–1510. https://doi.org/10.1016/j.ymssp.2005.09.012

[5] Lee, J., Bagheri, B., & Kao, H. A. (2021). A cyber-physical systems architecture for industry 4.0-based manufacturing systems. Manufacturing Letters, 3, 18–23. https://doi.org/10.1016/j.mfglet.2014.12.001

[6] World Health Organization (WHO). (2023). Global status report on road safety 2023. Geneva: WHO Press.

[7] Zhang, T., & Wang, X. (2020). Artificial intelligence applications in transportation systems: A review. Transportation Research Part C: Emerging Technologies, 114, 56–77. https://doi.org/10.1016/j.trc.2020.02.001

[8] Zhang, L., & Zhao, X. (2020). GPS-based fleet management systems: Optimization of routing and driver behavior. Journal of Transportation Technologies, 10(3), 215–229.

[9] Miller, T., & Johnson, P. (2019). Geofencing applications in logistics and supply chain monitoring. International Journal of Logistics Research, 22(4), 356–372.

[10] Chen, Y., & Lee, H. (2021). AI-driven driver behavior analysis for operational risk reduction. Transportation Data Science, 5(2), 112–128.

[11] European Logistics Association. (2022). Smart mobility and telematics in modern logistics operations. Brussels: ELA Publications.

RECENT APPROACHES IN SINGLE-LAP JOINTS: A SHORT REVIEW

TEK BİNDİRMELİ BAĞLANTILARDA SON YAKLAŞIMLAR: KISA BİR DERLEME

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ÖZET

Makine parçalarını ya da yapıları birleştirmek için kullanılan yapıştırma bağlantıları, kaynak ve cıvata-perçin bağlantılarına kıyasla daha uzun ömür, hafiflik ve farklı malzemelerin birleştirilmesine imkan vermektedir. Yapıştırma bağlantıları bu avantajlarından dolayı otomotiv, havacılık, gemi inşaatı gibi sektörlerde sıklıkla kullanılmaktadır. Yapıştırma bağlantıları içinde en çok kullanılan ve en basit birleştirme yöntemi olan tek bindirme bağlantıları (SLJ) araştırmacıların ilgi odağı olmayı sürdürmektedir. Fakat bu bağlantı türünde yaşanan gerilme yığılmaları, sınırlı kayma ve soyulma dayanımları, eksenel olmayan yükleme gibi durumlar bağlantının kullanımında yapısal sınırlılık oluşturmaktadır. Literatürde benzer ve farklı malzemelerle oluşturulan SLJ bağlantılarının performanslarının araştırılması ve geliştirilmesi için çeşitli yüzey işlemleri, nano ve mikro takviyeler, kısa ve uzun fiber demetleri, metal fiber ve plakalar, yapıştırıcının türü ve kalınlığı değişken olarak incelenmiştir. Çalışmalarda genellikle çekme testi gerçekleştirilerek yapıştırıcı bölgesindeki kayma gerilmesi hesaplanmıştır. Bunun yanı sıra üç nokta eğme ve düşük hızda darbe testleri ile bağlantının dayanımı ve rijit bir vurucuya karşı bağlantının cevabı incelenmektedir. Bu derleme bildirisinin amacı literatürde mevcut olan yapıştırıcı dayanımını arttırmaya yönelik çalışmaları bir araya getirerek araştırmacılara yeni çalışmaların gerçekleştirilebilmesi için ışık tutmaktır. İnceleme sonuçlarına göre metal takviye eklenmesi eğilme dayanımı ve kayma dayanımında sırasıyla yaklaşık %70 ve % 29 artışa neden olmuştur. Gerçekleştirilecek yeni çalışmalarda metal fiberlere uygulanacak yüzey işlemlerinin ve eklemeli imalat ile üretilen numunelerde metal takviyenin etkileri incelenmeyi bekleyen konular olarak dikkat çekmektedir.

Anahtar Kelimeler: Tek Bindirme Bağlantı (SLJ), Benzer ve Farklı Yapıştırılan Malzeme, Yapıştırıcı, Metal Takviye

ABSTRACT

Adhesively bonded joints, used to connect machine components or structural elements, offer longer service life, reduced weight, and compatibility with dissimilar materials compared with welded or bolted–riveted connections. Owing to these advantages, adhesive joints are widely employed in

industries such as automotive, aerospace, and shipbuilding. Among various adhesive joining configurations, the single-lap joint (SLJ) remains the most commonly used and structurally simplest type, continuing to attract significant research interest. However, stress concentrations, limited shear and peel strength, and eccentric loading inherent to this configuration introduce several constraints on its structural performance. In the literature, numerous studies have investigated and improved the performance of SLJ joints formed with similar or dissimilar materials by examining parameters such as surface treatments, nano- and micro-fillers, short and long fiber bundles, metallic fibers and plates, and variations in adhesive type and thickness. Most studies employ tensile testing to evaluate shear stresses within the adhesive layer, while three-point bending tests and low-velocity impact tests are also used to assess joint strength and the response to rigid impact loading. The objective of this review is to consolidate existing research focused on enhancing adhesive strength and to provide guidance for future investigations. According to the findings, the incorporation of metallic reinforcement results in approximately 70% and 29% increases in bending strength and shear strength, respectively. In future studies, the effects of surface treatments applied to metal fibers and the influence of metal reinforcement in additively manufactured specimens stand out as topics awaiting investigation.

Keywords: Single Lap Joint (SLJ); Similar and Dissimilar Adherend; Adhesive; Metal Reinforcement

GİRİŞ

Makine parçalarını ya da yapısal elemanları bir arada tutmak ve birbirine bağlamak için çeşitli yöntemler kullanılmaktadır. Bu yöntemlerden cıvata, somun ve vida elemanlarının kullanımı yapıda gerilme yığılması oluşturmakta ve yük taşıma kapasitesini düşürmektedir (Doğan et al., 2024). Bu yöntemlerin aksine yapıştırma bağlantıları, bağlantının oluşturulması için delik delinmesi gibi gerilme yığılması yaratacak işlemleri barındırmamaktadır. Ayrıca yapıştırma bağlantıları, yüksek kullanım ömrü, nem ve sıcaklığa dayanıklılık, ağırlığına oranla yüksek dayanım ve farklı malzemelerin bir araya getirilebilmesi gibi avantajlar sunmaktadır (Borges et al., 2023; Khayamdar et al., 2025). Özellikle otomotiv ve uzay sanayi dayanımı arttırırken ağırlık azaltma çalışmalarına önem vermektedir. Yapıştırma bağlantılar bu sektörlerde özellikle farklı malzemelerin birleştirilmesinde kullanılmaktadır (Kumar et al., 2025). Tüm avantajlarının yanı sıra yapıştırıcı bağlantılar bazı dezavantajlar barındırmaktadır. Bağlantının UV ışınlarına maruz kalması, sıcak-soğuk döngülerine hassas olması, sınırlı soyulma dayanımı, yapıştırılan malzemelere kıyasla düşük rijitliği, gerilmelerin yapıştırma bölgesi kenarlarında yığılması gibi nedenlerle kullanımında dikkatli olunması gerekmektedir (Damghani et al., 2025; Wei et al., 2024). Ayrıca bağlantının performansı yapıştırılan yüzeylere gerçekleştirilen işlemlerden, yapıştırma bağlantı türünden, bağlantı geometrisi ve ölçülerinden ve parçaya gelen zorlamanın türünden etkilenmektedir.

Bu derleme çalışmasının amacı literatürde tek bindirme yapıştırma bağlantılarında kayma dayanımını arttırmayı ve soyulma gerilmesini azaltmayı hedefleyen çalışmaları bir araya getirmek ve bu konuda çalışmayı düşünen araştırmacılara ışık tutmaktır. Bu amaçla benzer veya farklı malzemeleri birleştiren yapıştırma bağlantıları üç farklı kategoride incelenmiştir. Yapıştırıcının türü ve yapıştırma dizaynını ilgilendiren ilk bölüm, yapıştırıcı içerisine eklenen dolguları ve takviye elemanları inceleyen ikinci bölüm ve yapıştırıcı bölgesine eklenen metal takviyeleri inceleyen üçüncü bölümdür.

ARAŞTIRMA VE BULGULAR

Yapıştırıcı Türü, Kalınlığı ve Bindirme Uzunluğunun Etkisinin Araştırıldığı Çalışmalar

Işıktaş ve arkadaşları (2024), çalışmalarında alüminyum 5754-H111 malzemesi ile oluşturulmuş SLJ bağlantılarında yapıştırıcı kalınlığının (0,2 – 1 – 2 mm) ve yükleme hızının (1 – 10 – 100 mm/dk) kayma dayanımı üzerindeki etkisini deneysel olarak incelemiştir. Yapıştırıcı olarak Araldite AV138 epoksi kullanılmıştır. 1000x2000 mm olarak tedarik edilen alüminyum 5754-H111 levha, kesme tezgahı kullanılarak haddeleme yönünde (0°) 25x100 mm boyutlarında kesilmiştir. Yüzey P120 silisyum karbür zımpara kağıdı ile zımpara yapılmış ve yüzey pürüzlülüğü Ra= 1,3 ± 0,1 µm olarak ölçülmüştür. Yapıştırıcı, homojen bir bileşim elde etmek için hassas bir terazi kullanılarak 4:10

(sertleştirici/yapıştırıcı) oranında bir sertleştirici ile karıştırılmıştır. Numuneler 36 saat oda sıcaklığında kür edilmiştir. Kayma testleri, her parametre için 5 adet numune kullanılarak gerçekleştirilmiştir. Sonuç olarak yapıştırıcı kalınlığı 0,2 mm'den 1 mm'ye çıkarıldığında, kesme yükü yaklaşık %36 oranında azalmıştır. Yapıştırıcı kalınlığı 2 mm'ye çıkarıldığında ise kesme yükü yaklaşık %44 oranında azalmıştır. Yükleme hızı 1 mm/dk'dan 10 mm/dk'ya çıkarıldığında, bağlantı yaklaşık %14,6 ek yük taşıyabilmiştir. Yükleme hızı 10 mm/dk'dan 100 mm/dk'ya çıkarıldığında ise kesme yükündeki artış %14,6'dan %35,1'e yükselmiştir.

Apinyarat ve Chotickai (2025), CFRP-çelik tek bindirme bağlantıların çekme performansını artırmak amacıyla, yapıştırıcı taşma dolguları, çelik yüzeyine açılan kanallar ve yapıştırıcı tipinin etkilerini deneysel ve sayısal olarak incelemiştir. Çalışmada yapıştırılan malzeme olarak A36 çelik levhalar ve CFRP laminatlar; yapıştırıcı olarak ise biri sert (Yapıştırıcı A, E=8,40 GPa) diğeri nispeten sünek (Yapıştırıcı B, E=2,90 GPa) iki farklı yapısal yapıştırıcı kullanılmıştır. Çekme testleri 0,5 mm/dk yükleme hızında gerçekleştirilmiş ve gerilme dağılımları ANSYS kullanılarak analiz edilmiştir. Kare uçlu ve kanalsız (G0) numunelere kıyasla, spew fillet ve G3 kanal konfigürasyonunun (iki kenar + bir iç kanal) birlikte kullanımı en yüksek performansı sağlamıştır. Bu kombinasyon, sert yapıştırıcıda (A) nihai yük kapasitesini %24,6-%29,7 ve sünek yapıştırıcıda (B) ise %55,0-%59,3 oranında artırmıştır. Kenar kanalları kayma gerilmesini azaltırken, spew filletler soyulma gerilmesini, özellikle sert yapıştırıcıda, önemli ölçüde düşürmüştür. Sünek yapıştırıcıda kanalların çatlak durdurucu gibi davrandığı ve hasar sonrası artık kapasiteyi artırdığı gözlemlenmiştir .

Kumar ve arkadaşları (2025), CFRP ve AA 7050-T6 alüminyum alaşımı kullanılarak oluşturulan SLJ bağlantıların statik ve yorulma dayanımları üzerinde bindirme uzunluğu ve yapıştırıcı kalınlığının etkisini deneysel ve sayısal olarak incelemiştir. Çalışmada yapıştırıcı olarak Araldite 2015-1 epoksi, yapıştırılan malzeme olarak tek yönlü karbon kumaş takviyeli laminat ve AA 7050-T6 alüminyum alaşımı kullanılmıştır. Yarı statik testler 1 mm/dk hızda ve yorulma testleri ise 20 Hz frekans ve 0,1 yük oranında gerçekleştirilmiştir. Sonuçlara göre, bindirme uzunluğu 12,5 mm'den 37,5 mm'ye çıkarıldığında hasar yükü %108 artarken, yapıştırıcı kalınlığı 0,2 mm'den 1 mm'ye çıkarıldığında hasar yükü %33 oranında azalmıştır. En yüksek yük taşıma kapasitesi (10,40 kN), en ince yapıştırıcı (0,2 mm) ve en uzun bindirme (37,5 mm) konfigürasyonunda elde edilmiştir. Yorulma testlerinde, yapıştırıcı kalınlığının artması tüm bindirme uzunluklarında performansı düşürmüş; 106 çevrimde yük taşıma kapasitesi konfigürasyona bağlı olarak %19,42 ile %27,05 arasında azalma göstermiştir. Deneysel verilerle birleştirilen sonlu elemanlar analizinde, Smith-Watson-Topper (SWT) kriteri yorulma ömrünü en doğru tahmin eden model olmuştur.

Chen ve arkadaşları (2022), yapıştırıcı ile birleştirilmiş SLJ'lerin kayma dayanımı üzerine bindirme uzunluğu, yapıştırıcı kalınlığı, yapıştırıcı taşma şekli/uzunluğu ve laminat diziliminin etkilerini deneysel ve sayısal olarak incelemiştir. Deneylerde yapıştırıcı olarak LORD 320/322 epoksi yapısal yapıştırıcı, yapıştırılan malzeme olarak ZPNPREG 2551/150/37 karbon fiber/epoksi prepreg laminatlar kullanılmıştır. Testler, 1,3 mm/dk hızda gerçekleştirilmiştir. Sonuçlara göre, bindirme uzunluğu 12,5 mm'den 50 mm'ye çıkarıldığında kayma dayanımının %53,83 oranında azaldığını göstermiştir. Yapıştırıcı kalınlığı 0,25 mm'den 1,00 mm'ye çıktığında dayanım 19,81 MPa'dan 16,62 MPa'ya (yaklaşık %16,15) düşmüştür. Yapıştırıcı taşma uzunluğunun bindirme uzunluğunun %50'sine çıkarılması, kayma dayanımını 18,43 MPa'dan 22,00 MPa'ya (%19.37) yükseltmiştir. Laminat dizilimi açısından, [0]16s dizilimi en yüksek dayanıma (22,85 MPa) sahipken, [90]16s dizilimi en düşük dayanımı (8,00 MPa) göstermiş olup aralarında yaklaşık 3 kat fark tespit edilmiştir.

Kurnia ve arkadaşları (2024), alüminyum 2024-T6 ve GFRP kompozit plakalarla oluşturulan SLJ'lerde, yapıştırıcı türü, yapıştırıcı kalınlığı, birleşim geometrisi ve yüzey hazırlığı gibi parametrelerin bağlantı dayanımı ve karışık tip (soyulma ve kayma) gerilme oranı üzerindeki etkilerini incelemişlerdir. Çalışmada, her biri farklı değişkeni temsil eden birden fazla numune grubu üretilmiştir. İncelenen temel parametre setleri; yapıştırıcı türü (epoksi ve elastomerik), yapıştırıcı kalınlığı (0,2 mm, 0,4 mm, 0,6 mm ve 0,8 mm), yüzey hazırlığı ve üretim prosesi (180 ve 320 ağ zımpara ile yapılan hazırlık, sıkma uygulanmış ve uygulanmamış üretim yöntemleri) ile SLJ geometri varyasyonları (bindirme boyu ve plaka kalınlığı) olarak belirlenmiştir. Tüm numuneler ASTM D1002 standardına göre çekme testine

tabii tutulmuştur. Deneysel bulgular, Cohesive Zone Model (CZM) tabanlı sonlu eleman analizleri ve analitik çözümlerle doğrulanmıştır. Elde edilen sonuçlar, yapıştırıcı kalınlığının karışık tip davranışı üzerinde en kritik parametrelerden biri olduğunu göstermiştir. Özellikle 0,2 mm kalınlığındaki numunelerde gerilmenin daha homojen dağıldığı, kalınlığın artmasıyla birlikte soyulma gerilmelerinin uç bölgelerde belirgin biçimde yükseldiği ve bağlantı dayanımının azaldığı belirlenmiştir. Epoksi yapıştırıcıların daha yüksek kayma dayanımı sunduğu; elastomerik yapıştırıcıların ise soyulma etkilerine karşı daha sünek bir davranış sergilediği tespit edilmiştir. Ayrıca 180 ağ yüzey hazırlığının ve sıkma işleminin arayüz kalitesini artırarak bağlantı dayanımını anlamlı ölçüde iyileştirdiği gözlenmiştir. Sayısal analizlerin deneysel verilerle uyum göstermesi, kullanılan CZM modelinin geçerliliğini desteklemiştir. Sonuç olarak, SLJ bağlantılarında dayanımın yalnızca yapıştırıcının mekanik özellikleriyle değil; kalınlık, yüzey hazırlığı, malzeme seçimi ve geometri tarafından birlikte belirlenen karmaşık karışık tip gerilme dengesine bağlı olduğu ortaya koyulmuştur.

SLJ'lerde kullanılan düz olmayan (sinüzoidal) yüzeylerin, bağlantının gerilme dağılımı ve yük taşıma kapasitesi üzerindeki etkisi deneysel ve sayısal (numerik) olarak incelenmiştir (Razavi et al., 2018). Yapıştırılan malzeme ve yapıştırıcı olarak sırasıyla 5 mm kalınlığında alüminyum 7075-T6 levha ve Araldite 2015 iki bileşenli epoksi esaslı yapıştırıcı kullanılmıştır. Alüminyum yüzeyler yapıştırma işleminden önce asetonla temizlenmiştir ve DIN53281 standardına uygun olarak asit aşındırma işlemi uygulanmıştır. Beş farklı sinüzoidal profil ve bir düz kontrol numunesi kullanılmıştır. Bağlantının bindirme uzunluğu (L) 30 mm, yapıştırıcı kalınlığı (t) 0,2 mm ve başlangıç dalga yüksekliği (A) 1,5 mm olarak belirlenmiştir. Numuneler $y= A.\sin(x\pi/\lambda)$ sinusoid profilde farklı dalga boyu, dalga yüksekliği ve hem pozitif hem de negatif eğim olacak şekilde üretilmiştir. Numuneler 25°C'de 7 gün boyunca kürlenmiştir. Her konfigürasyon için 5 numune çekme testine (1 mm/dk) tabii tutulmuştur. Numune adlandırılması S(B)+- şeklinde yapılmıştır. S: sinüs yüzey, B: dalga boyu, +-: x=0 noktasındaki dalga eğimi şeklindedir. Negatif eğimli sinüzoidal profiller (S(L)-, S(L/2)-, S(L/3)-), bağlantı mukavemetini %51'e kadar artırmıştır. Pozitif eğimli profiller ise gerilmeleri artırarak bağlantıyı zayıflatmıştır. Sonuç olarak, düz olmayan sinüzoidal yüzey tasarımının, yapıştırıcı bağlantılarda daha dayanıklı ve uzun ömürlü yapıların elde edilmesi için etkili bir yöntem olduğu vurgulanmıştır.

Temiz ve arkadaşları (2013), tarafından SLJ'lerde görülen yüksek soyulma ve çekme gerilmelerinin azaltılması için yapıştırılan metal plakaların bindirme uç kısımlarına kavis verilerek, yapıştırma işlemi sırasında pres altında düzleştirilen bu bölgelerin kürleşme sonrası elastik geri yaylanma etkisiyle yapışma hattı uçlarında artık basma gerilmesi oluşturulması incelenmiştir. Bu basma gerilmelerinin, SLJ'lerde hasarı başlatan soyulma gerilmelerini azaltarak dayanımı arttırdığı görülmüştür. AISI-304 metal plakalar kullanılarak hem düz uçlu (SLJ) hem de kavisli uçlu (CSLJ) bağlantılar üretilmiştir. Metal plaka kalınlıkları 3 mm ve 5 mm olarak seçilmiş; kavisli numunelerde uç bölgelerine 105 mm, 132 mm ve 155 mm yarıçaplarında kavis uygulanmıştır. Yapıştırıcı olarak 0,25 mm kalınlığında FM73 epoksi film kullanılmıştır. Tüm numuneler, 120 °C sıcaklıkta ve 0,5 MPa basınç altında 120 dakika boyunca preslenerek kürlendikten sonra soğutulmuştur. Numuneler 5 mm/dk hızla çekme testine tabii tutulmuştur. Sonuçlar, kavisli uç geometrisinin bağlantı yük taşıma kapasitesini anlamlı seviyede artırdığını göstermiştir. 3 mm kalınlığında CSLJ'lerde düz SLJ'ye göre %20–%35, 5 mm kalınlığında ise %39–%46 arasında dayanım artışı elde edilmiştir. En yüksek artış, en küçük kavis yarıçapı olan 105 mm'de görülmüştür. Ayrıca daha kalın plakaların (5 mm) daha yüksek rijitlik göstermesi, geri yaylanma etkisini artırarak kavisli geometriyle birlikte daha büyük kazanç sağlamıştır.

Yapıştırıcıya Eklenen Dolguların ve Takviyelerin Etkisinin Araştırıldığı Çalışmalar

Darla ve arkadaşları (2022), çalışmalarında CFRP ve alüminyum gibi farklı yapışan malzemelerle SLJ'lerin bağlanma mukavemetini doğrulamayı amaçlamıştır. Alüminyum yapışan yüzey, SLJ'ler için reçine ön kaplama (RPC) ve NaOH kullanılarak yüzey işlemine tabi tutulmuştur. Yapıştırıcı içine takviye elemanlar (ZnO tetrapodları) karıştırılarak yapıştırma işlemi gerçekleştirilmiştir. Üretilmiş olan numunelere tahribatsız muayene (NDT), kayma testi ve üç nokta eğme testi gerçekleştirilmiştir. Ultrasonik C-scan ve X-ray görüntülerinde RPC yüzeyli numunelerde boşluk veya gözenek gözlenmemiştir. Bu, yapıştırıcının düzgün dağıldığını ve ara yüzde hata bulunmadığını göstermektedir. En yüksek kayma dayanımı, yüzeyi işlem görmemiş referans numuneye kıyasla %155 oranında artışla

RPC yüzeyinde elde edilmiştir. En yüksek eğilme dayanımı ise referans numuneye kıyasla %182 oranında artışla ZnO tetrapod eklenmiş yapıştırıcılarda elde edilmiştir.

Hülagü ve arkadaşlarının çalışmalarında (2021), epoksi bazlı yapıştırıcıya %1, %2, %3 ağırlıkça grafen nanoplaka (GNP) eklenerek elde edilen yapıştırıcılarla hazırlanan Al – Al çift bindirme yapıştırma bağlantılarının düşük hız darbe (5J ve 10J) ve üç noktada eğme davranışları incelenmiştir. Gerçekleştirilen testlerde yapıştırıcı olarak DP270 epoksi yapıştırıcı, yapıştırılacak malzeme olarak AA2024-T3 alüminyum plaka, takviye nano malzeme olarak ise GNP kullanılmıştır. Eğilme testi 5 kN yük hücreli üniversal test cihazıyla, 1 mm/dk hızda gerçekleştirilmiş ve her bağlantı türü için beş numune test edilmiştir. Darbe testleri 22 kN yük hücreli CEAST 9350 Fractovis Plus cihazında, 12,7 mm çap ve 5 kg ağırlığındaki yarım küre uçlu bir vurucu ile 5 J (1,42 m/s) ve 10 J (2,02 m/s) enerjilerde gerçekleştirilmiştir. Darbe testlerinin sonucunda, temas kuvvetindeki maksimum artış (%39 oranında), %1 grafen takviyesiyle meydana gelmiştir. 5 J darbe enerjisinde, sönümlenen enerji değerinde %3 GNP takviyesinde takviyesiz numuneye göre %4,57 azalma görülmüştür. 10 J enerjide ise en iyi sonuç %2 GNP takviyesiyle takviyesiz numuneye göre sönümlenen enerjide, %1,90 azalma görülmüştür. 5 J enerjide %1, %2 ve %3 GNP takviyesi temas süresini sırasıyla %2,43, %3,27 ve %4,24 oranında azalmıştır. Üç nokta eğme testinde ise en yüksek maksimum kuvvet değeri %2 GNP takviyeli numunelerde görüşmüştür. Takviyesiz numunelere kıyasla maksimum kuvvette %58'e varan bir artış elde edilmiştir.

Epoksi yapıştırıcılara kısa kevlar fiber eklemenin, CFRP ve SLJ yapıştırma bağlantılarının dayanımını nasıl etkilediği incelenmiştir (Shi et al., 2024). Bindirmenin her iki yüzü için CFRP laminatlar kullanılmıştır. Karbon fiber dokuma kumaş, 200 g/m² alan yoğunluklu CS03T 200 dimiden üretilmiştir. Yapıştırıcı, LY5288 CI epoksi reçinesinin HY5289 sertleştirici ile 100:23 oranında karıştırılmasıyla elde edilmiştir. 8 kat karbon fiber dokuma kumaş, epoksi reçine ile karıştırıcı da karıştırılıp kürlenmiştir. Karbon fiber laminatların yapıştırma bölgesindeki yapıştırma yüzeylerinin zımparalama işlemi sırasında karbon fiber laminatların yüzeyindeki epoksi reçine yapıştırıcı tabakasına zarar vermeden hafifçe zımparalanması için alüminyum oksit zımpara kağıdı (80 kum) kullanılmıştır. Karbon fiber laminatın her iki tarafındaki yapışkan bölge için sertleştirilmiş yapıştırıcıların hazırlanmasında, uzunluğu 1 mm'den az olan kısa kevlar elyaflar sırasıyla %1 ağırlık, %2 ağırlık, %3 ağırlık ve %4 ağırlık oranlarında eklenmiştir. Yapıştırıcı sürülmüş yüzeyler, önceden hazırlanmış parçaların 1 ton yük altında 30 dakika boyunca 50 °C'ye, ardından aynı yük altında 30 dakika boyunca 80 °C'ye ısıtılmasıyla oluşturulmuştur. Parçaların oda sıcaklığında 24 saat soğuması sağlanmıştır. Testler sonucunda %2 kısa Kevlar fiber içeren numunelerde maksimum yük ve uzama sırasıyla yaklaşık %30 ve %33 oranında artmıştır. Dijital görüntü korelasyonu (DIC) analizleri, Kevlar fiberlerinin yapışma bölgesindeki deformasyonları düşürdüğünü hem eksenel hem de kesme yönündeki gerinimleri azaltarak çatlak ilerlemesini geciktirdiğini ortaya koymuştur.

Behera ve arkadaşları (2023), SLJ'lerin dayanımını arttırmak için cam fiber takviyeli polimer (GFRP) kullanımını ele almışlardır. Deneysel çalışmada alüminyum malzemeden Metal-Metal (MTM) ve alüminyum ve GFRP'nin kullanıldığı Metal-Kompozit (MTC) bağlantılar üzerinde çalışılmıştır. Uzun cam elyaf demetlerinin yükleme yönü boyunca hizalanması, cam elyaf boyutu ve SLJ bindirme bölgesinde epoksi yapıştırıcı ile takviye edilmiş kısa cam elyafların ağırlık oranı mukavemete etkisi açısından incelenmiştir. Kullanılan kısa lifler 0,05 mm - 0,2 mm uzunluğunda ve 0,01 mm çapındadır, uzun lifler ise 25 mm uzunluğunda ve 1 mm çapındadır. MTM ve MTC bağlantılarda 4 farklı yapıştırıcı tipi denenmiştir. Tip1- saf epoksi, Tip2- yapıştırıcıya karıştırılmış kısa cam lifleri (SF%2, SF%4, SF%6 ve SF%8 olarak), Tip3- yapıştırıcıya karıştırılmış uzun cam lif demetleri ve bu lifler yük yönündedir (3 demet ise LF3 olarak adlandırılmaktadır), Tip4- Uzun lifler ek olarak bağlantının uç kısmına taşırılmış (3 demet ise LFF3 olarak adlandırılmıştır). Gerçekleştirilen çekme testleri (1 mm/dk) sonucunda LFF5'in en yüksek uzamayı gösterdiği ve kısa lif kullanımında SF%6'nin en iyi sonucu verdiği görülmüştür. LF5 ve LFF5 dayanımı ciddi oranda arttırmıştır. Ayrıca MTM bağlantılar MTC bağlantılardan daha güçlü olduğu görülmüştür.

Yapıştırıcıya Eklenen Metal Takviyelerin Etkisinin Araştırıldığı Çalışmalar

Khoramishad ve arkadaşları (2014), tek bindirme bağlantıların (SLJ) güçlendirilmesi için metal fiberler kullanmışlardır. Metal fiberlerin geometrik ve malzeme parametreleri, deneysel araştırmalar ve sonlu eleman modellemesi kullanılarak incelenmiştir. Metal fiberlerin çapı, sertliği ve fiberler arasındaki mesafe tasarımdaki üç önemli parametre olarak belirlenmiştir. Fiberler arasındaki mesafenin azaltılması, fiber çapının artırılması ve fiberler için daha sert malzeme seçilmesi gerilme dağılımını iyileştirdiği ve yapışkan tabakadaki maksimum ve ortalama gerilme değerlerini azalttığı görülmüştür. Yapıştırılan malzeme 12 mm kalınlığında 7075-T6 alüminyum alaşımı levha, yapıştırıcı olarak UHU Plus Endfest 300 adlı çözücüsüz iki bileşenli epoksi ve metal fiber olarak ise 0,4 mm çapında 7075 alüminyum alaşım kullanılmıştır. Yapıştırılan malzemeler; ASTM D3933-98 standardına göre uygun olarak kromik asit aşındırma ve fosforik asit anotlama işlemleri ile ön işlemden geçirilmiştir. Farklı a/t değerleri için testler yapılmıştır. Burada a; metal fiberler arasındaki mesafe, t ise yapıştırıcı kalınlığıdır. Takviyesiz bağlantılar için kesme dayanımı 12,3 MPa, a/t=0,35 olan takviyeli bağlantıda kesme dayanımı %133,9, a/t=2,6 için %45,9, a/t=1,1 için %73,4 artış görülmüştür. Ayrıca başlangıç rijitliği ve kopma uzaması da önemli ölçüde artmıştır. Kırılma yüzeyleri incelendiğinde, takviyesiz bağlantılarda ara yüzeysel kırılması görülürken fiberli bağlantılarda kırılma daha çok kohezif hale gelmiştir. En iyi sonuçlar; fiber aralığının küçük, fiber çapının büyük ve malzeme rijitliğinin uygun olduğu durumlarda elde edilmiştir.

Bayramoğlu ve arkadaşları (2020), çekme yüküne maruz kalan SLJ'nin, beş farklı iç basamak uzunluğuna sahip iç basamaklı bindirmeli bağlantının (ISLJ) ve beş farklı uzunluğa sahip metal parçalı takviyeli bindirmeli bağlantının (MRLJ) mekanik özelliklerini incelemiştir. Gerçekleştirilen deneyde yapıştırıcı olarak DP460 sıvı epoksi, yapıştırılacak malzeme olarak AA2024-T3 alüminyum, takviye metal parça olarak ise AISI 1040 çeliği kullanılmıştır. 21°C sıcaklıkta , %22 nem oranında, 100 kN yük hücreli test cihazı kullanılarak 1 mm/dk çekme hızında testler yapılmıştır. Aynı bindirme uzunluğuna (25 mm) sahip SLJ ve ISLJ tipleri karşılaştırıldığında, 21 mm, 17 mm, 13 mm, 9 mm ve 5 mm bağlantı tiplerinin iç basamak uzunluklarının hasar yükündeki artışı sırasıyla %26, %43, %51, %60 ve %33 olarak ölçülmüştür. Aynı bindirme uzunluğuna (25 mm) sahip SLJ ve MRLJ tipleri karşılaştırıldığında, 21 mm, 17 mm, 13 mm, 9 mm ve 5 mm bağlantı tiplerinin iç basamak uzunluklarının hasar yükündeki artışı sırasıyla %17, %25, %38, %41 ve %33 olarak ölçülmüştür. Bu çalışma, 9 mm iç basamak veya metal takviyenin en verimli tasarım olduğunu göstermiştir.

Taş (2025), yapıştırıcı tabakası içine yerleştirilen paslanmaz çelik örgü tel ağ (SSWWM) takviyesinin, alüminyum alaşımlı SLJ'lerin yük taşıma kapasitesine etkisini ağ sayısı, alan ve konum parametreleri üzerinden incelemiştir. Çalışmada yapıştırıcı olarak Loctite EA 9466 epoksi, yapıştırılan malzeme olarak AA5083 alüminyum alaşımı, takviye elemanı olarak ise farklı ağ sıklıklarına (20, 40, 60 ve 80 ağ) sahip 304 paslanmaz çelik örgü teller kullanılmıştır. Çekme testleri 1 mm/dk hızda, 27°C sıcaklık ve %33 nem oranında yapılmıştır. Sonuçlara göre, SSWWM takviyesi tepe kuvvetini %7 ile %46 arasında artırmıştır. Özellikle M60 (60 mesh) takviyeli numune, saf numuneye (5,890 kN) kıyasla %46 artışla 8,601 kN tepe kuvvetine ulaşmıştır. Takviye alanının 10x10 mm'den 25x25 mm'ye çıkarılması tepe kuvvetinde %28,9'luk artış sağlamıştır. Takviyenin konumu incelendiğinde, SSWWM'nin bindirme bölgesinin her iki ucuna yerleştirilmesi (M60-Edge), merkeze yerleştirilmesine (M60-Middle) kıyasla daha yüksek performans göstererek saf numuneye kıyasla %24,7 artış sağlamıştır.

Dinamik yükleme altında metalik elyaf takviyeli yapıştırıcı ile birleştirilmiş SLJ mekanik davranışları ve bağlantı genişliği boyunca farklı elyaf aralıklarının ve fiber aralığının yapıştırıcı kalınlığına (a) oranlarının SLJ'lerin mukavemeti üzerindeki etkisi deneysel olarak incelenmiştir (Razavi et al.,2020) Gerçekleştirilen testlerde yapıştırıcı olarak Araldite 2015 epoksi yapıştırıcı, yapıştırılan malzeme olarak çelik, takviye metal parça olarak 0,5 mm çapında Forta 304/4301 paslanmaz çelik fiber kullanılmıştır. Test şartları olarak; 0,2 mm/dk (statik), 10 mm/dk (orta hız) ve 50 mm/dk (yüksek/dinamik) olan 3 farklı hızda ve her bir durum için en az 3 numune test edilmiştir. a= 0,4 oranında hasar yükünün 0,2 mm/dk,10 mm/dk ve 50 mm/dk test hızlarında sırasıyla %61, %63, %73' lük artış gözlemlenmiştir. a= 0,9 oranında hasar yükünün 0,2 mm/dk,10 mm/dk ve 50 mm/dk test hızlarında sırasıyla %73, %76, %84'lük artış gözlemlenmiştir. a= 1,9 oranında ise hasar yükünün 0.,2 mm/dk, 10 mm/dk ve 50 mm/dk test hızlarında sırasıyla %34, %32, %49'lük artış gözlemlenmiştir.

Ramezani ve arkadaşları (2022), çalışmalarında karbon fiber takviyeli polimer (CFRP) birleşimlerinde, yapıştırma yapılan yüzeylere ek katmanlar ekleyerek delaminasyonu azaltmayı amaçlamışlardır. Bu amaçla iki çeşit katman kullanılmıştır; birincisi metal katman (alüminyum 2024-T3), ikincisi ise polimer katmandır (yapıştırıcı benzeri esnek bir katman). Araştırmada yapıştırılan malzeme olarak CFRP, takviye katman olarak alüminyum, Af 163-2k yapıştırıcı ise hem ana yapıştırıcı hem de polimer takviye olarak kullanılmıştır. Üretilen tek bindirme bağlantılarda numune genişliği sabit 15 mm alınmıştır. Bazı numunelerde CFRP'nin dış yüzeyine 0,4 mm veya 0,8 mm alüminyum katman eklenmiş, bazı numunelerde ise yüzeye 0,2/0,4/0,8mm kalınlığında polimer katman eklenmiştir. Yüzeyde; 0,2 mm polimer katman varsa CFRP+%12,5AF, 0,4 mm varsa CFRP+%25AF, 0,8 mm varsa CFRP+%50AF olarak ayrıca yüzeyde 0,4 mm metal katman varsa CFRP+%25Al, 0,8 mm varsa CFRP+%50Al olarak isimlendirilmiştir. Çalışmada, alüminyum levhaların yüzey hazırlığı için 3M Surface Pre-Treatment AC-130-2 adlı sol-jel esaslı fosforik asit yüzey işlemi uygulanmıştır. Bu işlem, yüzeye manuel fırçalama yöntemiyle sürülmüş ve böylece alüminyum tabaka ile CFRP arasında güçlü bir bağ oluşması sağlanmıştır. Tüm katmanlar 130˚C'de 1 saat kürlenmiştir. Üretilen numunelere yavaş (1 mm/dk) ve orta hızda (0,1 m/s) olarak iki farklı hızda çekme testi gerçekleştirilmiştir. Her bir test 3 kez tekrar edilmiştir. Polimer takviyesi delaminasyonu tamamen engelleyemese de daha yüksek yük taşıma kapasitesi ve yer değiştirme değerleri elde edilmiştir. Her iki yöntemde de gerilmelerin birleşim kenarlarında yoğunlaşması azalmış, yük daha geniş bir alana dağılmıştır. Alüminyum takviyesi, delaminasyonu tamamen ortadan kaldırmış ve bağlantının kohezyonel kopma ile sonlanmasını sağlamıştır. Sonuç olarak, CFRP+%25Al ve CFRP+%25AF yapılandırmaları hem statik hem de ara yükleme koşullarında en yüksek dayanımı göstermiştir.

CFRP'de SLJ delaminasyonunu azaltmak ve mekanik performansını artırmak amacıyla, fiber metal laminatlardan (FML) esinlenerek geliştirilen alüminyum laminat takviyeli (CML) bağlantıları deneysel ve sayısal olarak incelenmiştir (Morgado et al, 2019). Çalışmada yapıştırıcı olarak iki farklı epoksi bazlı yapıştırıcı; 3M Scotch Weld AF 163-2K (film) ve Nagase Denatite XNR6852E-3 (macun) kullanılmıştır. Yapıştırılacak malzeme olarak 0 derece yönelimli karbon/epoksi prepreg (HS 160T700), takviye metal parça olarak ise 0,4 mm ve 0,8 mm kalınlığında Alüminyum 2024-T3 Alclad serisi levhalar kullanılmıştır. Alüminyum yüzeyler kumlama, yağ giderme ve 3M AC-130-2 Sol-Gel işlemi ile hazırlanmıştır. Quasi-statik testler 1 mm/dk hızda, darbe testleri ise 3 m/s hızda (140,85 J) düşen ağırlık test makinesinde 24°C sıcaklıkta gerçekleştirilmiştir. AF 163-2K yapıştırıcı kullanılan 0,4 mm Al takviyeli numunelerde, quasi-statik hasar yükü referans CFRP bağlantıya göre %29,15 artışla 17,89 kN'den 23,10 kN'ye çıkmıştır. Darbe koşullarında ise aynı konfigürasyon %22,5 artışla 26.02 kN yük taşıma kapasitesine ulaşmış ve enerji sönümleme değeri de %105 artmıştır. 0,8 mm Al takviyesi kullanıldığında darbe dayanımı artışı %40,73'e ulaşmıştır. Ancak daha sert olan XNR 6852 E-3 yapıştırıcıda 0,4 mm takviye, performansı düşürürken (-%11,99), 0,8 mm takviye kullanımı hasar yükünü %29,34 oranında artırmıştır.

Rezvaninasab ve arkadaşları (2019), SLJ'lerde enine doğrultuda pim ve boyuna doğrultuda tel takviye elemanlarının, farklı malzemelerden (Alüminyum - GFRP) oluşan bağlantıların kayma ve eğilme özellikleri üzerindeki etkisini deneysel olarak incelemiştir. Gerçekleştirilen deneyde yapıştırıcı olarak Araldite 2015A/B epoksi, yapıştırılan malzeme olarak 2 mm kalınlığında Alüminyum 7075-T6 ve 2,5 mm kalınlığında GFRP, takviye elemanları olarak ise 1 mm çapında yüksek karbonlu çelik pimler ve 0.2 mm çapında AISI 304L paslanmaz çelik teller kullanılmıştır. Kayma gerilmesinin tespiti için çekme testleri 0,2 mm/dk sabit deplasman hızında, eğilme testleri ise 0,5 mm/dk hızda oda sıcaklığında gerçekleştirilmiştir. Takviyesiz (Tip 1), sadece tel takviyeli (Tip 2), sadece pim takviyeli (Tip 3) ve hem tel hem pim takviyeli (Tip 4) numuneler karşılaştırıldığında; Tip 4 bağlantıda kayma dayanımı Tip 1' e göre %38,24 artışla 13,90 MPa'ya, eğilme yükü ise %70,41 artışla 530 N değerine ulaşmıştır. Özgül özellikler (ağırlığa oranla) incelendiğinde, hibrit takviyeli (Tip 4) bağlantının özgül kayma dayanımı %33,48, özgül eğilme dayanımı %64,40 ve eğilme tokluğu %231,91 oranında artış göstermiştir. Çalışma, pimlerin eğilme dayanımını ve tokluğu artırdığını, tellerin ise kayma dayanımını ve modülü iyileştirdiğini göstermiştir.

SONUÇ VE ÖNERİLER

Literatürde metal takviyelerin bağlantı dayanımını artırdığı bilinmekle birlikte, metal fiberlere uygulanan farklı yüzey işlemlerinin yapışma performansı ve bağlantı dayanımı üzerindeki etkisine dair çalışmalar oldukça sınırlıdır; metal fiberlere uygulanacak farklı yüzey işlemlerinin yapışma ve dayanım üzerindeki etkilerinin deneysel olarak incelenmesi önerilmektedir. Bu bağlamda, metal fiber takviyesinin gerilme dağılımını iyileştirmesi ve çatlak köprüleme etkisi sayesinde bağlantı dayanımını yaklaşık %20–%130 oranında artırdığı, nano katkıların ara yüzey aderansını geliştirerek dayanımı %40–%180 aralığında yükselttiği ve Kevlar fiberlerin yüksek enerji yutma kapasitesiyle hasar ilerlemesini geciktirerek bağlantı dayanımında belirgin artışlar sağladığı literatürde rapor edilmiştir.

REFERANSLAR

Apinyarat, V., & Chotickai, P. (2025). Enhancing tensile performance of CFRP–steel single-lap joints: Effects of spew fillets, surface grooving, and adhesive layer type and thickness. *Case Studies in Construction Materials*, *23*, e05456. https://doi.org/10.1016/j.cscm.2025.e05456

Bayramoğlu, S., Demir, K., & Akpınar, S. (2020). Investigation of internal step and metal part reinforcement on joint strength in the adhesively bonded joint: Experimental and numerical analysis. *Theoretical and Applied Fracture Mechanics*, *108*, 102613. https://doi.org/10.1016/j.tafmec.2020.102613

Behera, R. K., Parida, S. K., & Das, R. R. (2023). Effect of using fibre reinforced epoxy adhesive on the strength of the adhesively bonded single lap joints. Composites Part B: Engineering, 248, 110358. https://doi.org/10.1016/j.compositesb.2022.110358

Borges, C. S. P., Akhavan-Safar, A., Tsokanas, P., et al. (2023). From fundamental concepts to recent developments in the adhesive bonding technology: A general view. *Discover Mechanical Engineering*, *2*, 8. https://doi.org/10.1007/s44245-023-00014-7

Chen, Q., Du, B., Zhang, X., Zhong, H., Ning, C., Bai, H., Li, Q., Pan, R., Zhou, B., & Hu, H. (2022). Parametric investigation into the shear strength of adhesively bonded single-lap joints. *Materials*, *15*(22), 8013. https://doi.org/10.3390/ma15228013

Damghani, M., Naidu, C., & Cole, D. (2025). Investigation of brittle adhesive reinforcement for single lap shear joints with composite adherends. *Structures*, *80*, 109844. https://doi.org/10.1016/j.istruc.2025.109844

Darla, V. R., Ben, S., & Srinadh, K. V. S. (2022). Evaluation of strength and performance for a single lap bonded joint by insertion of structural elements in adhesive. *International Journal of Adhesion and Adhesives*, *118*, 103240. https://doi.org/10.1016/j.ijadhadh.2022.103240

Doğan, N. F., Çakır, M. V., & Özbek, Ö. (2024). Bonding performance of nano boron nitride filled epoxy adhesive. *Journal of the Brazilian Society of Mechanical Sciences and Engineering*, *46*, 240. https://doi.org/10.1007/s40430-024-04799-w

Hülagü, B., Ünal, H. Y., Acar, V., Khan, T., Aydın, M. R., Aydın, O. A., Gök, S., Pekbey, Y., & Akbulut, H. (2021). Low-velocity impact and bending response of graphene nanoparticle-reinforced adhesively bonded double strap joints. *Journal of Adhesion Science and Technology*, *35*(22), 2391–2409. https://doi.org/10.1080/01694243.2021.1885924

Işıktaş, A., Balıkoğlu, F., & Demircioğlu, T. K. (2024). Effect of adhesive thickness and loading speed on bonding strength in single-lap adhesive joints with aluminum 5754-H111. *Journal of Balıkesir University Institute of Science and Technology*, *26*(2), 420–430. https://doi.org/10.25092/baunfbed.1434205

Khayamdar, M., Khoramishad, H., & Fatolahi, A. R. (2025). Synergistic reinforcing effects of shape memory alloy wires and multi-walled carbon nanotubes on the mechanical properties of adhesively bonded single lap joints. International Journal of Adhesion and Adhesives, 142, 104139. https://doi.org/10.1016/j.ijadhadh.2025.104139

Khoramishadn, H., & Razavi, N. (2014). Metallic fiber-reinforced adhesively bonded joints. *International Journal of Adhesion and Adhesives*, *55*, 114–122. https://doi.org/10.1016/j.ijadhadh.2014.08.005

Kumar, V., Sharma, S., & Singh, A. (2025). Impact of joint variables on shear and fatigue behavior of composite–metal single-lap adhesive joint. Engineering Failure Analysis, 168, 109079. https://doi.org/10.1016/j.engfailanal.2024.109079

Kurnia, A., Hadi, B. K., Syamsudin, H., & Suada, M. G. (2024). Analysis of the influence of adhesive, geometry, and manufacturing processes on mixed mode stress ratio in single lap shear adhesive joint structures of aluminum and composite plates. *Jurnal Penelitian Pendidikan IPA*, *10*(11), 8596–8601. https://doi.org/10.29303/jppipa.v10i11.9107

Morgado, M. A., Carbas, R. J. C., Marques, E. A. S., & da Silva, L. F. M. (2019). Reinforcement of CFRP single lap joints using metal laminates. *Composite Structures*, *230*, 111492. https://doi.org/10.1016/j.compstruct.2019.111492

Ramezani, F., Nunes, P. D. P., Carbas, R. J. C., Marques, E. A. S., & da Silva, L. F. M. (2022). The joint strength of hybrid composite joints reinforced with different laminates materials. *Journal of Advanced Joining Processes*, *5*, 100103. https://doi.org/10.1016/j.jajp.2022.100103

Razavi, N., Bale, E. S., Berto, F., & Bertolin, C. (2020). Mechanical behavior of metallic fiber-reinforced adhesive under dynamic loading. *Procedia Structural Integrity*, *26*, 229–233. https://doi.org/10.1016/j.prostr.2020.06.027

Razavi, S. M. J., Berto, F., Peron, M., & Torgersen, J. (2018). Parametric study of adhesive joints with non-flat sinusoid interfaces. *Theoretical and Applied Fracture Mechanics*, *93*, 44–55. https://doi.org/10.1016/j.tafmec.2017.06.019

Rezvaninasab, M., Farhadinia, M., Mirzaei, A., Ramzaninezhad, M., Khamseh, F., & Alaei, M. H. (2019). Experimental evaluation of reinforcing the single lap joint in both longitudinal and transverse direction under tensile and bending condition. *International Journal of Adhesion and Adhesives*, *88*, 19–25. https://doi.org/10.1016/j.ijadhadh.2018.05.020

Shi, S., Liu, Z., Lv, H., Zhou, X., Sun, Z., & Chen, B. (2024). The tensile properties of adhesively bonded single lap joints with short Kevlar fiber. *International Journal of Adhesion and Adhesives*, *134*, 103794. https://doi.org/10.1016/j.ijadhadh.2024.103794

Taş, H. (2025). Effects of stainless steel woven wire mesh reinforcement on the load-bearing capacity of adhesively bonded aluminium alloy single-lap joints. Arabian Journal for Science and Engineering, 50, 14043–14058. https://doi.org/10.1007/s13369-024-09652-9

Temiz, Ş., Akpinar, S., Aydın, M. D., & Sancaktar, E. (2013). Increasing single-lap joint strength by adherend curvature-induced residual stresses. *Journal of Adhesion Science and Technology*, *27*(3), 244–251. https://doi.org/10.1080/01694243.2012.705509

Wei, Y., Jin, X., Luo, Q., Li, Q., & Sun, G. (2024). Adhesively bonded joints: A review on design, manufacturing, experiments, modeling and challenges. Composites Part B: Engineering, 276, 111225. https://doi.org/10.1016/j.compositesb.2024.111225

YAPAY ZEKÂ DESTEKLİ VE GELENEKSEL CI/CD PİPELİNE GÜVENLİK PRATİKLERİNİN GERÇEK DÜNYA UYGULAMALARI VE ÖLÇEKLENEBİLİRLİĞİ

REAL-WORLD APPLICATIONS AND SCALABILITY OF AI-ASSITED AND TRADITİONAL CI/CD PIPELINE SECURITY PRACTICES

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ÖZET

Bu çalışma, yapay zekâ (YZ) destekli kod üretim sistemlerinin yazılım geliştirme süreçlerinde sağladığı verimlilik artışının, güvenlik açısından ortaya çıkardığı sistemik riskleri bütüncül bir yaklaşımla incelemektedir. Büyük Dil Modelleri (LLM) tabanlı araçların Secure SDLC üzerindeki etkileri hem teknik hem sosyo-teknik boyutlarıyla analiz edilmiştir. Çalışmada, YZ'nin istatistiksel yapısı ve sınırlı bağlamsal farkındalığı nedeniyle güvenlik açıklarını öngörülebilir biçimde ürettiği, YZ ile yürütülen düzeltme döngülerinin ise kimi durumlarda yeni zafiyetleri tetikleyerek "güvenlik yitimine" yol açtığı tespit edilmektedir. Bu durum yalnızca bireysel uygulamaları değil, yazılım tedarik zincirini de etkileyen sistemik bir risk alanı oluşturmaktadır. Sistem düzeyinde, YZ'nin karmaşıklığı artıran ve kod yayılımını hızlandıran özellikleri, Normal Kaza yaklaşımıyla uyumlu şekilde yüksek riskli koşullar üretmektedir. Ayrıca otomasyona aşırı güven, insan denetiminin zayıflaması, geliştirici körlüğü ve sorumluluk bulanıklığı gibi sosyo-teknik unsurlar bu riskleri daha da derinleştirmektedir. Çalışma, YZ'nin yazılım geliştirme süreçlerinde bir otorite değil, sürekli gözetim gerektiren denetime açık bir araç olarak konumlandırılması gerektiğini ve güvenli yazılım kültürüyle birlikte kullanıldığında sistem dayanıklılığını güçlendireceğini savunmaktadır.

Anahtar Kelimeler: Yapay Zekâ, CI/CD Güvenliği , Güvenli Yazılım Geliştirme (Secure SDLC) , Yazılım Tedarik Zinciri , Büyük Dil Modelleri (LLM) , Sistemik Risk , Normal Kaza Teorisi , Otomasyon ve Denetim

ABSTRACT

This study provides a comprehensive examination of the systemic security risks introduced by artificial intelligence (AI)–assisted code generation systems despite their productivity gains in software development. The impacts of Large Language Model (LLM)–based tools on the Secure Software Development Life Cycle (Secure SDLC) are analyzed from both technical and socio-technical perspectives. The findings indicate that, due to their statistical nature and limited contextual awareness,

AI systems can systematically generate security vulnerabilities, while AI-driven correction cycles may unintentionally trigger additional weaknesses, resulting in “security degradation.” These risks extend beyond individual software projects and pose a broader threat to the software supply chain. At the systemic level, AI’s tendency to increase complexity and accelerate code propagation creates high-risk conditions consistent with the Normal Accident perspective. Furthermore, socio-technical factors such as excessive reliance on automation, reduced human oversight, developer blindness, and responsibility ambiguity exacerbate these vulnerabilities. The study argues that AI should not be positioned as an authoritative entity in development pipelines but rather as a tool requiring strict supervision. It concludes that integrating AI within a culture of secure software development, supported by disciplined processes and human-centered oversight mechanisms, significantly enhances system resilience.

Key Words: Artificial Intelligence , CI/CD Security , Secure Software Development (Secure SDLC) , Software Supply Chain , Large Language Models (LLMs) , Systemic Risk , Normal Accident Theory , Automation and Oversight

1. GİRİŞ

Yapay zekâ destekli yazılım geliştirme araçlarının CI/CD süreçlerine entegrasyonu, güvenlik mekanizmalarının yeniden değerlendirilmesini zorunlu kılmaktadır. Literatürde, bu tür sistemlerin karar alma süreçlerinde şeffaflık eksikliği, insan denetiminin azalması ve otomasyona aşırı bağımlılık gibi riskler oluşturduğu belirtilmektedir (Bostrom, 2014; Floridi & Cowls, 2019). Özellikle büyük dil modellerinin istatistiksel yapısı, bağlamsal farkındalık sınırlamaları ve hatalı genelleme eğilimleri, yazılım tedarik zincirinde öngörülemeyen güvenlik açıklarının ortaya çıkmasına neden olabilmektedir (Weidinger et al., 2021). Bu risklerin kurumsal ölçekte yönetilebilmesi amacıyla, yapay zekâ temelli sistemlere yönelik yönetişim ve risk yönetimi yaklaşımları NIST tarafından yayımlanan AI Risk Management Framework kapsamında ele alınmaktadır (NIST, 1988). Ayrıca, AI destekli geliştirme pratiklerinin DevSecOps süreçleri ve yazılım tedarik zinciri güvenliği üzerindeki etkileri, hem akademik çalışmalar hem de endüstri raporlarında sistematik biçimde incelenmektedir (Huang et al., 2017; Rajapakse et al., 2022).Yazılım geliştirme ekosistemi son on yılda köklü bir dönüşüm geçirmiş ve bu dönüşümün merkezine DevOps kültürü ile CI/CD otomasyon yapıları yerleşmiştir . Sürekli Entegrasyon (Continuous Integration) ve Sürekli Dağıtım (Continuous Delivery/Deployment) hatları, geliştirme ekiplerinin kodu daha hızlı birleştirmesini, test etmesini ve güvenilir biçimde üretime aktarmasını sağlayarak yazılım teslim döngülerini radikal biçimde kısaltmıştır(Kuroki et al., 1992). Ancak üretim hızındaki bu artış, saldırı yüzeyinin de aynı ölçüde genişlemesine yol açmaktadır.

1.1. CI/CD güvenliğinin yeni paradigması

Klasik güvenlik yaklaşımları, çoğunlukla uygulama kodunu ve çalıştığı ortamı korumaya odaklanırken; modern yazılım tedarik zinciri saldırıları doğrudan CI/CD konfigürasyon dosyalarını, derleme ortamlarını, otomatik betikleri, bağımlılık yönetim zincirini ve dağıtım artefact'larını hedef almaktadır. Son yıllarda yaşanan SolarWinds, Codecov Bash Uploader ve PyTorch Nightly olayları, istismarların büyük ölçüde CI/CD süreçleri üzerinden gerçekleştiğini göstermektedir (Lazarovitz, 2021; Tsfaty & Fire, 2022; Zhang et al., 2022). Bunun temel nedeni, CI/CD süreçlerinin hem yüksek yetkiler içermesi hem de yoğun otomasyona dayandığı için anomali tespitinin güçleşmesidir. Bu bağlamda CI/CD güvenliği, yalnızca "sisteme güvenlik taraması eklemek" anlamında değil; geliştirici ortamından

derleme aşamasına, imzalı artefact üretiminden dağıtım politikalarına uzanan bütünsel bir güvenlik modelini gerektirmektedir.

1.2. Standardizasyonun yükselişi: SSDF, SLSA ve OWASP CI/CD Risks

NIST SP 800-218 Secure Software Development Framework (SSDF), güvenli yazılım geliştirme süreçlerinin görev tabanlı bir modelle tanımlanmasını ve kurumsal ölçekte standartlaştırılmasını önermektedir (Sharifi & Niya, 2016). Bu çerçeve, geliştirici ve DevOps ekiplerinin güvenli kod yazımı, bağımlılık doğrulaması, derleme adımlarının kayıt altına alınması ve imzalı artefact üretimi gibi operasyonları sistematik hâle getirmesini hedefler.

Supply-chain Levels for Software Artifacts (SLSA) v1.1 ise yazılımın nasıl üretildiğini doğrulanabilir kanıtlarla belgeleyen bir olgunluk modeli sunar (Jiang et al., 2019). SLSA'ya göre güvenilir bir artefact'ın; izole bir derleme ortamında üretilmesi, her adımının kriptografik olarak kayıt altına alınması, imzalanması ve bağımlılık zincirinin doğrulanmış olması gerekir.

OWASP Top 10 CI/CD Security Risks (2022) ise sektörde en sık gözlenen CI/CD zafiyetlerini pratik örneklerle sınıflandırmakta ve özellikle küçük ve orta ölçekli ekipler için güvenliğe başlangıç rehberi işlevi görmektedir (Huang et al., 2017; Papalia, 2025).

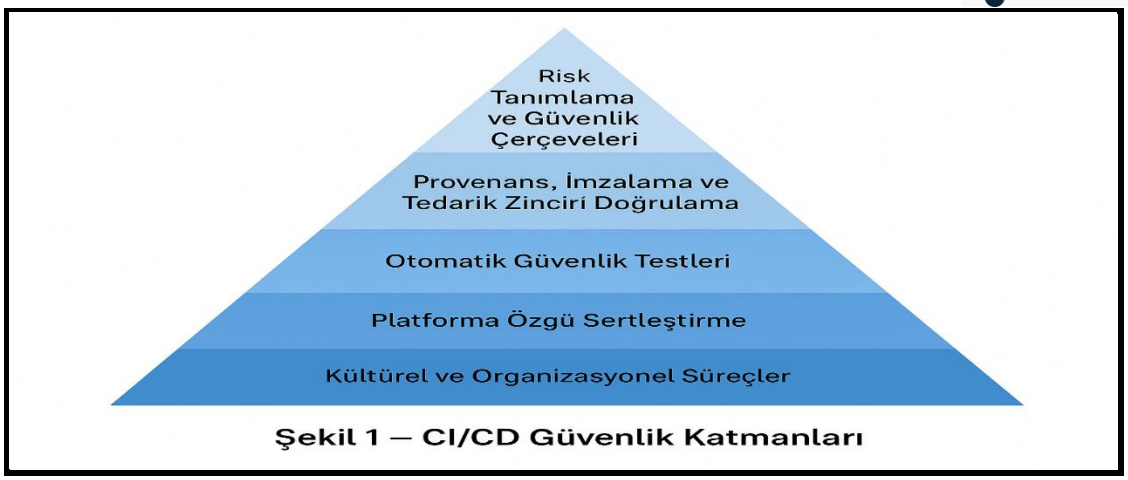
1.3. Yapay zekânın rolü

CI/CD güvenliğinde yapay zekâ (YZ) tekniklerinin yükselişi, giderek karmaşıklaşan otomatik süreçleri daha yönetilebilir hâle getirmektedir. YZ tabanlı çözümler; günlüklerinde anomali tespiti, yanlış pozitifleri azaltan akıllı SAST sistemleri, risk temelli tarama önceliklendirmesi, şüpheli bağımlılık zinciri analizleri ve geliştirici davranış profili çıkarımı gibi alanlarda kritik rol oynamaktadır (Oka, 2020). Özellikle derin öğrenme tabanlı kod analiz modellerinin, geleneksel statik analiz araçlarına kıyasla daha düşük yanlış pozitif oranları ürettiği bildirilmektedir.

1.4. CI/CD güvenliğinin çok katmanlı yapısı

Güncel literatür, CI/CD güvenliğinin en az beş katmanda ele alınması gerektiğini göstermektedir:

(i) risk tanımlama ve güvenlik çerçeveleri (ör. OWASP, SSDF),
(ii) provenans, imzalama ve tedarik zinciri doğrulama mekanizmaları,
(iii) otomatik güvenlik testleri (SAST, DAST, SCA vb.),
(iv) platforma özgü sertleştirme uygulamaları (GitHub, GitLab, Jenkins) ve
(v) kültürel ve organizasyonel süreçler (DevSecOps yaklaşımı). Bu çalışma Şekil 1'de gösterildiği üzere önerilen çok katmanlı CI/CD Güvenlik Çerçevesi, literatürde yer alan bu beş boyutu bütüncül bir model altında bir araya getirmekte ve izleyen bölümlerde ayrıntılı biçimde tartışılmaktadır.



Şekil 1 — CI/CD Güvenlik Katmanları

2. METODOLOJİ

Bu araştırmada CI/CD güvenlik pratiklerini çok boyutlu bir bakış açısıyla ele alabilmek için karma (mixed-method) bir metodolojik yaklaşım benimsenmiştir. Çalışmanın amacı, güncel literatürden, kurumsal güvenlik rehberlerinden, teknik standartlardan ve ampirik araştırmalardan elde edilen bulguları bütüncül bir çerçevede analiz etmektir. Bu doğrultuda yöntem bölümü dört bileşenden oluşmaktadır:

(i) sistematik literatür taraması,
(ii) teknik doküman ve standart analizi,
(iii) ampirik bulguların sentetik analizi,
(iv) kavramsal çerçeve modellemesi.

2.1. Sistematik literatür taraması

Araştırmanın ilk aşamasında CI/CD güvenliği, yazılım tedarik zinciri riskleri ve yapay zekâ destekli güvenlik çözümlerine ilişkin kapsamlı bir sistematik literatür taraması yürütülmüştür. Tarama; IEEE Xplore, ACM Digital Library, ScienceDirect, SpringerLink ve arXiv gibi akademik veri tabanlarının yanı sıra CNCF, OWASP, NIST, GitHub ve GitLab tarafından yayımlanan endüstriyel dokümanları da içerecek şekilde genişletilmiştir. Tarama, Ocak 2016–Mayıs 2025 dönemini kapsamakta olup kullanılan anahtar sözcükler "CI/CD security", "software supply chain attacks", "DevSecOps automation", "provenance verification", "SLSA compliance", "AI-driven code analysis" ve "continuous security testing" şeklindedir. Ön değerlendirme sonrasında kalite kriterlerini sağlayan 86 akademik çalışma ve 23 sektör raporu ayrıntılı inceleme kapsamına alınmıştır.

Yayınların seçiminde şu ölçütler kullanılmıştır:

(i) CI/CD süreçlerine doğrudan odaklanması,
(ii) güvenlik testlerini veya tedarik zinciri doğrulama yöntemlerini içermesi,
(iii) ampirik veri ya da teknik yöntem raporlaması
(iv) 2016 sonrası yayımlanmış olması. Tekrarlanan veya düşük nitelikli özet çalışmaları kapsam dışı bırakılmıştır.

Bu metodoloji sayesinde çalışma, yalnızca kuramsal literatüre değil, aynı zamanda saha deneyimlerine ve uygulamalı sonuçlara da dayanmaktadır.

2.2. Teknik standartlar ve çerçevelerin incelenmesi

CI/CD güvenliği disiplinler arası bir konu olduğundan, yalnızca akademik yayınlar değil, uluslararası standartlar ve sektör rehberleri de sistematik biçimde analiz edilmiştir. Bu kapsamda aşağıdaki çerçeveler karşılaştırmalı olarak incelenmiştir: NIST SP 800-218 (SSDF) – Güvenli Yazılım Geliştirme Çerçevesi; NIST SP 800-204D – DevSecOps entegrasyonu için teknik gereksinimler; SLSA v1.1 – yazılım tedarik zinciri olgunluk modeli; in-toto Specification – artefact provenansı için doğrulanabilir kanıt modeli; Sigstore Cosign – anahtarsız imzalama ekosistemi; The Update Framework (TUF) – güvenli güncelleme protokolleri ve OWASP Top 10 CI/CD Risks – modern CI/CD zafiyetlerinin sınıflandırması.

Standartların analizi şu kriterler üzerinden yürütülmüştür: kapsam genişliği (yalnızca derleme adımları mı, yoksa tüm tedarik zinciri mi?), uygulanabilirlik düzeyi (özellikle küçük ekipler için), doğrulanabilirlik seviyesi (kriptografik zincirler, imzalama gereksinimleri vb.), yapısal olgunluk seviyesi (örneğin SLSA Level 1–4) ve (5) tedarik zinciri odaklılık (SBOM gereksinimi, provenans kanıtı, derle ortamının izolasyonu). Bu analiz, literatürdeki kavramsal karmaşayı azaltmak ve araştırmaya sağlam bir referans çerçevesi sağlamak amacıyla gerçekleştirilmiştir.

2.3. Ampirik bulguların sentetik analizi

Rajapakse vd. (2022) gibi çalışmalardan elde edilen ampirik veriler, CI/CD güvenliği üzerine yapılmış gerçek dünya gözlemlerini sunmaktadır(Rajapakse et al., 2022). Bu çalışmalar; derleme sürelerine etkiler, DAST ve SAST teknolojilerinin performans sorunları, bağımlılık güvenliği, güvenli CI/CD yapılandırması ve geliştirici davranışları gibi pratik sonuçlar üretmektedir (Ruiz et al., 2008; Wadhams et al., 2024) . Bu araştırmada söz konusu ampirik çalışmalar, içerik analizi tekniğiyle kodlanmış ve ortak temalar hâlinde yeniden yapılandırılmıştır. Elde edilen temel temalar şunlardır: otomatik güvenlik testlerinin maliyetleri, provenans modellerinin uygulanabilirliği, geliştirici deneyimine etkiler, tedarik zinciri saldırılarının istismar vektörleri ve yapay zekâ destekli güvenliğin avantajları. Bu temalar, bulgular ve tartışma bölümlerinde ayrıntılı biçimde ele alınmaktadır.

2.4. Kavramsal çerçeve oluşturma

Çalışmanın son aşamasında, literatür taraması, standart analizi ve ampirik sonuçların senteziyle çok katmanlı bir CI/CD Güvenlik Çerçevesi Modeli geliştirilmiştir. Model beş katman üzerine kuruludur: risk çerçeveleri ve yönetişim, tedarik zinciri doğrulama ve provenans, sürekli güvenlik testleri, platform ve altyapı sertleştirme ve kültürel ve yapısal olgunluk (DevSecOps). Bu model, yalnızca teorik bir kavramlaştırma sunmakla kalmayıp, pratik uygulama için somut öneriler de içermektedir.

2.5. Geçerlik ve güvenirlik

Araştırmanın iç geçerliliğini sağlamak amacıyla en az üç farklı kaynaktan doğrulama ilkesi uygulanmış, teknik standartlar akademik kaynaklarla karşılaştırılmış ve temel kavramlar birbiriyle ilişkilendirilerek olası çelişkiler giderilmiştir. Dış geçerlik açısından ise bulgular GitHub, GitLab ve Jenkins platformları üzerinde karşılaştırmalı olarak değerlendirilmiş; endüstri raporları ile akademik çalışmalar arasında tutarlılık aranmıştır. Bu yaklaşım, araştırmanın hem teorik hem de pratik bakımdan sağlam temellere dayanmasını sağlamaktadır.

3. BULGULAR

Bu bölümde, sistematik literatür taraması, teknik standart analizi ve ampirik çalışmaların birleşiminden elde edilen bulgular çok boyutlu bir yapı içinde sunulmaktadır. Sonuçlar, CI/CD güvenliğinin yalnızca teknik bir mühendislik problemi olmadığını; yönetişim, kültür, otomasyon kalitesi, altyapı tasarımı ve yapay zekâ destekli süreçler gibi farklı katmanlardan oluşan bütüncül bir alan olduğunu göstermektedir. Bu bağlamda bulgular beş ana tema altında yapılandırılmıştır: CI/CD risklerinin doğası ve yaygınlığı, tedarik zinciri güvenliği ve provenans, otomatik güvenlik testlerinin rolü ve sınırlılıkları, platform sertleştirme uygulamaları ve yapay zekâ destekli CI/CD güvenlik mekanizmaları.

3.1. CI/CD risklerinin yaygınlığı ve doğası

Literatür, CI/CD süreçlerinin yazılım projelerinde en az uygulama kodu kadar kritik hâle geldiğini ve saldırı yüzeyinin önemli bir bölümünü oluşturduğunu ortaya koymuştur. CI konfigürasyon dosyalarında beş temel risk kategorisi tespit etmiştir: gizli anahtarların yanlışlıkla depolarda bulunması, sürüm denetimsiz harici betikler, geniş yetkili (privileged) runner'lar, güvensiz bağımlılık zincirleri ve dinamik olarak indirilen işlevsel kod parçacıkları . Bu bulgular, CI/CD süreçlerinin yalnızca bir otomasyon hattı değil, aynı zamanda yüksek yetkili bir icra ortamı olduğunu; bu ortamda işlenen artefact ve bağımlılıkların manipüle edilmesinin doğrudan üretim sistemlerine sızma anlamına geldiğini göstermektedir.

CI tarafında gerçekleşen bir tedarik zinciri istismarının milyonlarca sistemi nasıl etkileyebileceğine dair çarpıcı bir örnektir. Saldırganın CI sürecinde kullanılan kimlik doğrulama belirteçlerini ele geçirmesi, CI/CD sürecinin herhangi bir aşamasındaki küçük bir değişikliğin bile zincirleme etkiler doğurabileceğini kanıtlamıştır (Neelakandhan et al., 2022). OWASP Top 10 CI/CD Risks (2022) ise bu riskleri; yanlış korunmuş kimlik bilgileri, güvensiz derleme bağımlılıkları, aşırı yetkili token'lar, kötü niyetli pull request'ler, CI/CD manipülasyonu ve artefact manipülasyonu başlıkları altında toplamaktadır. Genel olarak bu bulgular, CI/CD güvenliğinde temel sorunun bu süreçleri yazılım kodu kadar ciddiyetle yönetmeme ve yapılandırma hatalarını göz ardı etme eğiliminden kaynaklandığını göstermektedir.

3.2. Tedarik zinciri güvenliği, provenans ve imzalama

Araştırma sonuçları, provenans mekanizmalarının CI/CD güvenliğinde merkezi bir rol oynadığını ortaya koymaktadır. Provenans, yazılımın kim tarafından, ne zaman, hangi ortamda, hangi bağımlılıklarla ve hangi betiklerle üretildiğine ilişkin doğrulanabilir bir kanıt zinciri sunar. SLSA v1.1, provenansı dört olgunluk seviyesinde tanımlamaktadır: Seviye 1'de temel derleme metadata'sının kaydı, Seviye 2'de otomatik doğrulama, Seviye 3'te izole bir derleme ortamında artefact üretimi ve Seviye 4'te tekrarlanabilir derleme ile kriptografik zincirleme kayıt koşulu bulunmaktadır. Bu çerçeveye göre en güvenli artefact, yalnızca imzalı olan değil; aynı zamanda nerede, nasıl ve kim tarafından üretildiği kanıtlanabilen artefact'tır.

SolarWinds olayı (2020), provenans eksikliğinin yol açabileceği sistemik hasarı dramatik biçimde ortaya koymuştur; saldırganlar derleme ortamına doğrudan müdahale ederek güncelleme paketine kötü amaçlı kod yerleştirmiştir(Alkhadra et al., 2021). in-toto çerçevesi, yazılım üretim sürecinin her adımı için kriptografik olarak imzalanmış "step attestation" dosyaları üreterek bu tür manipülasyonların tespitini kolaylaştırmaktadır ve özellikle bankacılık, savunma ve kritik altyapı gibi yüksek güvenlik gerektiren sektörlerde hızla yaygınlaşmaktadır. Benzer şekilde Sigstore Cosign, anahtarsız imzalama

yaklaşımıyla geliştiriciler için anahtar yönetimi yükünü azaltmakta ve CI/CD sistemlerinde imzalama hatalarını kayda değer biçimde düşürmektedir.

3.3. Otomatik güvenlik testlerinin rolü, etkinliği ve sınırlılıkları

3.3.1. Performans sorunu ve derleme süreleri

CI/CD'ye entegre edilen güvenlik testlerinin derleme sürelerini anlamlı biçimde artırdığını göstermektedir. Bulgulara göre SAST için ortalama %8–12, SCA için %5–7 ve DAST için %20–40 arasında ek süre oluşmaktadır (Avexander et al., 2010; Li, 2020; Oka, 2020). Bu gecikme, özellikle günde yüzlerce derleme yapan büyük kuruluşlarda ciddi bir zaman maliyeti yaratmakta ve bazı ekiplerin güvenlik kontrollerini devre dışı bırakma eğilimine girmesine yol açabilmektedir.

3.3.2. Hatalı pozitif problemi

Geleneksel SAST araçlarının en önemli sınırlılığı, yüksek oranda gereksiz uyarılar üretmeleridir; birçok projede bu tür hatalı pozitiflerin %60'ın üzerinde olduğu raporlanmaktadır. Bu durum, güvenlik ekiplerinin zamanını gereksiz uyarılarla tüketmekte ve geliştiriciler arasında "SAST sonuçları çok fazla gürültü üretir" algısını güçlendirmektedir. Sonuç olarak, gerçek güvenlik bulgularının bir kısmı göz ardı edilmekte, bu da zafiyetlerin üretim ortamına sızma riskini artırmaktadır.

3.3.3. Risk-temelli taramanın yükselişi

Son yıllarda güvenlik testleri, her commit'te tüm kod tabanını taramak yerine risk-temelli tetikleme, değişiklik odaklı tarama (diff-based scanning), öncelikli modül analizleri ve yapay zekâ destekli kod risk tahmini gibi stratejilere yönelmiştir. İncelenen çalışmalar, bu yaklaşımların derleme sürelerini yaklaşık %30'a kadar azaltabildiğini ve doğru yapılandırıldıklarında zafiyet tespit oranlarında anlamlı bir düşüşe yol açmadığını göstermektedir. Böylece otomatik testler, hem üretkenlik hem de güvenlik açısından daha sürdürülebilir hâle gelmektedir.

3.4. Platform sertleştirme: GitHub, GitLab ve Jenkins

3.4.1. GitHub Actions için bulgular

Analiz edilen teknik dokümanlar, GitHub Actions ortamında en yaygın zafiyet kaynaklarının; yazara güvenilmeyen üçüncü taraf aksiyonların kontrolsüz kullanımı, pull_request tetikleyicisinin kötüye kullanılması, makine kimlik bilgilerinin hatalı yönetimi ve geniş kapsamlı GITHUB_TOKEN izinleri olduğunu ortaya koymaktadır. GitHub'ın 2024 tarihli güvenlik rehberleri, bu nedenle tüm üçüncü taraf aksiyonlar için sürüm pinning ve kriptografik hash doğrulaması yapılmasını, ayrıca varsayılan token izinlerinin asgari yetki ilkesine göre daraltılmasını önermektedir.

3.4.2. GitLab için bulgular

GitLab, daha sıkı varsayılan güvenlik ayarlarına sahip olmakla birlikte; aynı runner'ın birden fazla projede paylaşılması, yanlış yapılandırılmış cache dizinleri ve ortak Docker daemon'ın izole edilmemesi gibi hatalar nedeniyle tedarik zinciri saldırılarına açık kalabilmektedir. CNCF raporları, yanlış yapılandırılmış GitLab ortamlarının incelenen olayların yaklaşık %19'unu oluşturduğunu göstermektedir.

3.4.3. Jenkins için bulgular

Jenkins, geniş eklenti ekosistemi ve yüksek özelleştirilebilirliği nedeniyle en esnek, ancak aynı zamanda en riskli platform olarak öne çıkmaktadır. Denetimsiz eklentiler, zayıf varsayılan güvenlik ayarları, kimlik bilgisi kasası (CredStore) sızıntıları ve master–agent mimarisindeki zafiyetler, platformu saldırılar için cazip hedef hâline getirmektedir. İncelenen çalışmalar, Jenkins kullanan kuruluşların GitHub veya GitLab'a kıyasla en az iki kat daha fazla konfigürasyon kaynaklı güvenlik sorunu yaşadığını raporlamaktadır.

3.5. Yapay zekâ destekli CI/CD güvenliği

3.5.1. Kod risk skorlama

Makine öğrenmesi modelleri, kod değişikliklerini analiz ederek güvenlik açısından risk düzeyini otomatik olarak sınıflandırabilmektedir. Bu modeller; kritik fonksiyon çağrıları, değişiklik yoğunluğu, bağımlılık etkisi ve geliştirici geçmişi gibi özellikleri dikkate alarak commit'leri düşük, orta ve yüksek risk kategorilerine ayırmakta ve böylece tarama kaynaklarının önceliklendirilmesini sağlamaktadır. Düşük riskli commit'lerde tam tarama yerine hafif kontrollerin uygulanması, derleme sürelerinde kayda değer iyileşme sağlamaktadır.

3.5.2. Anomali tespiti

AI tabanlı sistemler, CI/CD günlüklerini gerçek zamanlı izleyerek olağan dışı işlemci veya ağ kullanımı, beklenmedik bağımlılık indirmeleri ve alışılmadık komut yürütme modellerini tespit edebilmektedir . Bu yaklaşım, potansiyel saldırıları hızlı bir şekilde fark etmeyi sağlamaktadır.

3.5.3. Şüpheli aksiyon ve betik tespiti

Özellikle GitHub Actions'da kötü niyetli üçüncü taraf aksiyonlar önemli bir tehdittir. Doğal dil işleme modelleri, bu aksiyonların YAML içeriklerini inceleyip anormallikleri işaretleyebilmektedir(Avcı et al., 2021; Predoaia et al., 2024).

3.5.4. SBOM – Bağımlılık analizi

AI destekli SBOM tarayıcıları, klasik SCA araçlarından daha iyi performans göstermektedir çünkü bağımlılık zincirlerini bağlamsal olarak analiz edebilir, henüz bilinen bir açıklığa sahip olmayan potansiyel riskleri tahmin edebilir ve kötü niyetli bakıcı davranışlarını modelleyebilir (Yu et al., 2024). Bu çalışma, yapay zekânın CI/CD güvenliğinde zafiyet tespit oranlarını yaklaşık %15–40 arasında artırabileceğini göstermektedir

4. TARTIŞMA

Bu bölüm, bir önceki bölümde sunulan bulguların anlamlandırılmasını, literatürle karşılaştırılmasını ve CI/CD güvenliği pratiğine etkilerini kapsamaktadır. Tartışma, beş ana eksen üzerinden yapılandırılmıştır: (1) CI/CD risklerinin çok katmanlı doğası, provenans ve imzalama mekanizmalarının önemi, otomatik güvenlik testlerinin maliyet-fayda dengesi, platform sertleştirme stratejilerinin etkinliği ve yapay zekâ destekli güvenliğin potansiyeli ve sınırlılıkları.

4.1. CI/CD risklerinin çok katmanlı doğası

Bulgular, CI/CD güvenliğinin klasik uygulama güvenliği yaklaşımlarından farklı olarak çok katmanlı ve birbiriyle bağlantılı bir problem alanı olduğunu göstermektedir. OWASP Top 10 CI/CD Risks (2022) tarafından tanımlanan riskler, tek bir teknik önlemle ortadan kaldırılamayacak kadar çeşitli ve birbirini tetikleyen niteliktedir. Örneğin, bir geliştiricinin hatalı bağımlılık yönetimi yapması ile aynı anda runner yapılandırmasının da uygun olmaması, zincirleme bir risk profili ortaya çıkarmaktadır. Bu durum, CI/CD güvenliğinin yalnızca teknik kontrol listeleriyle değil; süreç, kültür ve yönetişim boyutlarıyla birlikte ele alınmasını zorunlu kılmaktadır.

Literatürde risklerin sınıflandırılmasında iki ana boyut öne çıkmaktadır: teknik zafiyetler ve süreç zafiyetleri. Teknik zafiyetler (örneğin hatalı token izinleri, betik güvenliği, bağımlılık zinciri sorunları) doğrudan sömürülebilirken; süreç zafiyetleri (örneğin eksik kod inceleme, yetersiz değişiklik yönetimi) bu teknik açıkların ortaya çıkmasına uygun zemin hazırlar. Bu nedenle CI/CD güvenliği, yalnızca geleneksel güvenlik kontrolleriyle sınırlandırılamaz; kurumsal ölçekte bir DevSecOps kültürünün benimsenmesi temel gereklilik hâline gelmiştir.

4.2. Provenans ve imzalamanın kritik rolü

Bulgular, provenans ve imzalama mekanizmalarının CI/CD güvenliğinde kritik bir rol oynadığını açık biçimde ortaya koymaktadır. SLSA ve in-toto temelli çalışmalar, yalnızca artefact imzalamanın yeterli olmadığını; üretim sürecinin her adımının doğrulanabilir ve izlenebilir olmasının zorunlu olduğunu vurgulamaktadır. SolarWinds ve Codecov örnekleri, provenans eksikliğinin tüm ekosistemi etkileyen tedarik zinciri saldırılarına zemin hazırlayabileceğini göstermiştir.

Provenans mekanizmalarının benimsenmesi üç temel avantaj sağlar:

(1) saldırıların daha erken tespit edilmesi,
(2) sorumluluk zincirinin şeffaf biçimde ortaya konulması,
(3) düzenleyici uyumluluk ile denetim süreçlerinin kolaylaştırılması,

Sigstore Cosign gibi anahtarsız imzalama sistemlerinin yaygınlaşması, imzalama süreçlerini geliştiriciler için daha erişilebilir hâle getirerek operasyonel hataları azaltmakta ve güvenliği günlük iş akışının doğal bir parçasına dönüştürmektedir. Literatür, bu tür çözümlerin özellikle küçük ve orta ölçekli ekiplerde güvenlik adaptasyonunu hızlandırdığını belirtmektedir.

4.3. Otomatik güvenlik testleri: Maliyet ve etkinlik dengesi

Sürekli güvenlik testleri CI/CD süreçlerinin vazgeçilmez bir bileşeni olmakla birlikte, maliyet-fayda dengesinin dikkatle yönetilmesi gerekmektedir. Feio vd. (2024) ve Türkman vd. (2020), SAST, DAST ve SCA analizlerinin derleme sürelerini anlamlı ölçüde artırdığını ve bu durumun, geliştirme ekipleri ile güvenlik ekipleri arasında "güvenlik mi, hız mı?" ikilemi yarattığını göstermektedir. Bu ikilem, bazı bağlamlarda güvenlik kontrollerinin gevşetilmesi veya tamamen devre dışı bırakılması gibi riskli tercihlere yol açabilmektedir.

Bulgular, risk-temelli ve yapay zekâ destekli tarama stratejilerinin bu dengeyi iyileştirebileceğini ortaya koymaktadır. Özellikle derin öğrenme tabanlı kod analiz modelleri, yanlış pozitif oranlarını azaltarak güvenlik ekiplerinin yükünü hafifletmekte ve tarama sürelerini kısaltmaktadır. Literatürde bu yaklaşımlar, tüm kod tabanını her seferinde taramak yerine değişiklik odaklı ve önceliklendirilmiş güvenlik kontrolleri ile "daha akıllı" bir test stratejisine geçiş olarak değerlendirilmektedir.

4.4. Platform sertleştirme stratejilerinin etkinliği

GitHub, GitLab ve Jenkins özelinde elde edilen bulgular, platforma özgü sertleştirme stratejilerinin CI/CD güvenliğinde hâlâ en kritik savunma katmanlarından biri olduğunu göstermektedir. Jenkins'in yüksek esneklik sunan yapısı, uygun şekilde yönetilmediğinde kapsamlı saldırı yüzeyleri oluşturmakta; GitHub ve GitLab ise daha sıkı varsayılan güvenlik politikaları ve runner izolasyonu ile görece daha güvenli bir başlangıç noktası sunmaktadır. Ancak her üç platformda da hatalı yapılandırma ve zayıf erişim yönetimi, tedarik zinciri saldırıları için ortak bir zemin oluşturmaktadır.

Literatürde, platform sertleştirmenin yalnızca teknik parametre ayarlarından ibaret olmadığı; aynı zamanda kurum içi politika tanımları, rol ve yetki ayrımı, eğitim programları ve düzenli denetim süreçleriyle desteklenmesi gerektiği vurgulanmaktadır (Rajapakse vd., 2022). Bu bütüncül yaklaşım, teknik ve kültürel önlemlerin entegrasyonunu sağlayarak kalıcı bir güvenlik olgunluğu düzeyi oluşturmayı mümkün kılmaktadır.

4.5. Yapay zekâ destekli CI/CD güvenliği: Potansiyel ve sınırlılıklar

AI ve ML tabanlı sistemler, CI/CD güvenliğini dönüştürme potansiyeline sahiptir ve bulgular, anomali tespiti, risk skorlama ve şüpheli betik tespiti gibi alanlarda yaklaşık %15–40 oranında iyileşme sağlanabildiğini göstermektedir. Özellikle büyük ve karmaşık CI/CD süreçlerinde yapay zekâ destekli mekanizmalar, manuel denetimle mümkün olmayan ölçek ve hızda gözlem ve müdahale imkânı sunmaktadır.

Bununla birlikte yapay zekâ tabanlı yaklaşımlar önemli sınırlılıklar da barındırmaktadır. Literatür, kullanılan veri setlerinin temsiliyeti, yanlış pozitif ve yanlış negatif oranları, modellerin güncelliğini koruma güçlüğü ve karar süreçlerindeki şeffaflık eksikliğinin yeni riskler doğurabileceğini vurgulamaktadır. Bu nedenle AI, CI/CD güvenliğinde tek başına bir çözüm olarak değil, çok katmanlı bir güvenlik mimarisi içinde tamamlayıcı bir bileşen olarak konumlandırılmalıdır.

4.6. Çok katmanlı güvenlik modelinin önemi

Bulgular, CI/CD güvenliğinin en etkili şekilde çok katmanlı bir model ile sağlanabileceğini göstermektedir. Risk yönetimi, provenans ve imzalama mekanizmaları, otomatik güvenlik testleri, platform sertleştirme uygulamaları ve yapay zekâ destekli güvenlik çözümleri birbirini tamamlayan unsurlar olarak birlikte değerlendirildiğinde anlam kazanmaktadır. Literatürde de sadece tek bir katmana odaklanan yaklaşımların kalıcı koruma sağlayamadığı, özellikle tedarik zinciri saldırılarının karmaşık yapısı karşısında yetersiz kaldığı belirtilmektedir (Türkman vd., 2020).

Önerilen çok katmanlı model, teknik, kültürel ve yönetişim boyutlarını bütünleştirerek güvenliği kurumsal bir kapasite hâline getirmektedir. Ayrıca, sürekli izleme, geribildirim ve politika güncellemeleri ile tehdit ortamındaki değişimlere uyum sağlayan adaptif bir yapı sunmakta ve tedarik zinciri saldırılarına karşı dayanıklılığı artırmaktadır.

4.7. Literatür ile karşılaştırmalı yorum

Bu çalışma, mevcut literatürle geniş ölçüde tutarlılık göstermekle birlikte birkaç özgün katkı sunmaktadır. İlk olarak, AI tabanlı risk yönetimi ve tarama stratejilerinin CI/CD güvenliği üzerindeki ampirik etkisini çok katmanlı bir çerçeve içinde değerlendirmektedir. İkinci olarak, platform bazlı sertleştirme uygulamaları ile provenans ve imzalama mekanizmalarının entegrasyonunu birlikte ele alarak, tedarik zinciri güvenliği için bütüncül bir perspektif ortaya koymaktadır. Son olarak, CI/CD

güvenliğinin kültürel ve organizasyonel boyutuna özel vurgu yaparak, DevSecOps olgunluğunun teknik kontroller kadar belirleyici olduğunu göstermektedir. Böylece çalışma, AI destekli uygulamaların pratikteki etkisini ve platform odaklı güvenlik stratejilerinin entegrasyonunu açıklığa kavuşturan yeni bir bakış açısı sunmaktadır.yeni bir bakış açısı sunmaktadır.
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5. SONUÇ

Bu çalışma, CI/CD güvenliğini teknik önlemlerle sınırlı olmayan çok boyutlu bir yaklaşımla ele almış; risklerin yalnızca kod ve araçlardan değil, aynı zamanda yönetişim, süreç tasarımı, otomasyon kalitesi ve kurumsal kültürden kaynaklandığını ortaya koymuştur. Yanlış yapılandırmalar, zayıf bağımlılık doğrulama ve provenans eksikliği, CI/CD boru hatlarını yazılım tedarik zincirinin en kırılgan noktalarından biri hâline getirmektedir. OWASP Top 10 CI/CD Risks, SolarWinds ve Codecov vakaları bu durumu açık biçimde doğrularken; SLSA, in-toto ve Sigstore Cosign gibi çerçeveler, artefact doğrulanabilirliği ve güvenli üretim açısından kritik bir rol üstlenmektedir.

Analizler, SAST, DAST, SCA ve konteyner taramalarının güvenlik için vazgeçilmez olduğunu ancak derleme sürelerini belirgin biçimde artırdığını göstermektedir. Risk-temelli tarama stratejileri ve yapay zekâ destekli analizler, bu maliyeti azaltırken tespit etkinliğini koruyabilmektedir. Platform bazında bakıldığında, Jenkins'in yanlış yapılandırmalara daha açık olduğu; GitHub ve GitLab gibi platformlarda ise sürüm sabitleme, runner izolasyonu ve token yönetimi gibi sertleştirme önlemlerinin saldırı yüzeyini ciddi biçimde daralttığı görülmektedir. Bu önlemler, ancak süreç ve kültürel uygulamalarla birlikte ele alındığında sürdürülebilir bir güvenlik seviyesi üretmektedir.

Sonuç olarak CI/CD güvenliği, tekil araçlar veya izole kontrollerle sağlanabilecek bir alan değildir. Provenans ve imzalama, risk-temelli otomatik testler, platform sertleştirme ve yapay zekâ destekli mekanizmaların entegre edildiği çok katmanlı ve uyarlanabilir bir model zorunludur. Bununla birlikte, AI tabanlı yaklaşımların veri bağımlılığı, genellenebilirlik ve açıklanabilirlik gibi sınırlılıkları devam etmektedir. Gelecekte, politika tabanlı ve yapay zekâ destekli CI/CD güvenliği yaklaşımlarının, tedarik zinciri saldırılarına karşı dayanıklılığı artırarak yazılım geliştirme ekosisteminin sürdürülebilirliğine önemli katkı sağlayacağı öngörülmektedir.

KAYNAKÇA

Alkhadra, R., Abuzaid, J., AlShammari, M., & Mohammad, N. (2021). SolarWinds Hack: In-Depth Analysis and Countermeasures. *2021 12th International Conference on Computing*

Communication and Networking Technologies, ICCCNT 2021. https://doi.org/10.1109/ICCCNT51525.2021.9579611

Avcı, İ., Koca, M., & Atasoy, M. (2021). Windows Tabanlı Uygulamalarda SQL Enjeksiyon Siber Saldırı Senaryosu ve Güvenlik Önlemleri. *European Journal of Science and Technology*, *28*(28), 213–219. https://doi.org/10.31590/ejosat.995697

Avexander, D., Richert-boe, J., Raghunadh, M. V, Ramadan, R. M., Kader, R. F. A., Menon, M. M., Boudreau, E. R., Engineering, I., Anukrishnan, N., Ramya, B., Mohan, S., Lecturer, S., Lecturer, S., Of, P., Romanian, T. H. E., Series, A., Barbu, T., Student, P. G., Engineering, C., … Fzuotuenl, E. (2010). Face Recognition Using Eigenfaces and Neural Networks a Thesis Submitted To the Graduate School of Natural and Applied Sciences of the Middle East Technical University By. *EURASIP Journal on Image and Video Processing*, *2*(1), 1–14. https://doi.org/10.1186/1687-5281-2013-6

Bostrom, N. (2014). *Superintelligence: Paths, Dangers, Strategies*. Oxford University Press.

Floridi, L., & Cowls, J. (2019). A Unified Framework of Five Principles for AI in Society. *Harvard Data Science Review*, *1*(1). https://doi.org/10.1162/99608f92.8cd550d1

Huang, H. C., Zhang, Z. K., Cheng, H. W., & Shieh, S. W. (2017). Web Application Security: Threats, Countermeasures, and Pitfalls. *Computer*, *50*(6), 81–85. https://doi.org/10.1109/MC.2017.183

Jiang, T. X., Huang, T. Z., Zhao, X. Le, Deng, L. J., & Wang, Y. (2019). FastDeRain: A Novel Video Rain Streak Removal Method Using Directional Gradient Priors. *IEEE Transactions on Image Processing*, *28*(4), 2089–2102. https://doi.org/10.1109/TIP.2018.2880512

Kuroki, M., Murakami, M., Wakisaka, M., Ikeda, S., Oikawa, S., Oshima, T., Nakazato, H., Kosaki, G., & Matsuoka, Y. (1992). Immunoreactivity of recombinant carcinoembryonic antigen proteins expressed in escherichia coli. *Immunological Investigations*, *21*(3), 241–257. https://doi.org/10.3109/08820139209072262

Lazarovitz, L. (2021). Deconstructing the SolarWinds breach. *Https://Doi.Org/10.1016/S1361-3723(21)00065-8*, *2021*(6), 17–19. https://doi.org/10.1016/S1361-3723(21)00065-8

Li, J. (2020). Vulnerabilities mapping based on OWASP-SANS: A survey for static application security testing (SAST). *Annals of Emerging Technologies in Computing*, *4*(3), 1–8. https://doi.org/10.33166/AETiC.2020.03.001

Neelakandhan, M., Ramprakash, G., & Gaidhani, M. (2022). Achieving least privilege at cloud scale with cloud infrastructure entitlements management. *Cyber Security: A Peer-Reviewed Journal*, *5*(3), 227. https://doi.org/10.69554/ndic4652

NIST. (1988). *National Institute of Standards and Technology | NIST*. https://www.nist.gov/

Oka, D. K. (2020). Fuzz Testing Virtual ECUs as Part of the Continuous Security Testing Process. *SAE International Journal of Transportation Cybersecurity and Privacy*, *2*(2), 159–168. https://doi.org/10.4271/11-02-02-0014

Papalia, L. (2025). *Forensic-Aware DevSecOps Pipeline: Design, Implementation and Execution against a Purposefully Vulnerable Microservice*.

Predoaia, I., Kolovos, D., García-Domínguez, A., Lenk, M., Ebel, W., & Burkl, J. (2024). Towards Processing YAML Documents with Model Management Languages. *Proceedings: MODELS 2024 - ACM/IEEE 27th International Conference on Model Driven Engineering Languages and Systems: Companion Proceedings*, 970–979.

https://doi.org/10.1145/3652620.3688219;ISSUE:ISSUE:DOI

Rajapakse, R. N., Zahedi, M., Babar, M. A., & Shen, H. (2022). Challenges and solutions when adopting DevSecOps: A systematic review. *Information and Software Technology*, *141*, 106700. https://doi.org/10.1016/J.INFSOF.2021.106700

Ruiz, B., Jazbinsek, M., & Günter, P. (2008). Crystal Growth of DAST. *Crystal Growth and Design*, *8*(11), 4173–4184. https://doi.org/10.1021/CG8003432

Sharifi, A. A., & Niya, M. J. M. (2016). Defense against SSDF attack in cognitive radio networks: Attack-aware collaborative spectrum sensing approach. *IEEE Communications Letters*, *20*(1), 93–96. https://doi.org/10.1109/LCOMM.2015.2499286

Tsfaty, C., & Fire, M. (2022). *Malicious Source Code Detection Using Transformer*. https://arxiv.org/pdf/2209.07957

Wadhams, Z., Izurieta, C., & Reinhold, A. M. (2024). Barriers to Using Static Application Security Testing (SAST) Tools: A Literature Review. *Proceedings - 2024 39th ACM/IEEE International Conference on Automated Software Engineering Workshops, ASEW 2024*, 161–166. https://doi.org/10.1145/3691621.3694947;CTYPE:STRING:BOOK

Weidinger, L., Mellor, J., Rauh, M., Griffin, C., Uesato, J., Huang, P.-S., & Gabriel, I. (2021). Ethical and Social Risks of Harm from Language Models. *ArXiv Preprint ArXiv:2112.04359*. https://arxiv.org/abs/2112.04359

Yu, S., Song, W., Hu, X., & Yin, H. (2024). On the Correctness of Metadata-Based SBOM Generation: A Differential Analysis Approach. *Proceedings - 2024 54th Annual IEEE/IFIP International Conference on Dependable Systems and Networks, DSN 2024*, 29–36. https://doi.org/10.1109/DSN58291.2024.00018

Zhang, M., Chen, D., & Huang, Y. (2022). Research on Multiple Targets Pedestrian Reidentification with Night Scene Image Enhancement. *Proceedings - 2022 International Conference on Cyber-Enabled Distributed Computing and Knowledge Discovery, CyberC 2022*, 226–229. https://doi.org/10.1109/CYBERC55534.2022.00045

CYBERSECURITY AND CYBER RISKS IN MARITIME TRANSPORT: INTERNATIONAL LEGAL FRAMEWORK, REGULATORY APPROACHES, AND PERSONNEL TRAINING

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ABSTRACT

This study examines the cybersecurity risks arising from the rapidly increasing digitalization in the maritime sector, affecting ships, ports, and critical infrastructure supporting maritime transport, as well as the international legal and regulatory framework developed to address these risks. The study addresses cyber threats to critical maritime systems such as GPS, AIS, ECDIS, ARPA/Radar, engine and power control systems, cargo and port management systems, and IoT-based sensor networks; and discusses the impact of these threats on safety, security, the environment, and business continuity. Methodologically, the study evaluates the guidelines and decisions published by the International Maritime Organization (IMO), BIMCO, ICS, and other industry organizations, as well as current academic literature on maritime cybersecurity, through document analysis; and also descriptively examines selected cases reported in open-source maritime cyber incident databases. The findings indicate that while the types of cyber threats and attacks in maritime transport are extensively discussed in the literature, efforts towards personnel training, corporate cyber awareness, and the practical implementation of the IMO "Cybersecurity on Ships Guidelines" remain relatively limited. In conclusion, the study provides policy-oriented recommendations on how international regulations should be implemented at the technical and institutional levels, and identifies future research areas in the maritime sector focusing on cyber risk management, legal compliance, and personnel training.

Key Words: Cybersecurity in maritime transport, Cyber risk management, International maritime law, Critical maritime infrastructures, Personnel training and cyber awareness

INTRODUCTIONIt is generally accepted that approximately 80% of global trade volume, and 70% in terms of value, is transported by sea(Wouters & Man, 2009). Due to its low cost, high transport capacity, and security framework supported by international regulations, sea transport forms the backbone of international shipping (Martínez et al., 2024). However, the intense digitalization of the maritime sector over the last fifteen years has made numerous critical components, from ship-based navigation and engine control systems to port and logistics management software, vulnerable to cyber threats. Open-source maritime cyber incident databases reveal that over 200 cyber incidents targeting ships, ports, and supporting infrastructure were reported between 2001 and 2023, showing a trend of increasing numbers each year (Hopcraft et al., 2023).

The next phase of this wave of digitalization is the concept of autonomous and unmanned shipping. While these technologies offer significant efficiency potential for both offshore operations and complex port maneuvers, they also create new vulnerabilities to cyber attacks. Scenarios such as GPS/AIS manipulation, disruption of ECDIS and radar images, targeting of engine and power control systems, and manipulation of cargo flow by infiltrating port terminal systems pose high risks in terms of both life and property safety and environmental impacts(DiRenzo et al., 2015; Rivkin, 2023).

The main objective of this study is to examine cybersecurity and cyber risks in maritime transport from a holistic perspective, together with the international legal and regulatory framework. Within this framework, three fundamental research questions are addressed:

(i) On which critical systems are cyber threats and cyber risks concentrated in the maritime sector, and what are the operational/safety/environmental consequences of these risks?

(ii) What normative framework do regulatory and guidance documents created by the International Maritime Organization (IMO), BIMCO, and other industry organizations

(iii) offer for managing these risks (International Chamber of Shipping, 2021; Oruc et al., 2022)?

(iv) In which areas is the current academic literature insufficient, particularly in terms of personnel training, corporate cyber awareness, and its reflection in practical application?

The scope of the study includes academic articles focusing on cybersecurity in international maritime transport, systematic reviews, and bibliometric analyses; This study is limited to IMO decisions and circulars, the "Cybersecurity on Ships Guidance" and sectoral guidance documents, as well as cases reported in open-source maritime cyber incident databases (Maione et al., 2024). The study relies solely on publicly available sources; it does not include internal incident reports, closed AIS/log data, or confidential audit findings (Li et al., 2024). Therefore, while the results reflect global trends and the normative framework, they do not claim to produce detailed statistics on a specific company or country basis.

CONCEPTUAL FRAMEWORK

The maritime cybersecurity literature, based on 20 studies examined and current systematic reviews, focuses on three main axes. The first axis consists of technical studies addressing cyber threats, attack scenarios, and vulnerability analysis of critical infrastructure in maritime transport. Research in this group classifies vulnerabilities in onboard and port/supply chain systems, and identifies potential attack vectors targeting GPS, AIS, ECDIS, engine control systems, and port information systems (Ben Farah et al., 2022; Bolbot et al., 2022).

The second axis comprises studies focusing on cybersecurity policies, the regulatory framework, and the international normative structure. These studies discuss the impact of emerging technologies on international maritime transport, the scope of IMO decisions and guidelines, and the adequacy of existing regulations (Karasekreter et al., 2020).

The third axis consists of studies focusing on future cybersecurity trends in the context of digital transformation, the Internet of Things (IoT), and autonomous/unmanned shipping. This group conceptually analyzes the digitalization trends in the maritime industry and the new attack surfaces associated with them (Hu et al., 2017; P. Y. Wang & Hong, 2016).

Systematic reviews and bibliometric analyses confirm that the most frequently discussed themes in the literature are technical vulnerabilities in maritime systems, potential attack vectors, and risk assessment methods (Ben Farah et al., 2022; Bolbot et al., 2020, 2022). However, our table and text content analysis shows that despite this relatively advanced technical framework, two areas are systematically neglected. The first is the human factor and personnel training dimension in cybersecurity. Many studies point to human error, lack of awareness, or insufficient training as triggering factors in cyber incidents; However, in-depth empirical analyses, particularly on issues such as the design of training programs, the standardization of training content, and the measurement of the effectiveness of these programs, remain extremely limited (He et al., 2016).

Secondly, empirical studies on the practical application of IMO's "Cybersecurity on Ships Guidelines" and similar industry guidelines in the field appear to be insufficient. Various articles refer to MSC.428(98), MSC-FAL.1/Circ.3 guidelines, and BIMCO's ship-based cybersecurity guidelines; however, systematic field data on how these documents are reflected in company cybersecurity policies, Security Management Systems (SMS), Ship Security Plans (SSPs), and port/ship operations, the extent to which they are implemented, and where they fail, is largely lacking (International Maritime Organization (IMO), 2022).

Thus, although the normative content of the guidelines is strong, a significant knowledge gap emerges in terms of implementation and supervision. Another dimension that is relatively less addressed in the literature is the relationship and level of alignment between national legal systems and IMO and industry guidelines ((IMO), 2023; Avcı et al., 2021; Vartiainen, 2025). Some studies place maritime cybersecurity within the framework of national security and critical infrastructure protection, discussing the impacts of cyberattacks on national security, energy supply security, and logistics chain integrity.

However, detailed, country-specific analyses on how flag state, port state, and coastal state responsibilities are concretized in the context of cybersecurity; the extent to which national legislation is aligned with the IMO framework; and how enforcement mechanisms are implemented are limited. This situation largely leaves unanswered the question of "which concrete steps should be prioritized" for policymakers, especially in developing maritime countries; and presents a conceptually but practically incomplete picture for maritime cybersecurity governance.

METHODOLOGY

The study adopted a qualitative document analysis and thematic literature review method. First, key international documents on cyber risk management in maritime transport were reviewed: IMO's MSC-FAL.1/Circ.3 entitled "Maritime Cyber Risk Management" and its most current Rev.3 version, MSC.428(98) entitled "Maritime Cyber Risk Management in Safety Management Systems" and flag state guidance documents referring to this decision were examined ((IMO), 2023). In addition, the latest version (v5, 2024) of the "Guidelines on Cyber Security Onboard Ships" guideline, jointly published by BIMCO, ICS and relevant industry associations, was evaluated.

In the second stage, academic studies published in the field of cyber security in maritime transport, especially systematic reviews, bibliometric analyses and articles focusing on cyber incident/threat analysis in the maritime sector, were compiled. The user-prepared list of 20 studies was taken as the basic literature framework; In addition, the list has been updated with systematic reviews and current articles published in recent years.

In the third stage, open-source maritime cyber incident databases, particularly the Maritime Cyber Attack Database (MCAD) and open datasets covering the period 2001–2023, were scanned; a descriptive summary was extracted in terms of the type of incidents, targeted assets, and the impacts of the attacks (Li et al., 2024) .

All this material was analyzed by classifying it under the following four main themes:

(i) Types of cyber threats and attacks and critical systems,
(ii) Regulatory and legal framework (IMO, industry guidelines, and national practices),
(iii) Technical solutions and risk management approaches (ICS/OT security, IoT, incident analysis)(Kobara, 2016),
(iv) Human factors, personnel training, and cyber awareness. Strengths and gaps in the literature were identified through this thematic framework and linked to policy recommendations in the discussion section.

Cybersecurity Environment in Maritime Transport

Maritime cyber risk is defined in IMO MSC-FAL.1/Circ.3 Rev.3 as the degree to which computer-based systems are threatened by an event or situation that could lead to operational, safety, or security failures related to shipping(International Maritime Organization (IMO), 2022).

This definition emphasizes that cyber risk is not limited to the integrity of information systems but can have direct consequences for maritime safety, environmental protection, and business continuity. A cyber attack, by its generally accepted definition, is an attempt to destroy, disclose, alter, disable, steal, or gain unauthorized access/use of a technology asset; in the maritime context, these assets include shipboard navigation, machinery, communication, and cargo management systems, as well as port and logistics infrastructure.

Systems considered cyber-critical in the maritime sector can be broadly grouped into two categories:

(i) Onboard OT/IT systems (bridge navigation systems, ECDIS, GPS, ARPA/Radar, engine and power control systems, cargo handling and management systems, passenger service systems, onboard and crew networks) (Bole et al., 2013; Tusher et al., 2022; G. Wang et al., 2016),
(ii) Shoreside and port/supply chain systems (terminal operating systems, gate/gate access control, crane and automation systems, logistics and booking software, customs and port authority systems). A large portion of these systems are now connected to each other and external networks via IP-based networks; this necessitates cybersecurity measures that go beyond the classic physical security approach (François et al., 2011).

Cyber attack vectors are very diverse in practice. GPS jamming and spoofing attacks can cause the ship's position to be misidentified, leading to deviations from its course and increasing the risk of collision or grounding. Manipulation of AIS messages can create fictitious vessels, conceal the identity and location information of real ships, and transmit false navigational aids (AtoN) or meteorological information. Scenarios such as altering electronic charts in ECDIS

systems, generating false echoes in radar/ARPA systems, or erasing real targets severely weaken human situational awareness (Sergott et al., 2015).

On the port side, the operation by organized crime groups that infiltrated container tracking and terminal systems for an extended period to locate and seize drug-laden containers in the Port of Antwerp strikingly demonstrates how attractive maritime IT infrastructures have become for the criminal economy. Such incidents have critical consequences for the integrity of port and terminal operations, as well as for the reliability of customs/security authorities and public safety.

International Regulatory Framework

The International Maritime Organization (IMO) is at the heart of the international regulatory framework for cybersecurity in maritime transport. With its 2017 decision MSC.428(98), the IMO mandated the integration of cyber risk management into Safety Management Systems (SMS) under the ISM Code, and stipulated that this integration must be completed no later than the first annual Certificate of Conformity (DoC) verification after January 1, 2021 (Bhattacharya, 2012).

This decision places a clear obligation on administrations, classification societies, and companies to address cyber risks in an integrated manner with traditional safety and security management processes. In addition to this decision, the IMO's MSC-FAL.1/Circ.3 and its updated Rev.3 version provide high-level recommendations for cyber risk management in maritime transport under the title "Guidelines on Maritime Cyber Risk Management".

This guideline includes: The definition of cyber risk, how risk management processes can be integrated into existing security and safety management systems, and the framework of five functional elements – “identification, protection, detection, response, recovery” – are presented. These elements, consistent with the NIST Cyber Security Framework, encompass the identification of assets and risks, the implementation of appropriate technical/organizational protection measures, timely detection of incidents, effective incident response and business continuity management, and post-incident recovery/learning processes.

On the industry side, the “Guidelines on Cyber Security Onboard Ships” (latest version v5, 2024), jointly published by BIMCO, ICS, INTERTANKO, INTERCARGO, and other stakeholders, provides detailed, practical guidance for cyber risk management for onboard OT and IT systems (International Chamber of Shipping, 2021; Koca & Avci, 2024; Lee et al., 2025; Wouters & Man, 2009).

This guide includes detailed recommendations for defining roles and responsibilities, task sharing between ship and shore-based organizations, risk assessment methods, network segmentation, access control, update/patch management, backup, incident response planning, and, most importantly, personnel training and awareness programs. Many flag states and classification societies have updated their own guidelines and rules to align with these industry documents and IMO guidelines.

CONCLUSION AND DISCUSSION

The findings of this study demonstrate that cyber risk management in the maritime sector cannot be limited solely to technical measures and IT solutions, but rather needs to be supported by a strong legal, institutional, and governance framework. IMO resolutions and guidance documents, as well as

guidelines published by BIMCO and similar industry organizations, provide a high-level and practical reference framework for cybersecurity in maritime transport. However, it is understood that additional strengthening is needed in specific areas for this framework to be translated into concrete national policies, internal company procedures, and daily operational practices.

The priority area is the human factor and personnel training dimension. Existing literature and open-source incident records show that in numerous cyber incidents, in addition to technical vulnerabilities, misconfigurations, weak password implementations, user behavior with low security awareness, and procedural violations are decisive factors. Therefore, the creation of task-based, modular cybersecurity training programs for bridge officers, engine officers, port and terminal operators, and shore office personnel appears critical. These programs should go beyond general theoretical lectures and be supported by real cyber incident cases, simulations, and scenario-based exercises; For example, integrating concrete examples, such as the Port of Antwerp case, into the training content to make the real impact of cyber incidents visible is important for ensuring lasting cyber awareness.

Secondly, national maritime administrations, flag state and port state authorities need to develop clear and implementable roadmaps based on the IMO MSC.428(98) and MSC-FAL.1/Circ.3 framework. Minimum cybersecurity requirements for companies operating in maritime transport should be clearly defined in these roadmaps; checklists and performance indicators should be used to ensure that cyber risk management elements are not merely on paper but are actually implemented during the renewal processes of Audit and Conformity Certificates (DoC and SMC). Thus, cybersecurity can be made a natural part of the security management systems under the ISM Code.

Thirdly, practical guidelines and checklists specific to the maritime sector need to be developed for each stage of the cyber risk management cycle. In the identification phase, how to inventory information assets and critical systems on board the ship and at the port side should be determined; The design of OT/IT network segmentation, access controls, and patching/updating processes during the protection phase; which log sources will be monitored during the detection and response phases, at what threshold values alarms will be generated, and how incident response teams will be structured; and how backup, business continuity, and post-incident learning mechanisms will be operated during the recovery phase should be concretized at both the ship and port levels. Such sector-specific practical guidelines can serve as a critical bridge in translating existing high-level norms into operational standards.

From the perspective of the Turkish maritime sector, it is important for national legislation to adopt an integrated structure that addresses cybersecurity in maritime transport together with maritime safety and environmental protection, in line with the IMO framework. Clearly defining cyber incident reporting obligations for ship operators and port authorities, defining minimum technical and organizational measures in regulatory texts, clarifying training and certification requirements, and making audit and enforcement mechanisms in these areas transparent are necessary. Such steps will both facilitate the fulfillment of international obligations and increase the cyber resilience of the national maritime ecosystem.

The general framework of this study describes the cybersecurity environment in maritime transport in the context of increasing cyber threats and risks, through critical systems, attack vectors, and open-source incident data. It is observed that IMO resolutions and guidelines, as well as industry documents such as BIMCO, provide a strong foundation for cyber risk management in maritime transport; however, this foundation contains significant gaps in terms of human factors, personnel training, depth of implementation, and integration with national law. Literature analysis reveals that while a significant

body of knowledge has been accumulated regarding cyber threats, attack scenarios, and technical vulnerabilities in maritime transport, studies focusing on the design of cybersecurity training programs, the practical implementation of the "Cybersecurity on Board Ships Guide," and their integration with national legal systems remain limited.

Therefore, future research should prioritize empirical analyses supported by open-source incident data and field studies; comparatively examine cybersecurity practices in different flag and port states; and particularly focus on training.It is necessary to focus on the areas of awareness and policy design. Furthermore, developing quantitative and qualitative performance indicators to monitor the effectiveness of the international regulatory framework, and conducting regular evaluations based on these indicators, is also a crucial need.

In conclusion, cybersecurity in maritime transport is not merely an IT problem in the narrow sense; it is a multi-dimensional governance issue directly related to safety, the environment, business continuity, and national security. The international normative framework can only be truly effective if shipping companies, port authorities, national administrations, and personnel training systems develop a model of harmonious, integrated, and continuous cooperation.

REFERENCES

(IMO), I. M. O. (2023). Cyber Security Guidance. In *International Maritime Organization (IMO)*. https://www.imo.org/en/OurWork/Security/Pages/Guidance-home.aspx

Avcı, İ., Koca, M., & Atasoy, M. (2021). Windows Tabanlı Uygulamalarda SQL Enjeksiyon Siber Saldırı Senaryosu ve Güvenlik Önlemleri. *European Journal of Science and Technology*, *28*(28), 213–219. https://doi.org/10.31590/ejosat.995697

Ben Farah, M. A., Ukwandu, E., Hindy, H., Brosset, D., Bures, M., Andonovic, I., & Bellekens, X. (2022). Cyber Security in the Maritime Industry: A Systematic Survey of Recent Advances and Future Trends. *Information 2022, Vol. 13, Page 22*, *13*(1), 22. https://doi.org/10.3390/INFO13010022

Bhattacharya, S. (2012). The effectiveness of the ISM Code: A qualitative enquiry. *Marine Policy*, *36*(2), 528–535. https://doi.org/10.1016/J.MARPOL.2011.09.004

Bolbot, V., Kulkarni, K., Brunou, P., Banda, O. V., & Musharraf, M. (2022). Developments and research directions in maritime cybersecurity: A systematic literature review and bibliometric analysis. *International Journal of Critical Infrastructure Protection*, *39*, 100571. https://doi.org/10.1016/J.IJCIP.2022.100571

Bolbot, V., Theotokatos, G., Boulougouris, E., & Vassalos, D. (2020). A novel cyber-risk assessment method for ship systems. *Safety Science*, *131*. https://doi.org/10.1016/J.SSCI.2020.104908

Bole, A., Wall, A., & Norris, A. (2013). *Radar and ARPA manual: radar, AIS and target tracking for marine radar users*. https://books.google.com/books?hl=tr&lr=&id=po1XHQG0fP8C&oi=fnd&pg=PP1&dq=%22arpa%22+vulnerability+in+vessel&ots=_sYfnxsrJp&sig=8QoQjUcrEN06sAdSZPZ44zZFnIM

DiRenzo, J., Goward, D., & Roberts, F. S. (2015). The little-known challenge of maritime cyber security. *IEEE, n 2015 6th International Conference on Information, Intelligence, Systems and Applications (IISA)*, 1–5. http://dimacs.rutgers.edu/People/Staff/froberts/MaritimeCyberCorfuPaper.final.pdf

François, J., Wang, S., Bronzi, W., State, R., & Engel, T. (2011). BotCloud: Detecting botnets using MapReduce. *2011 IEEE International Workshop on Information Forensics and Security, WIFS 2011*. https://doi.org/10.1109/WIFS.2011.6123125

He, K., Zhang, X., Ren, S., & Sun, J. (2016). Deep residual learning for image recognition. *Proceedings of the IEEE Computer Society Conference on Computer Vision and Pattern Recognition*, *2016–Decem*, 770–778. https://doi.org/10.1109/CVPR.2016.90

Hopcraft, R., Harish, A. V., Tam, K., & Jones, K. (2023). Raising the Standard of Maritime Voyage Data Recorder Security. *Journal of Marine Science and Engineering*, *11*(2), 267. https://doi.org/10.3390/JMSE11020267

Hu, P., Ning, H., Qiu, T., Song, H., Wang, Y., & Yao, X. (2017). Security and Privacy Preservation Scheme of Face Identification and Resolution Framework Using Fog Computing in Internet of Things. *IEEE Internet of Things Journal*, *4*(5), 1143–1155. https://doi.org/10.1109/JIOT.2017.2659783

International Chamber of Shipping. (2021). *Seafarer workforce report*. Https://Www.Ics-Shipping.Org/Press-Release/New-Bimco-Ics-Seafarer-Workforce-Report-Warns-of-Serious-Potential-Officer-Shortage/. https://www.bimco.org/products/publications/titles/seafarer-workforce-report/

International Maritime Organization (IMO). (2022). *GUIDELINES ON MARITIME CYBER RISK MANAGEMENT*. https://wwwcdn.imo.org/localresources/en/OurWork/Security/Documents/MSC-FAL.1-Circ.3-Rev.2 - Guidelines On Maritime Cyber Risk Management (Secretariat) (1).pdf

Karasekreter, N., Şahman, M. A., Başçiftçi, F., & Fidan, U. (2020). PSO-based clustering for the optimization of energy consumption in wireless sensor network. *Https://Doi.Org/10.1680/Jemmr.20.00107*, *9*(3), 776–783. https://doi.org/10.1680/JEMMR.20.00107

Kobara, K. (2016). Cyber physical security for Industrial Control Systems and IoT. *IEICE Transactions on Information and Systems*, *E99D*(4), 787–795. https://doi.org/10.1587/TRANSINF.2015ICI0001

Koca, M., & Avci, I. (2024). A Novel Hybrid Model Detection of Security Vulnerabilities in Industrial Control Systems and IoT Using GCN+LSTM. *IEEE Access*. https://doi.org/10.1109/ACCESS.2024.3466391

Lee, S., No, Y., Cho, J., Jin, G., Kim, J., Lee, J., Jeon, S., Alfouzan, F. A., & Kim, K. (2025). Securing Maritime Autonomous Surface Ships: Cyber Threat Scenarios and Testbed Validation. *IEEE Access*. https://doi.org/10.1109/ACCESS.2025.3527132

Li, M., Zhou, J., Chattopadhyay, S., & Goh, M. (2024). *Maritime Cybersecurity: A Comprehensive Review*. https://arxiv.org/pdf/2409.11417

Maione, G., Cuccurullo, C., -, A. T., Policy, M. and, & 2024, undefined. (2024). Biodiversity accounting: a bibliometric analysis for comprehensive literature mapping. *Emerald.Com*, *15*(5), 2040–8021. https://doi.org/10.1108/SAMPJ-04-2022-0214

Martínez, F., Sànchez, L. E., Santos-Olmo, A., Rosado, D. G., & Fernàndez-Medina, E. (2024). Maritime cybersecurity: protecting digital seas. *Springer*, *23*(2), 1429–1457. https://doi.org/10.1007/S10207-023-00800-0

Oruc, A., Gkioulos, V., & Katsikas, S. (2022). Towards a Cyber-Physical Range for the Integrated Navigation System (INS). *Journal of Marine Science and Engineering*, *10*(1). https://doi.org/10.3390/jmse10010107

Rivkin, B. S. (2023). Maritime Cybersecurity. Navigational Aspect. *Gyroscopy and Navigation*, *14*(4), 386–400. https://doi.org/10.1134/S207510872470010X

Sergott, R. C., Bennett, J. L., Rieckmann, P., Montalban, X., Mikol, D., Freudensprung, U., Plitz, T., & Van Beek, J. (2015). ATON: Results from a Phase II randomized trial of the B-cell-targeting agent atacicept in patients with optic neuritis. *Journal of the Neurological Sciences*, *351*(1–2), 174–178. https://doi.org/10.1016/J.JNS.2015.02.019

Tusher, H. M., Munim, Z. H., Notteboom, T. E., Kim, T. E., & Nazir, S. (2022). Cyber security risk assessment in autonomous shipping. *Maritime Economics and Logistics*, *24*(2), 208–227. https://doi.org/10.1057/S41278-022-00214-0

Vartiainen, R. (2025). *Multi-factor authentication under NIS2: requirements and implementation for regulated entities*. https://www.theseus.fi/handle/10024/888791

Wang, G., Wei, S., Chen, G., Tian, X., Shen, D., Pham, K., Nguyen, T. M., & Blasch, E. (2016). Cyber security with radio frequency interferences mitigation study for satellite systems. *Https://Doi.Org/10.1117/12.2224632*, *9838*, 179–187. https://doi.org/10.1117/12.2224632

Wang, P. Y., & Hong, M. Q. (2016). A Secure Management Scheme Designed in Cloud. *Proceedings - 2nd IEEE International Conference on Big Data Security on Cloud, IEEE BigDataSecurity 2016, 2nd IEEE International Conference on High Performance and Smart Computing, IEEE HPSC 2016 and IEEE International Conference on Intelligent Data and S*, 158–162. https://doi.org/10.1109/BigDataSecurity-HPSC-IDS.2016.16

Wouters, J., & Man, P. De. (2009). International Association of lndependent Tanker Owners (Intertanko), International Association of Dry Cargo Shipowners (Intercargo), Greek Shipping Co-operation Committee, Lloyd's Register and International Salvage Union v. Secretary of State for Transpo…. *American Journal of International Law*, *103*(3), 555–561. https://doi.org/10.1017/S0002930000020005

SELF-SUPERVISED LEARNING STRATEGIES FOR ACUTE LYMPHOBLASTIC LEUKEMIA DETECTION WITH LIMITED DATA

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ABSTRACT

The lack of labeled data in medical image analysis constitutes a critical problem in the diagnosis of rare diseases such as acute lymphoblastic leukemia. The labeling process performed by expert pathologists requires intensive expertise and also imposes significant time and cost constraints. In this context, self-supervised learning methods emerge as innovative approaches with the potential to overcome this problem by reducing the dependency on labeled data. In the study, four different self-supervised learning approaches—SimCLR, Barlow Twins, BYOL, and SimSiam—are systematically compared under few-shot learning scenarios on publicly available peripheral blood smear microscopy images. Comprehensive evaluations conducted with different numbers of samples reveal that the SimSiam method exhibits the highest performance with an accuracy rate of 71.37% in the five-sample training scenario. On the dataset consisting of four different class types, both the statistical reliability of the results is analyzed, different few-shot learning scenarios are tested, and a comparative performance evaluation of the self-supervised learning methods is carried out. The experimental results confirm that all methods achieve better performance as the number of samples increases, and under the same conditions, the most consistent and highest results are obtained with the SimSiam algorithm.

Key Words: Acute Lymphoblastic Leukemia; Self-supervised Learning; Few-shot Learning; SimSiam;

INTRODUCTION

Leukemia is a type of cancer that arises from the uncontrolled proliferation and structural deterioration of blood cells produced in the bone marrow. This cancer primarily affects White Blood Cells (WBCs),

which play a crucial role in the immune system. In healthy individuals, WBCs are produced only as needed; however, when leukemia develops, the loss of bone marrow function leads to their abnormal and uncontrolled proliferation (Khandekar et al., 2021). This uncontrolled increase over time results in a reduction of healthy red blood cells and platelets and causes weakening of the immune system. Consequently, the body becomes vulnerable to infections (Kamath-Loeb et al., 2022). When this process, which begins in the bone marrow, spreads into the bloodstream and disseminates to organs such as the spleen and lymph nodes, it may pose a life-threatening risk.

Leukemia is among the most common types of cancer in childhood and accounts for approximately 25–30% of childhood cancers (Nunna et al., 2024). According to the American Cancer Society, in the United States alone, one person is diagnosed with leukemia every 3 minutes, and for the year 2024, 62,770 new cases and 23,670 deaths are estimated (Tarver, 2012). Leukemia is generally examined in two main categories: acute and chronic. Acute leukemia progresses rapidly and prevents the proper functioning of immature cells, whereas chronic leukemia follows a slower course. Acute leukemia cases constitute the vast majority of all leukemia's and are classified as Acute Myeloid Leukemia (AML) or Acute Lymphoblastic Leukemia (ALL) according to the type of affected cell.

In recent years, the diagnosis of ALL is established using time-consuming, error-prone, and costly methods such as complete blood count, bone marrow aspiration, and microscopic examination. Owing to these challenges, there is a need for a reliable, cost-effective, and automated system that can accelerate the diagnostic process. Recent studies indicate that artificial intelligence, and particularly deep learning-based methods, have increasingly gained prominence in the literature for the early diagnosis and classification of this disease.

In the method proposed in (Bonab et al., 2026), a novel technique called the Embedding-Space Re-sampling Technique (ESRT) is introduced to address the problem of class imbalance. By generating synthetic data for classes with limited samples, the method aims to enable the model to better learn these underrepresented classes. In the study, the Munich Leukemia Laboratory dataset (Matek et al., 2021) is used. In this dataset, which contains 171,375 images from 945 patients, some cell types are represented by only 8 images, whereas others are represented by up to 29,424 images. Since this severe imbalance in the dataset makes it difficult for the model to correctly learn all classes, ESRT identifies challenging samples from classes with insufficient data and generates new data around these samples in the feature space to balance the dataset. According to the results of the study, the model achieves 89.90% accuracy, 90.81% precision, 91.17% recall, and 90.94% F1-score (Rainio et al., 2024). In addition, the Matthews Correlation Coefficient (MCC) (Chicco et al., 2021), which is a more suitable metric for class imbalance, is found to be 73.19%.

In the method proposed in (Mustaqim et al., 2025), a data augmentation technique called FocusAugMix is developed through studies conducted on the Subtype ALL (Fatonah et al., 2020), ALL-IDB1, and ALL-IDB2 datasets (Labati et al., 2011). This method aims to preserve and diversify critical regions in cell images by combining techniques such as Grad-CAM (Selvaraju et al., 2016)-based regional focusing, SaliencyMix (Uddin et al., 2020), OcCaMix (Sabnis et al., 2019), and Multi-Head Attention (Vaswani et al., 2017). It is particularly aimed at directing the model's attention to meaningful regions in small or imbalanced classes. Since a single augmentation method fails to achieve the same level of success across all datasets used in the study, four different variants of the FocusAugMix method are designed. Each variant targets different challenges and aims to improve performance on specific cellular structures. The highest performance is achieved using the FocusAugMixV1 variant on the ALL-IDB1 dataset, yielding maximum values of 99.07% accuracy, 99.02% precision, 99.17% recall, and 99.09% F1-score

In the study conducted by (Das et al., 2025), a hybrid machine learning framework is proposed to address the challenges caused by overlapping, noisy, or unwanted cells that hinder the automatic detection of ALL and AML. The primary objective of the study is to obtain a more efficient segmentation model and

improved classification performance. The ALL-IDB1 (Labati et al.,) and ASH-AML (Kantarjian et al., 2021) datasets are used in the study. In the proposed method, the gray level co-occurrence matrix is employed for feature extraction from the images (Sebastian et al., 2012), principal component analysis is utilized for dimensionality reduction (Abdi et al., 2010), and adaptive weight-optimized level set evolution is used for segmentation. For overlapping cells, the marker-controlled watershed segmentation method (Gaetano et al., 2014) is applied. In the classification stage, a hybrid model that combines the strengths of random forest (Cutler et al., 2012) and support vector machine (Hearst et al., 1998) is used. Through this hybrid structure, accuracy rates of 99.07% on the ALL-IDB1 dataset and 96.25% on the AML dataset are achieved.

In (Jawahar et al., 2024), an attention-based deep learning model called the deep dilated residual network (DDRNet) with extended residual connections is proposed for ALL classification. This model aims to enhance feature extraction and discriminative capability from blood cell images by integrating the deep residual dilated block (DRDB) (Yu et al., 2017), global and local feature enhancement block (GLFEB) (Kim et al., 2020), and channel and spatial attention block (CSAB) (Woo et al., 2018) structures. The model specifically aims to address issues such as insufficient dataset size, class imbalance, and vanishing gradients in traditional models. The Kaggle dataset (Mooney, 2025), containing only 362 images in total, is used. To overcome data insufficiency and class imbalance, a total of 16,249 images are generated by applying techniques such as rotation, zooming, and horizontal flipping. The model trained on this augmented dataset achieves 91.98% accuracy and 96% F1-Score.

In (Zhao et al., 2026), a YOLOv8-based FCE-YOLO model is proposed for the diagnosis of ALL cells using the four-class blood cell cancer dataset (Hosseini et al., 2023) and the BCCD dataset (Shenggan, 2018). To obtain diverse feature representations while reducing computational cost, the model incorporates the C2f_Faster (Zhu et al., 2024) and CSP_PTB (Wang et al., 2024) modules. Instead of the original YOLOv8 loss function, EMASlideLoss (Ding et al., 2024), which facilitates the detection of small cells with high similarity, is preferred. The model is trained with an image enhancement strategy that includes advanced image correction techniques such as gamma correction and motion blur. The model achieves precision values of 99.2% for ALL-Benign, 99.5% for Early Pre-B, 99.4% for Pre-B, and 99.5% for Pro-B. The overall mAP@0.5 is reported as 99.3%, and the mAP@[0.5:0.95] is reported as 90.1%.

In (Abbas et al., 2025), a Lightweight convolutional neural network (CNN) model, intended to be an efficient classifier, is developed for ALL classification on the B-ALL dataset (Aria et al., 2021). The model strengthens feature representation by integrating Squeeze-and-Excitation (Hu et al., 2018) blocks within inverted residual blocks (Sandler et al., 2018). This architecture provides a low computational-cost solution for mobile and embedded devices. The model achieves 99.77% precision, 99.82% F1-score, 99.87% sensitivity, 99.95% specificity, and 99.79% MCC. These results demonstrate the strong generalization capability and reliability of the proposed method. In addition, the model achieves 99.85% accuracy in cross-dataset validation conducted on an independent dataset.

In (Hosseini et al., 2023), a lightweight MobileNetV2 (Sandler et al., 2018)-based classification model is proposed using the blood cell cancer dataset. Since the model has a compact size and a small number of parameters, it is considered suitable for mobile devices. As preprocessing techniques, horizontal flip and vertical flip are preferred. Both the original and segmented images are used as input. The test performance of the model is reported as 100% across all metrics, including accuracy, sensitivity, and specificity. The researchers state that this extremely high result may be due to the insufficiency of the dataset.

In (Ghaderzadeh et al., 2022), a two-channel CNN model based on DenseNet-201 (Huang et al., 2017), which processes both original and segmented images, is proposed for ALL diagnosis and subtype classification. In the study, the B-ALL dataset (Aria et al., 2021), consisting of 3,256 images acquired from 89 patients, is used. The classification is divided into four categories: benign and early pre-B, pre-

B, and pro-B ALL. The model is evaluated using 5-fold cross-validation and achieves an overall accuracy of 99.85% and an F1-score of 99.63%.

In the study conducted in (Akter et al., 2025), a hybrid deep learning architecture named ReVGG-R2Net is proposed for microscopic blood cell segmentation. The model enhances precise boundary delineation and feature extraction by combining a VGG16-based recurrent encoder with an R2U-Net decoder. The RaabinWBCSeg (Raabin Database, 2021) and BBBC041Seg (Depto et al., 2021) datasets are used in the study. On the RaabinWBCSeg dataset, 96.3% accuracy and a 92.8% dice score are achieved, while on the BBBC041Seg dataset, 97.8% accuracy and a 96.2% dice score are obtained. These results demonstrate that the model is effective in accurately segmenting clustered and morphologically variable cells.

In (Das et al., 2025), an LSTM–LeNet hybrid model whose weights are optimized using tangent sand cat swarm optimization (Seyyedabbasi et al., 2023) is proposed on the blood cell cancer dataset (Hosseini et al., 2023). The main component of the model is the L-LeNet architecture, which incorporates LeNet (LeCun et al., 2002) and long short-term memory (Hochreiter et al., 1997) components. The objective of the model is post-segmentation classification. The dataset images are first preprocessed using an adaptive median filter, followed by segmentation. Feature extraction is then performed, and classification is carried out. The model achieves 98.7% accuracy, 97.9% precision, 96.7% recall, and 91% AUC.

In (Başaran et al., 2025), a hybrid model referred to as the regional focused neural encoder model is proposed in a study conducted using the B-ALL dataset (Aria et al., 2021). The model aims to extract deep features using DarkNet19 ESA (Redmon et al., 2017) and Grad-CAM techniques. These extracted features are fused and enriched using an auto-encoder network (Bank et al., 2023). Subsequently, in order to improve computational efficiency and performance, the harris hawk optimization algorithm (Heidari et al., 2019) is employed for feature selection. In the final stage, the selected features are evaluated using classifiers such as k-nearest neighbors (Cover et al., 1967) and decision tree (Quinlan, 1986). When the model is tested using the 10-fold cross-validation method, the k-NN algorithm achieves 98.52% accuracy.

Few-shot learning (Brown et al., 2020) is of critical importance for addressing the problem of limited labeled data in the medical imaging domain. In clinical settings, collecting images of rare diseases is both costly and time-consuming. Moreover, since expert diagnosis requires a high level of knowledge and attention, datasets are often imbalanced and small. In this study, self-supervised learning (SSL)-based approaches are addressed to tackle the limited labeled data problem encountered in the diagnosis and detection of ALL, and the performance of these methods against this problem is comparatively investigated. For this purpose, a systematic few-shot learning evaluation is conducted using a publicly available dataset, and the K values are set to 1, 5, 10, 20, and 50. For each K value, the experimental performances of the SimCLR, Barlow Twins, BYOL, and SimSiam methods are analyzed.

The remainder of the paper is organized as follows: Firstly, it describes the dataset and the methods used in the proposed model; secondly, it presents and interprets the obtained experiment results; and finally, it provides the discussion and conclusions of the study.

MATERIALS

Used Dataset

The ALL image dataset used in this study is created at the Bone Marrow Laboratory of Taleqani Hospital and made publicly accessible via the Kaggle platform (Aria et al., 2021; Ghaderzadeh et al., 2022). The dataset consists of a total of 3,256 peripheral blood smear (PBS) microscopy images obtained from 89 patients with suspected ALL. Among the participants, 25 healthy individuals are diagnosed as benign, and 64 patients receive definitive diagnoses of the Early Pre-B, Pre-B, and Pro-B ALL subtypes. The images are acquired from blood samples prepared and stained by experienced laboratory personnel. The

dataset contains 504 images in the benign class, 985 images in the Early Pre-B class, 963 images in the Pre-B class, and 804 images in the Pro-B class. In Fig. 1, the distribution of classes in the dataset is presented as a pie chart. In Fig. 2, visual examples belonging to the four different classes in the dataset are provided.

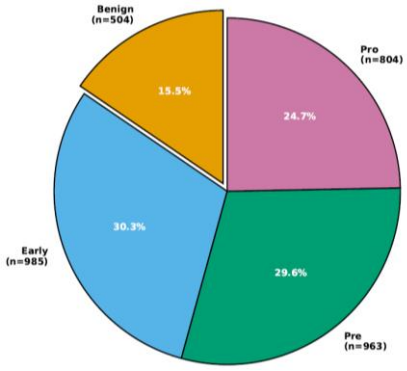

Fig.1 (Ghaderzadeh et al., 2022) depicts the distribution of image types in the dataset as a pie chart.

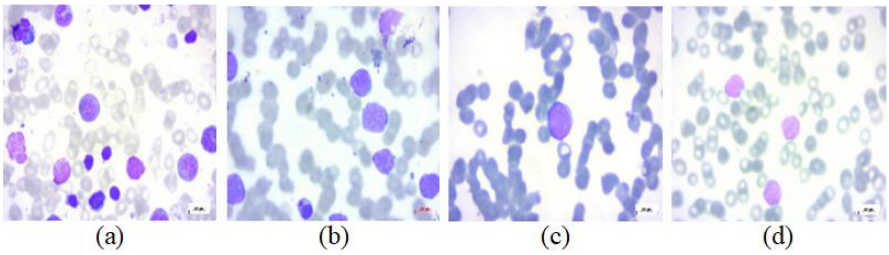

Fig.2 presents visual samples of the four different data classes in the dataset (Ghaderzadeh et al., 2022): (a) benign class, (b) early pre-B class, (c) pre-B class, and (d) Pro-B class.

Self-Supervised Learning Methods

Simple Framework for Contrastive Learning of Visual Representations (SimCLR) (Chen et al., 2020) is a simple yet effective self-supervised method that focuses on learning comprehensive representations from image data. This method aims to develop high-quality, general-purpose representations from high-dimensional image datasets without using labels.

SimCLR attempts to learn that any two images belong to the same object by applying different data augmentation techniques—such as cropping, rotation, resizing, and color transformation—to the same image. Two images originating from the same source are referred to as a positive pair. Images belonging to different objects are referred to as negative samples. The objective of the model is to increase the similarity between positive pairs and to enhance the separation between negative samples. To increase the diversity of information in negative samples, it is important to use large batch sizes and rich, diverse data augmentations. The mathematical expression of the contrastive loss function used for SimCLR is given in Equation (1).

$$l_{i,j} = -\log \frac{\exp(sim(z_i, z_j)/\tau)}{\sum_{k=1}^{2N} 1_{[k \neq i]} \exp(sim(z_i, z_k)/\tau)} \quad (1)$$

Here, the parameters z_i and z_j form a positive pair obtained from two different views of the same image. The parameter $sim(z_i, z_j)$ denotes the cosine similarity between the two representations. The parameter τi s the temperature parameter and is used to scale the similarity values.

Barlow Twins (Zbontar et al., 2021) passes two differently augmented versions of the same image through twin neural networks. In this way, it produces embedding vectors and presents a self-supervised learning method that aims to bring the cross-correlation matrix between these vectors close to the identity matrix. The fundamental principle of the method is to ensure that the representations obtained from different views of the same image are similar by pushing the diagonal elements of the cross-correlation matrix toward 1. However, by pushing the off-diagonal elements toward 0, it reduces unnecessary information redundancy between embedding dimensions. This optimization is achieved using a special loss function composed of two terms, as shown in Equation (2

$$L = \lambda \sum_{i} \sum_{j \neq i} C_{ij}^2 + \sum_{i} (1 - C_{ii})^2 \quad (2)$$

Here, the parameter C_{ii} represents the main diagonal elements of the cross-correlation matrix and indicates the similarity of the same features across the two views. As this value approaches 1, it signifies a high degree of similarity between the representations. As the value 1-C_{ii} deviates from zero, it contributes to the error, thereby encouraging the model to keep the same features as consistent as possible. The parameter C_{ij} represents the off-diagonal elements of the matrix and reflects the unnecessary correlations between different features. As these values approach 0, each feature is encouraged to carry independent information. In this way, the second part of the loss function reduces redundant relationships within the representation, enabling the emergence of a more structured and non-redundant feature representation.

Bootstrap Your Own Latent (BYOL) (Grill et al., 2020) is a self-supervised learning approach proposed in 2020 that differs fundamentally from contrastive learning methods. Unlike contrastive approaches, this method does not require negative sample pairs. Negative sample pairs are those used in contrastive learning to represent different images; contrastive methods such as SimCLR learn by forcing the model to bring positive pairs closer while pushing negative pairs farther apart. However, BYOL instead of using negative samples to distinguish different images, learns consistency only between different versions of the same image. BYOL employs two parallel neural networks: an online network and a target network. The online network consists of three components whereas the target network has the same structure but does not contain a predictor. The online network is the student network that is actively trained and continuously updated via gradient descent. The target network is the teacher network that moves slowly and produces stable targets. The encoder extracts high-level feature representations from the image, the projector maps this representation into a lower-dimensional latent space, and the predictor attempts to match the output of the online network to that of the target network. This asymmetric structure of BYOL prevents the problem of representation collapse, in which the model produces the same output for all inputs. The distinctive characteristic of BYOL is that the weights of the target network are updated from the online network using an exponential moving average (EMA). Its mathematical formulation is presented in Equation (3) as follows:

$$\xi \leftarrow \tau\xi + (1 - \tau)\theta \quad (3)$$

Here, the parameter ξ denotes the parameters of the target network, θ denotes the parameters of the online network, and $\boldsymbol{\tau \in [0,1]}$ represents the momentum coefficient.

Simple Siamese Networks (SimSiam) (Chen et al., 2021) is a self-supervised learning approach proposed in 2021 that differs fundamentally from contrastive learning methods. SimSiam employs a Siamese network architecture with shared weights. These network branches share the same encoder, but only one branch contains a predictor. The encoder extracts high-level feature representations from the image, after which the projection head (a multilayer perceptron, MLP) maps this representation into the latent space. The latent space is a low-dimensional mathematical space in which the compressed and semantically meaningful features of the image are represented. The predictor exists only in one branch

and attempts to match the output of this branch to that of the other branch. The fundamental mechanism by which SimSiam prevents representation collapse is the stop-gradient operation. Representation collapse refers to the situation in which the model produces the same constant output for all inputs. In this case, the model cannot learn any meaningful features, and even if the loss is minimized, the representations contain no informative content. The stop-gradient operation is a mathematical procedure that halts the gradient flow in one branch and treats the output of that branch as a constant target. As a result, gradients flow only through the branch containing the predictor, and the model performs asymmetric optimization.

Implementation Detail

The proposed methodology is implemented using the PyTorch deep learning framework and the Lightly library for self-supervised learning applications. To ensure a fair comparison, the ImageNet-pre-trained ResNet-50 (He et al., 2016) architecture is used as the feature extraction backbone for all SSL methods. The dataset (Ghaderzadeh et al., 2022) is split into training, validation, and test subsets using fixed random seeds to ensure reproducibility while following a stratified partitioning protocol. Accordingly, 70% of the data is allocated for training, 15% for validation, and 15% for testing. To preserve the intrinsic structural properties of the microscopy images, the preprocessing step is kept to a minimum. During preprocessing, all images are resized to 224 × 224 pixels and normalized using the mean and standard deviation values of ImageNet. During SSL pretraining, no data augmentation technique is employed, and the pre-training is conducted as a pilot study for 50 epochs with a batch size of 32 using the Adam optimizer with a learning rate of 0.001. For the few-shot learning evaluation, to ensure class balance, 1, 5, 10, 20, and 50 labeled samples per class are randomly sampled using stratified selection and performed with seed values of 42, 123, and 999 to assess statistical significance.

EXPERIMENTAL RESULTS AND DISCUSSIONS

In this study, four SSL methods, SimCLR, BYOL, Barlow Twins, and SimSiam, are comprehensively evaluated under few-shot learning scenarios on the ALL cell image dataset. For each method, K = 1, 5, 10, 20, and 50 labeled samples per class are used. A total of 60 independent experiments are conducted using random seeds of 42, 123, and 999. As performance metrics, Accuracy, F1-macro, and F1-weighted, which are commonly used for multi-class classification, are taken as the primary evaluation criteria. The mathematical definitions of these metrics are given in Equations (4)–(7).

$$Accuracy = \frac{\sum_{i=1}^{K} TP_i}{N} \quad (4)$$

Here, the parameter K represents the number of classes, TP_i denotes the number of correctly classified samples for the *i-th* class, and N denotes the total number of samples.

The F1 score is calculated separately for each class, and when their arithmetic mean is taken, the $F1_{macro}$ score is obtained.

$$F1_{macro} = \frac{1}{K}\sum_{i=1}^{K} F1_i \quad (5)$$

Here, the parameter $F1_i$ is mathematically defined in Equation (6). This metric represents the F1 score for the *i-th* class.

$$F1_i = \frac{2TP_i}{2TP_i + FP_i + FN_i} \quad (6)$$

When the F1 value for each class is weighted by the support value of that class, the $F1_{weighted}$ metric is obtained.

$$F1_{weighted} = \sum_{i=1}^{K} w_i \cdot F1_i \quad (7)$$

The overall performance results obtained by the four SSL methods in the prepared experimental environment are presented in Table 1. As the number of samples increases, a significant improvement in accuracy is observed for all methods. Under the most constrained scenario, K = 1, the highest *Accuracy* is achieved by the BYOL method with 58.62 ± 5.27%, whereas the SimCLR and Barlow Twins methods lag behind with 36.67 ± 7.63% and 32.86 ± 10.61%, respectively. In the K = 5 scenario, the SimSiam method exhibits the highest performance with an accuracy of 71.37 ± 2.36%, followed by the BYOL method with 69.60 ± 7.25%. At the K = 50 level, although all methods reach higher accuracy values, SimSiam achieves the highest accuracy at 76.76 ± 3.52%. This comparison is visually presented in Fig. 3. According to this figure, a clear relationship is observed between the increase in the K value and the improvement in accuracy.

Table 1. Overall Performance Comparison – Accuracy Rate (%)

SSL Method	K=1	K=5	K=10	K=20	K=50
SimCLR	36.67±7.63	50.17±1.80	52.90±5.94	60.46±2.11	62.51±2.57
Barlow Twins	32.86±10.61	50.85±0.67	54.19±2.75	59.44±5.63	61.69±4.27
BYOL	58.62±5.27	69.60±7.25	71.17±2.81	72.46±2.61	71.57±3.28
SimSiam	49.01±8.08	71.37±2.36	68.30±2.85	77.23±1.84	76.76±3.52

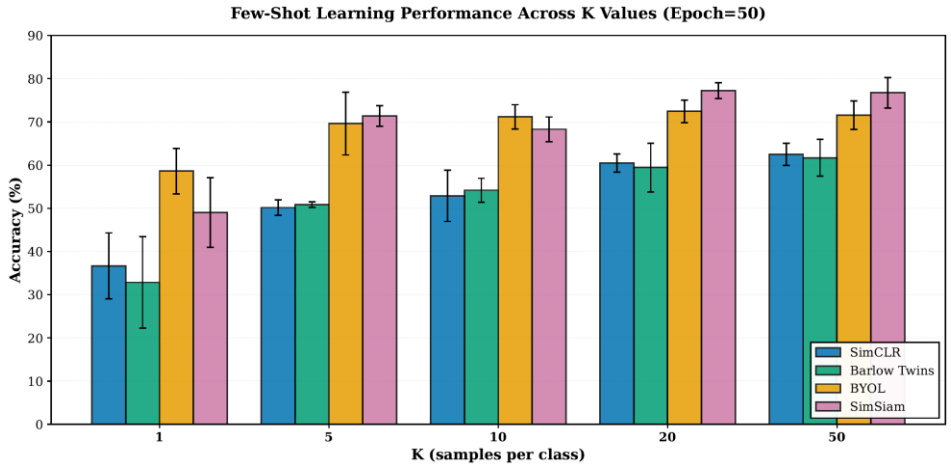

Fig.3 Few-shot learning performance across k values (epoch=50)

In many SSL studies (Chen et al., 2020; Chen et al., 2021), K = 5 has been the most commonly preferred value. For this reason, the experimental results in this study are presented based on the K = 5 scenario. Detailed performance comparisons for the K = 5 scenario are provided in Table 2. The SimSiam method achieves an *Accuracy* of 71.37 ± 2.36%, an F1-macro of 73.88 ± 2.41%, and an F1-weighted of 74.09 ± 2.40%, demonstrating the most balanced classification performance. BYOL ranks second, whereas the Barlow Twins and SimCLR methods exhibit significantly lower performance in both *Accuracy* and F1 metrics. A visual comparison of the methods is presented in Fig. 4.

Table 2. K=5 Detailed Performance Comparison

SSL Method	Accuracy (%)	F1 Macro (%)	F1 Weighted (%)
SimCLR	50.17±1.80	48.01±1.80	47.41±1.80
Barlow Twins	50.85±0.67	49.69±0.67	52.48±0.67
BYOL	69.60±7.25	70.99±7.69	71.37±7.25
SimSiam	71.37±2.36	73.88±2.41	74.09±2.40

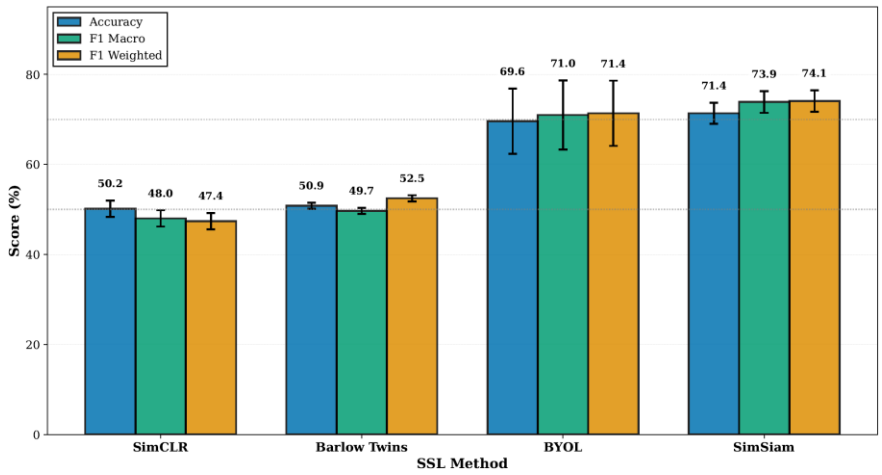

Fig.4 K=5 performance comparison (epoch=50)

Particularly at the clinically critical point of K = 5, corresponding to five labeled samples per patient, the SimSiam method exhibits the best performance with an accuracy of approximately 71.4%, whereas the contrastive methods remain around 50%. This 20% performance gap is attributed to the fact that contrastive learning requires large batch sizes and high data diversity. The class-wise F1 scores are detailed in Table 3. According to these results, the *Pro* class exhibits the highest discriminative performance across all methods. The BYOL method achieves an F1 score of 90.69% for the *Pro* class, while SimSiam, Barlow Twins, and SimCLR achieve F1-scores of 84.98%, 62.63%, and 46.74%, respectively. In contrast, the *Benign* class is the class in which the lowest performance is observed for all methods. SimSiam produces the best result for the *Benign* class with an F1-score of 66.23%. For the *Early* and *Pre* classes, it is observed that the SimSiam and BYOL methods, in particular, achieve F1-scores above 70%.

Table 3. Class-Based F1 Scores (K=5)

SSL Method	Benign (%)	Early(%)	Pre(%)	**Pro(%)**	**Std Dev(%)**
SimCLR	52.22	38.74	54.33	46.74	6.54
Barlow Twins	26.18	59.94	50.00	62.63	16.49
BYOL	50.53	59.04	83.70	90.69	18.29
SimSiam	66.23	69.21	75.10	84.98	8.91

The results of the seed variance analysis conducted for the SimSiam method are presented in Table 4. The low variance of 2.36% observed for overall accuracy indicates that the method exhibits a stable structure with respect to sample selection. However, the high standard deviation of 12.88% observed

for the Early class reveals increased model sensitivity attributable to the heterogeneous nature of this class. The values reported in the table are visually presented in Fig. 5.

Table 4. Seed Variance Analysis (K=5, SimSiam)

Seed	Accuracy (%)	Benign F1 (%)	Early F1 (%)	Pre F1 (%)	**Pro F1(%)**
42	74.03	66.23	69.21	75.10	84.98
123	71.78	63.31	67.34	74.53	79.09
999	68.30	62.86	46.23	71.16	85.49
Mean	71.37	64.13	60.93	73.60	83.19
Std	2.36	1.86	12.88	2.04	3.47

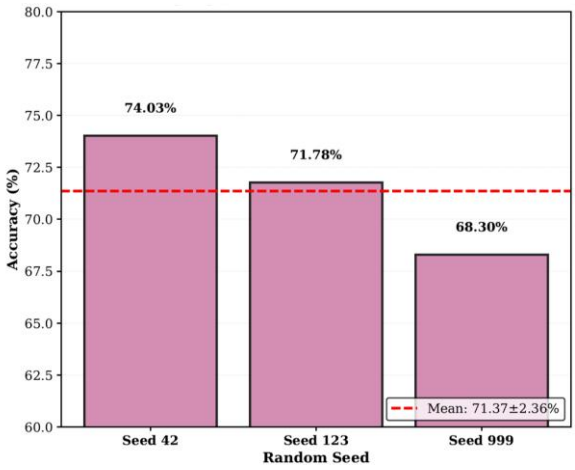

Fig. 5. SimSiam Accuracy variance (K=5)

CONCLUSION, LIMITATION AND FUTURE

In this study, the SimCLR, Barlow Twins, BYOL, and SimSiam methods are systematically compared under few-shot learning conditions on the ALL cell image dataset (see Tables 1–4). The obtained results demonstrate that the SimSiam method achieves the highest performance with an accuracy of 71.37% under clinically realistic data scenarios such as K = 5, and that the stop-gradient mechanism is able to generate strong and stable representations in low-data regimes (see Tables 1 and 2). The BYOL method, on the other hand, exhibits superiority under extremely data-limited conditions such as K = 1, revealing the stabilizing effect of the momentum-based architecture.

The limited success of the SimCLR and Barlow Twins approaches in low-sample regimes (Table 1) confirms that these methods are more highly dependent on large negative sample diversity. The class-wise analyses (see Tables 3 and 4) reveal that the difficulty in distinguishing between the Benign and Early classes constitutes the primary limiting factor for clinical applicability.

Since the dataset obtained from Taleqani Hospital, consisting of 3,256 PBS microscopy images from 89 patients, is collected from a single center, the generalization capability of the models is limited. Multicenter validation studies involving different microscopy systems, staining protocols, and population genetic differences are critical for clinical applicability. In clinical practice, the misclassification of the *Benign* class as the *Early Pre-B* class may increase the risk of false-positive diagnoses and lead to unnecessary invasive tests. Therefore, it is important to emphasize that SSL-based systems are not yet sufficient for standalone clinical use and should be positioned as decision support systems within the pathology workflow.

The proposed approach constitutes a pioneering study for systems focusing on both the classification and segmentation tasks of ALL subtypes under limited data conditions and demonstrates that SSL can provide a practical solution to the data scarcity problem in medical imaging. In future studies, it is planned to improve model performance through the visualization of model decisions using explainable AI (XAI) methods to enhance pathological interpretability, and through the integration of multi-task learning approaches.

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REFERENCES

Abbas, A., Abdulrazaq, M. B., & Adel, A. Z. (2025). Efficient lightweight CNN for automated classification of B-cell acute lymphoblastic leukemia. Computational Biology and Chemistry, 108645.

Abdi, H., & Williams, L. J. (2010). Principal component analysis. Wiley Interdisciplinary Reviews: Computational Statistics, 2(4), 433–459.

Akter, M. S., Sultan, M. F., Karim, T., & Shaon, M. S. H. (2025). ReVGG-R2Net: Optimized recurrent framework for microscopic blood cell segmentation. Tissue and Cell, 103189.

Sabnis, A., Sitaraman, R. K., & Towsley, D. (2019). OCCAM: An optimization based approach to network inference. ACM SIGMETRICS Performance Evaluation Review, 46(2), 36–38.

Aria, M., Ghaderzadeh, M., Bashash, D., Abolghasemi, H., Asadi, F., & Hosseini, A. (2021). Acute Lymphoblastic Leukemia (ALL) Image Dataset. Kaggle. https://www.kaggle.com/datasets/mehradaria/leukemia

Bank, D., Koenigstein, N., & Giryes, R. (2023). Autoencoders. In Machine Learning for Data Science Handbook (pp. 353–374).

Başaran, E., Çelik, G., & Toğaçar, M. (2025). Regionally focused neural-coder model designed for the diagnosis of acute lymphoblastic leukemia disease. Measurement, 118176.

Bonab, Z. A., Shamekhi, S., & Talebi, M. (2026). Deep learning-based bone marrow cytology classification: A solution to class imbalance. Biomedical Signal Processing and Control, 111, 108247.

Brown, T., Mann, B., Ryder, N., Subbiah, M., Kaplan, J. D., Dhariwal, P., ... & Amodei, D. (2020). Language models are few-shot learners. Advances in Neural Information Processing Systems, 33, 1877–1901.

Chen, T., Kornblith, S., Swersky, K., Norouzi, M., & Hinton, G. E. (2020). Big self-supervised models are strong semi-supervised learners. NeurIPS, 33, 22243–22255.

Chen, X., & He, K. (2021). Exploring simple Siamese representation learning. In CVPR (pp. 15750–15758).

Chicco, D., Warrens, M. J., & Jurman, G. (2021). The Matthews correlation coefficient is more informative than Cohen's Kappa and Brier score. IEEE Access, 9, 78368–78381.

Cutler, A., Cutler, D. R., & Stevens, J. R. (2012). Random forests. In Ensemble Machine Learning (pp. 157–175). Springer.

Cover, T., & Hart, P. (1967). Nearest neighbor pattern classification. IEEE transactions on information theory, 13(1), 21-27.

Das, P. K., Sahu, A., Meher, S., Panda, R., & Abraham, A. (2025). Enhanced detection of acute leukemia: A hybrid ML framework. Engineering Applications of AI, 161, 112244.

Das, S., & Padmanaban, K. (2025). Incremental learning for acute lymphoblastic leukemia classification. Computational Biology and Chemistry, 118, 108456.

Depto, D. S., Rahman, S., Hosen, M. M., Akter, M. S., Reme, T. R., Rahman, A., ... & Mahdy, M. R. C. (2021). Automatic segmentation of blood cells. Tissue and Cell, 73, 101653.

Ding, B., Zhang, Y., & Ma, S. (2024). Infrared object detection model based on YOLOv8. Drones, 8(9), 479.

Fatonah, N. S., Tjandrasa, H., & Fatichah, C. (2020). Identification of ALL subtypes in touching cells. International Journal of Intelligent Engineering & Systems, 13(4).

Gaetano, R., Masi, G., Poggi, G., Verdoliva, L., & Scarpa, G. (2014). Watershed-based segmentation. IEEE Transactions on Geoscience and Remote Sensing, 53(6), 2987–3004.

Ghaderzadeh, M., Aria, M., Hosseini, A., Asadi, F., Bashash, D., & Abolghasemi, H. (2022). A fast and efficient CNN model for B-ALL diagnosis. International Journal of Intelligent Systems, 37(8), 5113–5133.

Grill, J. B., Strub, F., Altché, F., Tallec, C., Richemond, P., Buchatskaya, E., ... & Valko, M. (2020). Bootstrap your own latent (BYOL). NeurIPS, 33, 21271–21284.

Hearst, M. A., Dumais, S. T., Osuna, E., Platt, J., & Scholkopf, B. (1998). Support vector machines. IEEE Intelligent Systems, 13(4), 18–28.

He, K., Zhang, X., Ren, S., & Sun, J. (2016). Deep residual learning for image recognition. In Proceedings of the IEEE conference on computer vision and pattern recognition (pp. 770-778).

Heidari, A. A., Mirjalili, S., Faris, H., Aljarah, I., Mafarja, M., & Chen, H. (2019). Harris hawks optimization. FGCS, 97, 849–872.

Hochreiter, S., & Schmidhuber, J. (1997). LSTM. Neural Computation, 9(8), 1735–1780.

Hosseini, A., Eshraghi, M. A., Taami, T., Sadeghsalehi, H., Hoseinzadeh, Z., Ghaderzadeh, M., & Rafiee, M. (2023). A mobile application based on efficient lightweight CNN model for classification of B-ALL cancer from non-cancerous cells: A design and implementation study. Informatics in Medicine Unlocked, 39, 101244.

Hu, J., Shen, L., & Sun, G. (2018). Squeeze-and-excitation networks. In Proceedings of the IEEE conference on computer vision and pattern recognition (pp. 7132-7141).

Huang, G., Liu, Z., Van Der Maaten, L., & Weinberger, K. Q. (2017). Densely connected convolutional networks. In Proceedings of the IEEE conference on computer vision and pattern recognition (pp. 4700-4708).

Jawahar, M., Anbarasi, L. J., Narayanan, S., & Gandomi, A. H. (2024). Attention-based deep learning for ALL. Scientific Reports, 14(1), 17447.

Kamath-Loeb, A. S., Shen, J. C., Schmitt, M. W., Kohrn, B. F., Loeb, K. R., Estey, E. H., ... & Becker, P. S. (2022). Subclonal variants detection. Leukemia Research, 115, 106822.

Kantarjian, H. M., Short, N. J., Fathi, A. T., Marcucci, G., Ravandi, F., Tallman, M., ... & Wei, A. H. (2021). AML historical progress. Clinical Lymphoma Myeloma and Leukemia, 21(9), 580–597.

Khandekar, R., Shastry, P., Jaishankar, S., Faust, O., & Sampathila, N. (2021). Automated blast cell detection. Biomedical Signal Processing and Control, 68, 102690.

Kim, H. U., Koh, Y. J., & Kim, C. S. (2020). Global and local enhancement networks. In ECCV (pp. 339–354).

Labati, R. D., Piuri, V., & Scotti, F. (2011). ALL-IDB database. In ICIP (pp. 2045–2048).

LeCun, Y., Bottou, L., Bengio, Y., & Haffner, P. (2002). Gradient-based learning. Proceedings of the IEEE, 86(11), 2278–2324.

Matek, C., Krappe, S., Münzenmayer, C., Haferlach, T., & Marr, C. (2021). Bone marrow cytology dataset. The Cancer Imaging Archive.

Mooney, Blood cell images (Accessed: 05.12.2025) https://www.kaggle.com/datasets/paultimothymooney/blood-cells

Mustaqim, T., Fatichah, C., Suciati, N., Obi, T., & Lee, J. S. (2025). FocusAugMix. Intelligent Systems with Applications, 26, 200512.

Nunna, H. K., Altable, A., Gundala, P., & Rangarajan, P. K. (2024). VisTA: ViT-Attention CNN ensemble. International Journal of Information Technology, 1–18.

Quinlan, J. R. (1986). Induction of decision trees. Machine Learning, 1(1), 81–106.

Raabin Database. (Accessed: 02 December 2025). Acute Myeloblastic Leukemia dataset. https://raabindata.com/

Rainio, O., Teuho, J., & Klén, R. (2024). Evaluation metrics and statistical tests. Scientific Reports, 14(1), 6086.

Redmon, J., & Farhadi, A. (2017). YOLO9000: better, faster, stronger. In Proceedings of the IEEE conference on computer vision and pattern recognition (pp. 7263-7271).

Sandler, M., Howard, A., Zhu, M., Zhmoginov, A., & Chen, L. C. (2018). MobileNetV2. In CVPR (pp. 4510–4520).

Sebastian V, B., Unnikrishnan, A., & Balakrishnan, K. (2012). GLCM generalisation. arXiv:1205.4831.

Selvaraju, R. R., Cogswell, M., Das, A., Vedantam, R., Parikh, D., & Batra, D. (2017). Grad-cam: Visual explanations from deep networks via gradient-based localization. In Proceedings of the IEEE international conference on computer vision (pp. 618-626).

Seyyedabbasi, A., & Kiani, F. (2023). Sand Cat swarm optimization. Engineering with Computers, 39(4), 2627–2651.

Shenggan (Accessed: 04 December 2025). BCCD dataset https://github.com/Shenggan/BCCD_Dataset .

Tarver, T. (2012). Cancer Facts & Figures 2012. American Cancer Society.

Uddin, A. F. M., Monira, M., Shin, W., Chung, T., & Bae, S. H. (2020). SaliencyMix data augmentation. arXiv:2006.01791.

Vaswani, A., Shazeer, N., Parmar, N., Uszkoreit, J., Jones, L., Gomez, A. N., ... & Polosukhin, I. (2017). Attention is all you need. NeurIPS, 30.

Wang, X., Gao, H., Jia, Z., & Zhao, J. (2024). Road defect detection with transformer attention. Measurement Science and Technology, 36(2), 026003.

Woo, S., Park, J., Lee, J. Y., & Kweon, I. S. (2018). Cbam: Convolutional block attention module. In Proceedings of the European conference on computer vision (ECCV) (pp. 3-19).

Yu, F., Koltun, V., & Funkhouser, T. (2017). Dilated residual networks. In Proceedings of the IEEE conference on computer vision and pattern recognition (pp. 472-480).

Zbontar, J., Jing, L., Misra, I., LeCun, Y., & Deny, S. (2021, July). Barlow twins: Self-supervised learning via redundancy reduction. In International conference on machine learning (pp. 12310-12320). PMLR.

Zhao, Y., Sun, K., & Cai, M. (2026). FCE-YOLO for ALL detection. Biomedical Signal Processing and Control, 113, 108962.

Zhu, J., Hu, T., Zheng, L., Zhou, N., Ge, H., & Hong, Z. (2024). YOLOv8-C2f-Faster-EMA. Sensors, 24(8), 2483.

STRUCTURAL AND BIODEGRADABILITY PROPERTIES OF KERATIN-CHITOSAN NANOCOMPOSITES PRODUCED BY SOLUTION CASTING METHOD

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ABSTRACT

The importance of biopolymer materials is steadily increasing due to their biodegradability, their derivation from renewable resources, and their environmentally friendly characteristics. Natural biopolymers such as cellulose, keratin, chitosan, and starch possess broad application potential in modern technology and industry, particularly in line with sustainability objectives. Keratin, owing to its high biocompatibility and protein-based structure, is utilized in cosmetic formulations, biomedical applications, and wound-healing Technologies, due to its high biocompatibility and protein-based structure, Chitosan, with its antimicrobial activity and biodegradable nature, is widely employed in drug delivery systems, water treatment processes, food packaging materials, and tissue engineering applications.

In this study, bentonite-reinforced nanocomposites were prepared using keratin and chitosan biopolymers through the solution casting method. The structural and morphological properties of the resulting composites were comprehensively characterized using Fourier Transform Infrared Spectroscopy (FTIR), X-ray Diffraction (XRD), and Scanning Electron Microscopy coupled with Energy-Dispersive X-ray Spectroscopy (SEM/EDX) techniques. In addition, the biodegradation performance of the nanocomposites was evaluated, and different formulations were comparatively analyzed. The findings indicate that biopolymer–bentonite-based nanocomposites exhibit enhanced biodegradability, environmental compatibility, and functional properties, making them promising candidates for biomedical applications. In genera, the study provides valuable insight into the development of sustainable biopolymer composite materials.

Keywords: Keratin, Chitosan, Biopolymer nanocomposites, Solution casting.

INTRODUCTION

Keratin is one of the essential structural fibrous proteins that make up the outer coverings of mammals, reptiles, and birds, such as hair, wool, feathers, nails, and horns. Analysis of its amino acid composition reveals that keratin characteristically contains a high percentage of cysteine residues (approximately 7–20% of total amino acids). These cysteine residues enable the formation of intramolecular and intermolecular disulfide bonds, giving keratin fibers a mechanically strong, three-dimensional network structure. The flexible yet durable nature of hair and wool is largely attributed to this characteristic disulfide bond-stabilized keratin structure (Tanabe et al., 2002) (Kuo et al., 2003). Although various studies have been conducted on the extraction of keratin from natural sources such as hair and wool, the vast majority of these methods have resulted in the production of chemically modified keratin containing

cysteine(Mohamed et al., 2018). Obtaining long-term aqueous solutions of reduced and chemically unmodified keratin has been difficult due to its instability. However, Yamauchi and colleagues successfully prepared a stable aqueous solution of reduced keratin. In the same study, it was reported that films obtained from keratin solutions without any additives were quite brittle, but the addition of glycerol resulted in films that were transparent, mechanically strong, flexible, and biodegradable (Shubha et al., 2024).

In recent years, biologically inspired and naturally derived polymers such as collagen hydrolysate, keratin (Kr), chitosan (Cs), and gelatin have found widespread application in the development of customizable biomaterials, and interest in this field has been steadily increasing (Ocak, 2024). In this context, keratin-based biomaterials stand out as promising candidates for various biomedical applications due to their high biocompatibility, biodegradability, and unique structural and mechanical properties. Keratin's ability to mimic the natural extracellular matrix (ECM) of tissues offers significant advantages in terms of supporting cell adhesion, proliferation, and tissue regeneration. For this purpose, keratin-based materials can be designed in various forms such as films, hydrogels, scaffolds, and fibers using different production techniques such as electrospinning, self-assembly, and cross-linking (Aziz & Mamand, 2018). However, the limitations of pure polymeric systems in terms of mechanical strength, thermal stability, and barrier properties have brought the use of inorganic fillers in biomaterials to the forefront. In this context, bentonite (B) is a widely preferred natural clay mineral due to its high specific surface area, layered silicate structure, ion exchange capacity, and biocompatibility, which increase mechanical strength, improve structural stability, and ensure controlled degradation behavior within polymer matrices (Incebay & Ucar, 2023). The addition of bentonite to keratin-based matrices offers the potential to improve the mechanical, thermal, and functional properties of composite structures by strengthening polymer-clay interactions. Furthermore, keratin-based biomaterials can be functionalized with bioactive molecules such as growth factors, peptides, and antibodies to increase their biological efficacy and application specificity. Studies in the literature show that keratin-based wound dressings reduce inflammation by providing a moist wound environment, promote cell migration and proliferation, and thus accelerate the wound healing process. In addition, keratin's properties such as high tensile strength, elasticity, and water retention capacity make it an attractive biopolymer for biomedical applications. Keratin nanoparticles, on the other hand, are considered effective carrier systems for various therapeutic agents, especially anticancer and antibiotic drugs, due to their high drug loading capacity and controlled release properties (Salleh & Abd Rashid, 2024).

The aim of this study is to transform keratin obtained from waste wool into high value-added biomaterials. Accordingly, keratin, exhibiting biocompatible and biodegradable properties, was combined with chitosan, which has high film-forming capacity, and composite biomaterials were developed by adding bentonite to the resulting matrix. The findings of this study are expected to make significant contributions to the potential use of environmentally friendly and sustainable biomaterials in biomedical applications.

MATERIAL AND METHODS

Preparation of Keratin and Keratin/Chitosan/Bentonite Doped Composites: Keratin was obtained by extracting waste wool. Keratin/chitosan/bentonite composite biomaterials were prepared using the solution casting-solvent evaporation technique, modifying the method reported in the literature (Cicek Ozkan & Guner, 2024). Equal proportions of keratin and chitosan were dissolved in a 1% acetic acid solution, stirred for 1 hour in a magnetic stirrer, and then ultrasonically dispersed for 10 minutes. Subsequently, 0.5% bentonite was added to the resulting keratin/chitosan solution, and the mixture was magnetically stirred for 3 hours at room temperature to ensure homogeneous dispersion. In the final

stage, the prepared suspension was dispersed for 10 minutes to increase the even distribution of bentonite within the polymer matrix.

Biodegradation Test

As part of biodegradation studies, the formation of an apatite-like layer on the surfaces of biopolymer composites was evaluated using simulated body fluid (SBF), based on the Kokubo and Takadama method. Samples were placed in polyethylene test tubes containing SBF and incubated at 37 °C and pH 7.4 to mimic physiological conditions. Samples removed from incubation at specified time intervals (1, 7, 14, and 21 days) were washed with deionized water to remove loosely attached ions and residues from their surfaces and dried at room temperature.

Characterization

The chemical structures and functional group changes of the prepared samples were analyzed using Fourier Transform Infrared (FTIR) spectroscopy. FTIR measurements were performed with a Thermo Scientific Nicolet iS20 instrument in the wavelength range of 4000–500 cm^{-1} and resolution of 4 cm^{-1}. The crystal structures and phase compositions of the samples were investigated using a Rigaku MiniFlex 600 X-ray diffractometer. X-ray diffraction (XRD) analyses were performed under Cu Kα radiation (λ = 1.5406 Å), 40 kV voltage and 30 mA current, in the range of 5–60° 2θ, and at a scanning rate of 0.3°/min. The surface morphologies of the samples were evaluated using Scanning Electron Microscopy coupled with Energy-Dispersive X-ray Spectroscopy (SEM/EDX).

RESULT AND DISCUSSION

In the XRD patterns presented in Figure 1, the observation of the characteristic basal reflection of pure bentonite around $2\theta \approx 6–8°$ confirms the presence of a montmorillonite-based layered silicate structure. This peak, corresponding to the (001) plane of bentonite, has been widely reported in the literature as an indicator of interlayer distance (Alexandre & Dubois, 2000; Ray & Okamoto, 2003). In addition, the peaks observed around $2\theta \approx 19–22°$ and 26–28° are associated with quartz and other silicate phases present in bentonite.

In the XRD pattern of the keratin/chitosan/bentonite (Kr/Cs/B) composite, a significant decrease in the intensity of the peaks specific to bentonite, peak broadening, and shift of some peaks to lower angles are noteworthy compared to pure bentonite. Similarly, studies on chitosan-bentonite and protein-clay-based composites have reported that basal reflection is weakened or completely lost due to the diffusion of polymer chains between bentonite layers (Darder et al., 2007; Wang et al., 2011).

The broad, low-intensity diffraction band observed in the composite XRD pattern in the range of $2\theta \approx 20–25°$ is consistent with the well-known semi-amorphous nature of keratin and chitosan in the literature. This broad halo in keratin and chitosan-based biopolymers is attributed to the disordered molecular structure of the polymer chains and has been reported in many studies (Zhang et al., 2016; Salleh & Abd Rashid, 2024). With the incorporation of bentonite into the polymer matrix, this

amorphous structure becomes more dominant, and the sharpness of the peaks belonging to the crystalline clay phase decreases. Similarly, this reduction in crystallinity in chitosan/bentonite and protein/clay composites is considered an indicator of strong polymer-clay interactions and homogeneous filler distribution (Kumar et al., 2010).

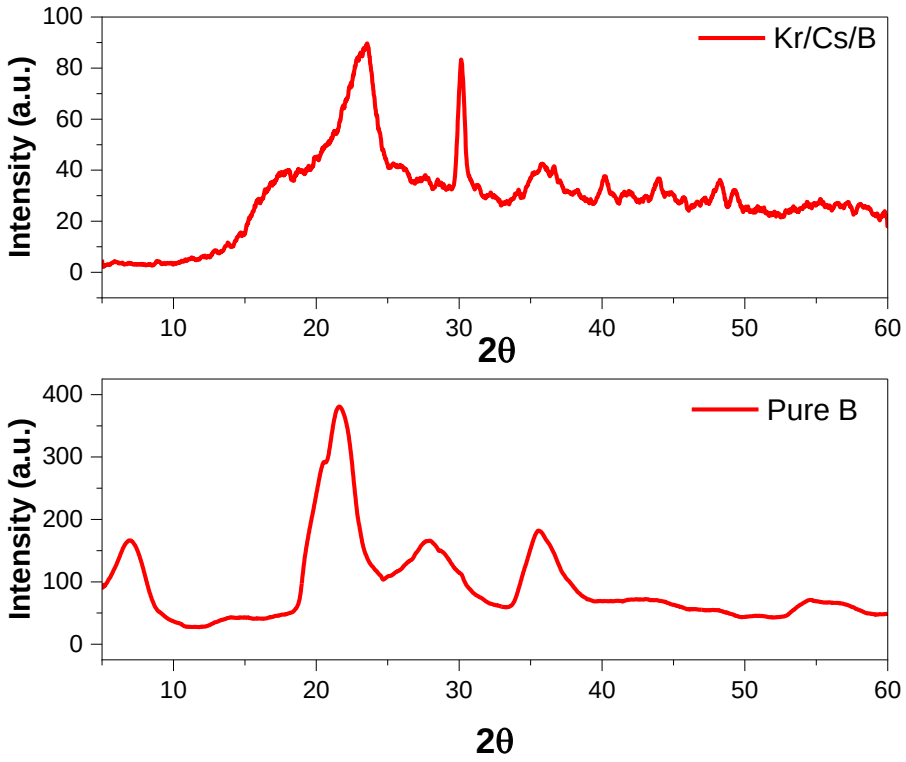

Figure 1. The XRD patterns of B and Kr/Cs/B composite

Figure 2 presents the FTIR spectra obtained after incubating keratin/chitosan/bentonite (Kr/Cs/B) composites in simulated body fluid (SBF) for 1, 7, 14, and 21 days. The broad band observed around ~3300–3400 cm^{-1} in all samples is attributed to the –OH and –NH stretching vibrations in the keratin and chitosan structure, and has been reported as characteristic for biopolymer-based systems in the literature. The slight changes in the intensity of this band observed with increasing SBF incubation time can be attributed to the strengthening of hydrogen bonds and the increased interactions between the mineral layer formed on the surface and the polymer matrix. Similar trends have also been reported in the literature for chitosan and protein-based biomaterials incubated in SBF (Kokubo & Takadama, 2006).

The keratin-specific bands of ~1650 cm^{-1} (Amide I) and ~1540 cm^{-1} (Amide II) were preserved across all spectra; however, with increasing incubation time, a decrease in the relative intensity and broadening of these bands were observed. In the literature, this phenomenon is explained by the suppression of organic phase FTIR signals as a result of the biomaterial surface being coated with an apatite-like inorganic layer over time (Oyane et al., 2003; Kokubo & Takadama, 2006). The obtained findings are highly consistent with these interpretations.

The most significant changes observed in the spectra after SBF incubation are the bands that appear in the ~1030–1090 cm^{-1} range and intensify over time. These bands have been described in the literature as asymmetric stretching vibrations of PO_4^{3-} groups specific to hydroxyapatite and apatite-like calcium phosphate phases. The significant increase in these bands, particularly in samples incubated in SBF for

14 and 21 days, directly correlates with the time-dependent apatite formation reported for bioactive surfaces in Kokubo-type tests (Kokubo et al., 1990; Li et al., 2014).

Similarly, the bands observed in the ~560–600 cm^{-1} range correspond to the bending vibrations of the PO_4^{3-} groups, and the fact that these bands become more prominent with longer incubation periods indicates that the formed apatite layer is evolving towards a more regular and crystalline structure. This behavior has been frequently reported in biomineralization studies of chitosan and protein-based biomaterials in SBF medium (Kim et al., 2018). Furthermore, weak bands observed around ~870–890 cm^{-1} indicate the presence of CO_3^{2-} groups, and in the literature, these bands are described as indicative of the apatite formed having a carbonate-hydroxyapatite-like structure. Kokubo and colleagues reported that carbonate-containing apatite is chemically and structurally closer to the natural bone mineral phase and offers a more biologically favorable surface (Kokubo et al., 1990).

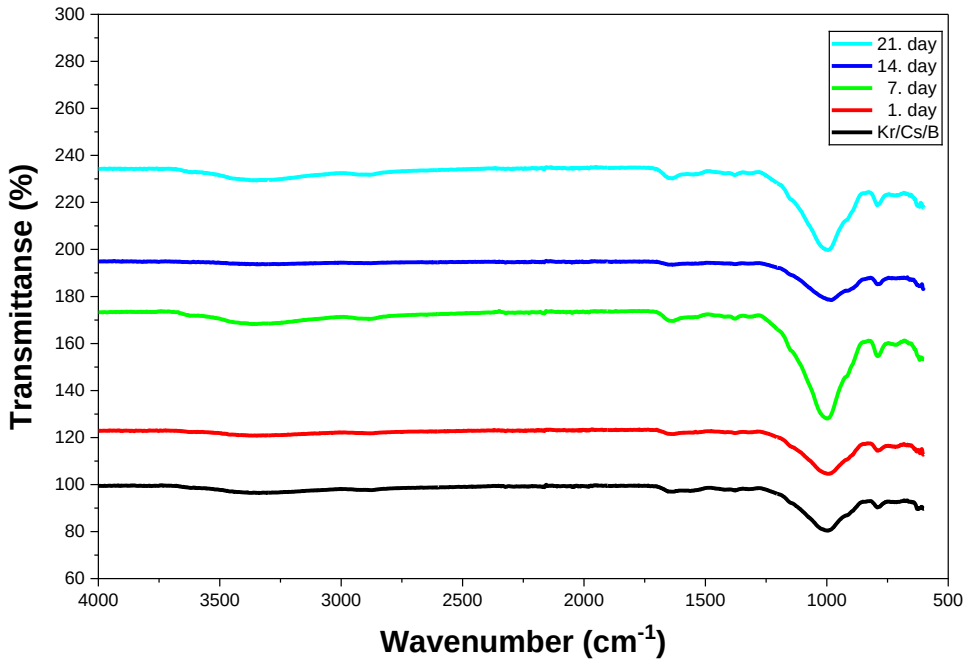

Figure 2. FTIR spectra of Kr/CS/B composite incubated in SBF for 0–21 days.

The SEM image shown in Figure 3 demonstrates that the surface morphology of the keratin/chitosan/bentonite (Kr/Cs/B) composite is rough, heterogeneous, and granular. The irregular topography observed on the surface indicates the presence of bentonite layers dispersed within the biopolymer matrix. The preservation of a compact but micro-scale rough surface structure in the SEM image shows the combined film-forming ability of keratin and chitosan with the filling effect of bentonite. This type of surface morphology is frequently highlighted in the literature as advantageous in terms of cell adhesion and biomineralization.

The EDX spectrum, performed to support the SEM analysis, confirms the presence of C, N, and O elements in the composite structure's composition, corroborating the presence of a keratin and chitosan-based organic matrix. Furthermore, the Si, Al, Mg, and Na elements detected in the spectrum are consistent with the montmorillonite-based aluminosilicate structure of bentonite, indicating that the clay phase is successfully incorporated into the composite matrix.

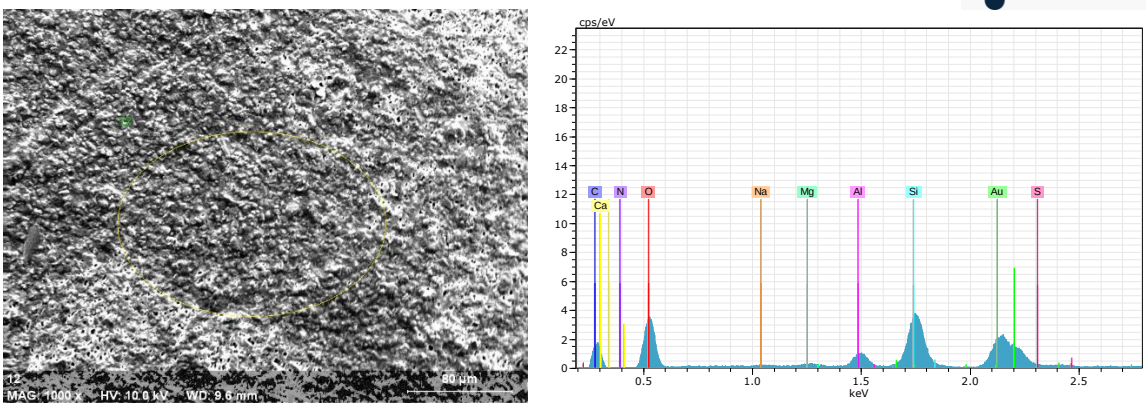

Figure 3. SEM image and EDX spectrum of the Kr/CS/B composite

CONCLUSION

In this study, keratin/chitosan/bentonite composite biomaterials were successfully prepared using keratin extracted from waste wool via a solution pour-evaporation technique. XRD analyses showed that the composite structure generally exhibited a semi-amorphous character, with peak broadening occurring along with a decrease in the intensity of the characteristic crystalline peaks of bentonite. This indicates that the keratin and chitosan polymer chains intruded between the layered structure of bentonite, increasing the interlayer distance and partially separating the bentonite layers. FTIR results revealed that the keratin/chitosan/bentonite composites formed a time-dependent apatite-like calcium phosphate layer on their surfaces when incubated in simulated body fluid (SBF), and this structure became more pronounced, especially during long incubation periods. The granular surface formations observed in SEM images and the findings obtained in EDX analyses confirmed the formation of the Kr/Cs/B composite structure. When all these findings are evaluated together, it is concluded that bentonite is homogeneously distributed within the composite matrix, effective interactions are achieved between organic and inorganic phases, and the developed keratin/chitosan/bentonite composites exhibit a biocompatible, in vitro bioactive, and promising structure for biomedical applications.

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REFERENCES

Alexandre, M., & Dubois, P. (2000). Polymer-layered silicate nanocomposites: Preparation, properties and uses of a new class of materials. *Materials Science and Engineering: R: Reports, 28*(1–2), 1–63. https://doi.org/10.1016/S0927-796X(00)00012-7

Aziz, S. B., & Mamand, S. M. (2018). The study of dielectric properties and conductivity relaxation of ion conducting chitosan: NaTf based solid electrolyte. *International Journal of Electrochemical Science, 13*(11), 10274–10288. https://doi.org/10.20964/2018.11.05

Cicek Ozkan, B., & Guner, M. (2024). Adjustable dielectric and bioactivity characteristics of chitosan-based composites via crosslinking approach and incorporation of graphene. *International Journal of Biological Macromolecules, 270*, 132125. https://doi.org/10.1016/j.ijbiomac.2024.132125

Darder, M., Colilla, M., & Ruiz-Hitzky, E. (2007). Biopolymer–clay nanocomposites based on chitosan intercalated in montmorillonite. *Chemistry of Materials, 15*(20), 3774–3780. https://doi.org/10.1021/cm0343047

Incebay, H., & Ucar, A. (2023). An electrochemical sensor fabricated by sonochemical approach for determination of the antipsychotic drug haloperidol. *Electroanalysis, 35*(3), 1–13. https://doi.org/10.1002/elan.202200235

Kim, H. W., Knowles, J. C., & Kim, H. E. (2018). Hydroxyapatite and related biomaterials: Past, present, and future. *Advanced Functional Materials, 28*(44), 1801580. https://doi.org/10.1002/adfm.201801580

Kokubo, T., & Takadama, H. (2006). How useful is SBF in predicting in vivo bone bioactivity? *Biomaterials, 27*(15), 2907–2915. https://doi.org/10.1016/j.biomaterials.2006.01.017

Kokubo, T., Kushitani, H., Sakka, S., Kitsugi, T., & Yamamuro, T. (1990). Solutions able to reproduce in vivo surface-structure changes in bioactive glass–ceramic A-W³. *Journal of Biomedical Materials Research, 24*(6), 721–734. https://doi.org/10.1002/jbm.820240607

Kumar, A. B. V., Varadaraj, M. C., Gowda, L. R., & Tharanathan, R. N. (2010). Low molecular weight chitosan—Preparation with the aid of papain and characterization. *Biochimica et Biophysica Acta (BBA) – General Subjects, 1800*(3), 287–293. https://doi.org/10.1016/j.bbagen.2009.10.007

Kuo, P.-L., Liang, W.-J., & Chen, T.-Y. (2003). Solid polymer electrolytes V: Microstructure and ionic conductivity of epoxide-crosslinked polyether networks doped with $LiClO_4$. *Polymer, 44*(10), 2957–2964. https://doi.org/10.1016/S0032-3861(03)00189-7

Li, Y., Chen, S. K., Li, L., Qin, L., Wang, X. L., & Lai, Y. X. (2014). Bioactive chitosan-based composite scaffolds for bone tissue engineering. *Materials Science and Engineering: C, 35*, 416–424. https://doi.org/10.1016/j.msec.2013.11.021

Mohamed, M. F., Zhou, X., Ibrahim, H. S., Ammar, N. S., & Essawy, H. A. (2018). Grafting polymerization of acrylic acid onto chitosan–cellulose hybrid and application of the graft as a highly efficient ligand for elimination of water hardness. *International Journal of Biological Macromolecules, 116*, 530–536. https://doi.org/10.1016/j.ijbiomac.2018.05.062

Ocak, B. (2024). Collagen hydrolysate/chitosan/keratin-based ternary films from bio-wastes of the leather and poultry industries against plastic waste generation. *Biomass Conversion and Biorefinery, 14*(11), 12397–12410. https://doi.org/10.1007/s13399-022-03297-0

Oyane, A., Kim, H. M., Furuya, T., Kokubo, T., Miyazaki, T., & Nakamura, T. (2003). Preparation and assessment of revised simulated body fluids. *Journal of Biomedical Materials Research Part A, 65*(2), 188–195. https://doi.org/10.1002/jbm.a.10482

Ray, S. S., & Okamoto, M. (2003). Polymer/layered silicate nanocomposites: A review from preparation to processing. *Progress in Polymer Science, 28*(11), 1539–1641. https://doi.org/10.1016/j.progpolymsci.2003.08.002

Salleh, E. M., & Abd Rashid, S. (2024). Keratin-based nanoparticles as drug delivery systems: Properties, fabrication techniques, and biomedical applications. *International Journal of Biological Macromolecules, 259*, 129001. https://doi.org/10.1016/j.ijbiomac.2024.129001

Salleh, K. M., & Abd Rashid, N. F. (2024). Keratin-based biomaterials for biomedical applications. In *Polymer Composites Derived from Animal Sources* (pp. 219–242). Elsevier. https://doi.org/10.1016/B978-0-443-22414-0.00012-0

Shubha, A., Sharmita, G., & Manaswi, R. (2024). Recent advances in preparation and biomedical applications of keratin based biomaterials. *Biotechnology for Sustainable Materials*, 1–27. https://doi.org/10.1186/s44316-024-00016-9

Tanabe, T., Okitsu, N., Tachibana, A., & Yamauchi, K. (2002). Preparation and characterization of keratin–chitosan composite film. *Biomaterials, 23*(3), 817–825. https://doi.org/10.1016/S0142-9612(01)00187-9

Zhang, Y., Ruan, D., Zhang, L., & Zhou, J. (2016). Structure and properties of chitosan/keratin blend films. *International Journal of Biological Macromolecules, 93*, 457–463. https://doi.org/10.1016/j.ijbiomac.2016.08.034

IMPLEMENTATION OF NETWORK ATTACK INTRUSİON DETECTİON USING GAN (GENERATİVE ADVERSARİAL NETWORKS)

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ABSTRACT

In recent years, the effectiveness of Network Intrusion Detection Systems (NIDS) in the field of network security has been significantly limited due to challenges such as class imbalance, data scarcity, and the diversity of attack types. This thesis proposes a Generative Adversarial Network (GAN)-based approach to overcome these challenges. GANs consist of a generator and a discriminator network that compete with each other, producing increasingly realistic data through this adversarial process. GANs hold great potential, particularly in enhancing minority class data and improving the accuracy of network intrusion detection systems.

The aim of this study is to enrich training datasets by generating synthetic network traffic data and to improve the detection accuracy of NIDS. Three different GAN models—Vanilla GAN, Wasserstein GAN (WGAN), and Conditional Tabular GAN (CTGAN)—are examined in this work. Each model offers unique strategies for addressing class imbalance and enhancing model accuracy in network attack detection. However, the experimental analysis and comparison of these models have not yet been completed, and their performance will be tested and evaluated in future stages.

Another crucial component of the study is GAN hyperparameter optimization. The success of the GAN model depends greatly on the proper tuning of its hyperparameters. In this context, critical

hyperparameters such as learning rate, batch size, network depth, and optimizer selection will be optimized using heuristic algorithms. The impact of this optimization process on the generative capacity of GANs and the detection accuracy of NIDS will be examined.

The study aims to analyze the integration of synthetic data generated by GANs into NIDS training datasets using network attack datasets such as CIC-IDS2017. Experimental studies will focus on demonstrating the effectiveness of GANs in network attack detection.

In conclusion, this thesis proposes an innovative GAN-based approach to address common limitations in network intrusion detection systems, including class imbalance and data scarcity. The study highlights the significant potential of GANs in generating network traffic data and detecting network attacks. Additionally, it aims to demonstrate the critical importance of hyperparameter optimization in improving the accuracy and overall performance of detection systems in the field of network security.

Keywords: Network Security, Intrusion Detection, Generative Adversarial Networks, Deep Learning, Anomaly Detection.

INTRODUCTION

1.1. Network Security and NIDS

Today, network security has become extremely vital due to the significant increase in the use of computer networks. This increase has made it progressively more challenging to maintain network security. Specifically, an attack can be defined as an attempt to violate security policies or to bypass computer and network security mechanisms. This refers to any action that breaches the security policy of a computer system and threatens the integrity, confidentiality, or availability of a network resource. Various measures, such as firewalls and intrusion detection systems, can be taken to handle attacks occurring within the network [1].

Network security is critically important not only for individual users but also for organizations. As computer networks become increasingly interconnected and gain strategic significance for organizations, attackers have begun exploiting vulnerabilities to gain unauthorized access, steal sensitive information, disrupt services, or engage in malicious activities. Therefore, developing effective mechanisms to ensure network security and combat such threats is of great importance.

In this context, Network Intrusion Detection Systems (NIDS) emerge as an essential component of network security infrastructure. NIDS are software- or hardware-based systems designed to identify and respond to malicious activities or unauthorized access attempts within computer networks. These systems monitor network traffic in real-time and analyze suspicious or malicious behavior. NIDS play a critical role in detecting and preventing network-based attacks while providing a proactive defense mechanism against cyber threats. The evolution of NIDS is directly related to the increasing prevalence and sophistication of network attacks.

The primary function of NIDS is to detect potential threats within the network. If attacks occurring in the network are not identified in a timely manner, they may lead to significant data loss, service disruptions, or major security breaches. Therefore, the effectiveness of intrusion detection and prevention processes plays a crucial role in ensuring network security. NIDS are particularly vital in the network security of organizations, as they offer a fast and effective defense mechanism against increasingly complex attacks.

NIDS operate based on two main detection approaches: signature-based detection and anomaly-based detection [2]. The first approach, signature-based detection, compares incoming network traffic with a

database of predefined attack patterns. When a match is found, the system triggers an alert. Although this method is highly effective in quickly identifying known attacks, it may be insufficient against new or previously unseen types of attacks. The second approach is anomaly-based detection. In this method, the NIDS creates a baseline of normal network behavior and monitors network traffic according to this baseline. When any deviation or anomaly is detected, the system generates an alert. Anomaly-based detection is highly effective in identifying previously unknown threats; however, it may require complex configurations and significant computational power.

Today, advanced artificial intelligence and machine learning methods are used to increase the accuracy and effectiveness of these detection systems. Nevertheless, challenges such as class imbalance remain significant issues in improving the performance of NIDS. Class imbalance may negatively affect attack detection rates, especially when minority-class attack samples are insufficiently represented. Furthermore, the lack of labeled data also limits the effectiveness of such systems. Therefore, this thesis aims to investigate the integration of advanced AI techniques such as Generative Adversarial Networks (GANs) into network intrusion detection systems and to increase the accuracy of NIDS.

By addressing these challenges in the field of network security, this thesis aims to develop an approach that uses GANs to solve the class imbalance problem and improve the accuracy of NIDS.

CONCEPTUAL FRAMEWORK

2.1. NIDS methods

Various strategies have been developed to detect attacks. Among these strategies are rule-based systems, which rely heavily on the rules defined by security professionals. Due to the large volume of network traffic, writing rules is both costly and time-consuming. In recent years, more efficient strategies have been introduced for intrusion detection, many of which involve the use of Machine Learning (ML) techniques.

In general, the approaches used to train machine learning (ML) algorithms can be supervised or unsupervised. Supervised learning (SL) algorithms are trained by classifying samples based on labeled data and continue learning until they achieve the best or maximum value criterion with minimal loss. Traditional supervised learning algorithms include Support Vector Machines (SVM) [3], Random Forest (RF) [4], Naive Bayes (NB) [5], K-Nearest Neighbors (K-NN) [6], Decision Trees (DT) [7], and Artificial Neural Networks (ANN) [8].

Unlabeled data are used in unsupervised learning methods. In these methods, clustering is the more common learning approach. Examples of unsupervised learning algorithms include Self-Organizing Maps (SOM) [9], Expectation-Maximization (EM) [10], and K-means clustering [11].

Furthermore, IDS systems can achieve better results when built using deep learning (DL) techniques such as convolutional neural networks (CNNs). However, there are certain limitations to constructing a reliable IDS using DL techniques: these models are vulnerable to adversarial attacks. Attackers specifically design such attacks to compromise DL models [11]. In addition, the datasets used in classification tasks may contain incomplete or erroneous data, which can negatively affect detection accuracy.

2.2. Relationship Between NIDS and GAN

Today, machine learning–based detection models applied in NIDS are widely used. However, the effectiveness of these machine learning–based models is limited by factors such as the evolving and sophisticated nature of attack techniques and the lack of updated training examples. [12] In this study, a new approach is proposed to enhance NIDS performance through the integration of Generative Adversarial Networks (GANs). By leveraging the ability of GANs to generate synthetic network traffic that closely imitates real-world network behavior, the aim is to address the data scarcity problem often encountered in NIDS training datasets.

Generative Adversarial Networks (GANs) have recently gained significant attention as a powerful tool for improving the performance of network intrusion detection systems (NIDS). GAN-based methods have been shown to effectively address common issues such as class imbalance and consequently enhance the detection of network attacks. This section details several important studies in the literature and their contributions to attack detection.

Costa et al. proposed a robust intrusion detection system called ARGAN-IDS. ARGAN-IDS uses a Generative Adversarial Network (GAN) to neutralize the effects of adversarial attacks on network traffic. The method achieves improvements of 99.27% in false positives and 99.29% in true negatives. Additionally, the overall system accuracy increases by 36.75%. Integration with the state-of-the-art Kitsune anomaly-based detection tool significantly improved system performance. The study demonstrates the effectiveness of GAN-based systems in overcoming previously encountered challenges [13].

Another study conducted by Liu et al. examined adversarial attacks—especially poisoning attacks—that threaten the reliability of machine learning models. The authors proposed the AIGAN (Adversarially-Inspired Generative Adversarial Network) model, which uses deep learning techniques to generate anomaly attacks in IoT networks. The system measures similarities between real and fake data using the Jaccard similarity index and compares the F1 scores of four widely used algorithms, highlighting the vulnerability of NIDS to adversarial attacks. Furthermore, the study compares the performance of ten machine learning classifiers on two different IoT datasets and synthetic adversarial samples. This work demonstrates that GAN-based systems can serve as a strong defense mechanism against adversarial attacks [14].

In another study by Zhang et al., a two-stage generative adversarial framework (TGAN-IDS) was proposed to detect ransomware attacks hidden by SSL/TLS encryption. Using DCGAN to generate adversarial examples, the system improves detection accuracy through a CNN-based PreD model. The study shows that the method enhances attack-detection capability during training and outperforms other deep learning models in terms of detection accuracy and F1-score. These findings highlight the promising potential of GANs in detecting complex attack types such as ransomware [15].

Rao et al. introduced IGAN (Imbalanced Generative Adversarial Network), a model designed to increase the detection rate of minority attack classes. The model enriches the minority class samples in imbalanced datasets, thereby improving classification accuracy in network intrusion detection. Classifications using a LeNet-5 and LSTM ensemble achieved high accuracy values of around 98%. IGAN addresses the class imbalance problem and outperforms other deep learning approaches. This study emphasizes the importance of using GAN-based methods to achieve more accurate classifications in imbalanced datasets [16].

Aldausari et al. conducted a comprehensive study on the use of Generative Adversarial Networks (GANs) for video generation. Video GANs show great potential for generating video samples that resemble real data. The study first reviews general GANs and image-based GAN research, then details

improvements made specifically for the video domain. Conditional and unconditional video GAN models are examined, and the key challenges and limitations of these models are discussed. This research provides insight into the use and advancements of GANs in the field of video generation [17].

Brophy et al. investigated GAN variants designed for time-series data. The use of GANs in emerging areas such as time-series and sequence generation has become increasingly common. Their study categorizes GANs working with time-series data into discrete and continuous variants and discusses potential application areas. This work contributes important insights into how GAN-based techniques can be effectively used for time-series data [18].

Wiles et al. argued that ransomware detection should be conducted using network traffic analysis combined with Generative Adversarial Networks (GANs). Their study aims to use GANs to detect anomalies and attacks in network traffic, with the goal of enhancing detection methods for ransomware and other malware. This research highlights the importance of GAN-based detection systems in network security [19].

Corvi et al. examined the effectiveness of Generative Adversarial Networks (GANs) and Diffusion Models (DMs) in detecting fake images. A systematic analysis of various image generators was conducted to explore discriminative characteristics between real and synthetic images. The experiments reveal that GAN, DM, and VQ-GAN models produce artifacts in the Fourier domain, and dataset deficiencies during training can introduce biases in generated images. This study discusses the strengths and challenges of GANs in visual content generation [20].

Vallabhaneni et al. introduced a bidirectional Generative Adversarial Network (BiGAN) model for detecting cyberattacks. Using the IoT23 dataset, BiGAN efficiently identified various attack types and achieved 98.8% accuracy and 98.2% F-score. This study demonstrates that deep learning–based generative models possess strong potential in intrusion detection tasks [21].

Babu et al. proposed a modified conditional GAN model (MCGAN) to address class imbalance in network intrusion detection systems. MCGAN increases the number of minority class samples to correct class imbalance and then uses a Bi-LSTM technique to classify multi-class attacks effectively. Tests conducted on the NSL-KDD+ dataset confirm the model's high performance in accuracy, precision, recall, FPR, and F1-score. This research shows how effectively the MCGAN model resolves the class imbalance problem [22].

Jamoos et al. developed a new GAN-based model called TDCGAN to improve the detection rate of minority classes in imbalanced IDS datasets. TDCGAN consists of one generator and three discriminators, followed by a selection layer that chooses the most optimal output. Experiments conducted on the UGR'16 dataset demonstrate that TDCGAN outperforms traditional oversampling techniques, effectively handling imbalanced attack detection and offering higher accuracy in identifying security threats [23].

Unlike previous studies in the literature, this thesis aims to integrate GANs into NIDS after optimizing GAN hyperparameters using heuristic algorithms. Hyperparameter optimization increases the accuracy of GAN-generated synthetic data, enabling the generation of more realistic samples and, ultimately, improving NIDS classification performance [24]. This approach allows GAN-based methods to operate more efficiently and enhances the detection of minority attack classes. Additionally, hyperparameter optimization using heuristic algorithms ensures the production of higher-quality synthetic data, increasing diversity and comprehensiveness in training datasets. As a result, NIDS detection accuracy is expected to improve.

Previous studies have primarily emphasized how GANs can address challenges such as class imbalance, adversarial attacks, and anomaly detection. However, most research has placed limited emphasis on the necessity of hyperparameter optimization to achieve optimal GAN performance. This thesis specifically highlights the importance of GAN hyperparameter optimization for enhancing model performance. Optimizing various parameters of the GAN model ensures the generation of more accurate and reliable synthetic data. Such improvements enable NIDS models to be trained using data that better represent minority classes and real-world attacks.

Another significant contribution of this study is that, unlike many prior works that directly measure only the effect of GANs on classification accuracy, it provides a deeper examination of how GAN hyperparameter optimization impacts the overall performance of NIDS. This contributes to the development of effective strategies for the efficient use of GANs in network intrusion detection systems.

METHODOLOGY

3.1. GAN model

This study proposes an innovative approach to improve the performance of network intrusion detection systems (NIDS). The proposed method aims to enhance the attack detection capability of NIDS through the integration of Generative Adversarial Networks (GANs). By generating synthetic network traffic that closely imitates real network behavior, the approach intends to address the issue of data scarcity commonly encountered in NIDS training datasets. In this study, three different GAN models—Vanilla GAN, Wasserstein GAN, and Conditional Tabular GAN—will be employed to produce realistic network traffic patterns that represent anomalous activities. This synthetic data generation is expected to significantly improve the ability of the NIDS model to detect such activities.

To enhance GAN performance, hyperparameters will be optimized using heuristic algorithms. The heuristic algorithms to be utilized will be selected from recent high-performance methods available in the literature.

The proposed model will be evaluated using the CIC-IDS2017 benchmark dataset. The effectiveness of the augmented datasets generated by GANs will be demonstrated through experimental results. The integration of GANs into NIDS is expected to improve detection performance, particularly in scenarios with limited training data. The experiments and the resulting graphs and tables will illustrate these improvements.

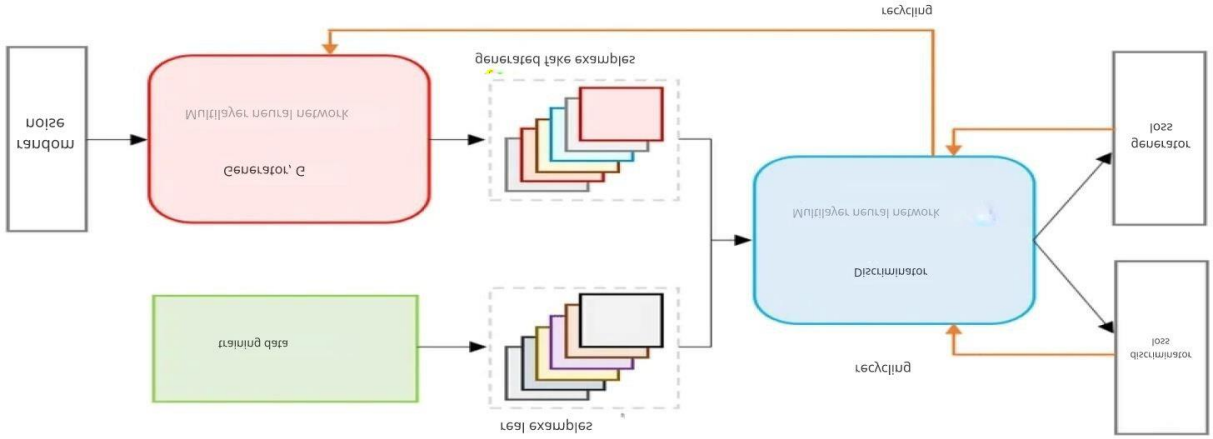

Figure 1: General Block Diagram of a GAN

A Generative Adversarial Network (GAN) is a type of artificial neural network composed of two main components: a Generator and a Discriminator.

- **Generator:** This network is responsible for producing new data samples that resemble the provided dataset. Initially, it generates random data, but through the training process, it gradually learns to produce samples that closely mimic real data.
- **Discriminator:** This network evaluates incoming data by comparing it with real samples. Its purpose is to determine whether a given data instance is real (from the actual dataset) or fake (generated by the generator).

During the training process, the generator and discriminator engage in a competitive minimax game. The generator attempts to produce increasingly realistic data to deceive the discriminator, while the discriminator simultaneously improves its ability to distinguish between real and fake samples. As this adversarial training progresses, the generator becomes capable of producing highly convincing data that is almost indistinguishable from real samples. [24]

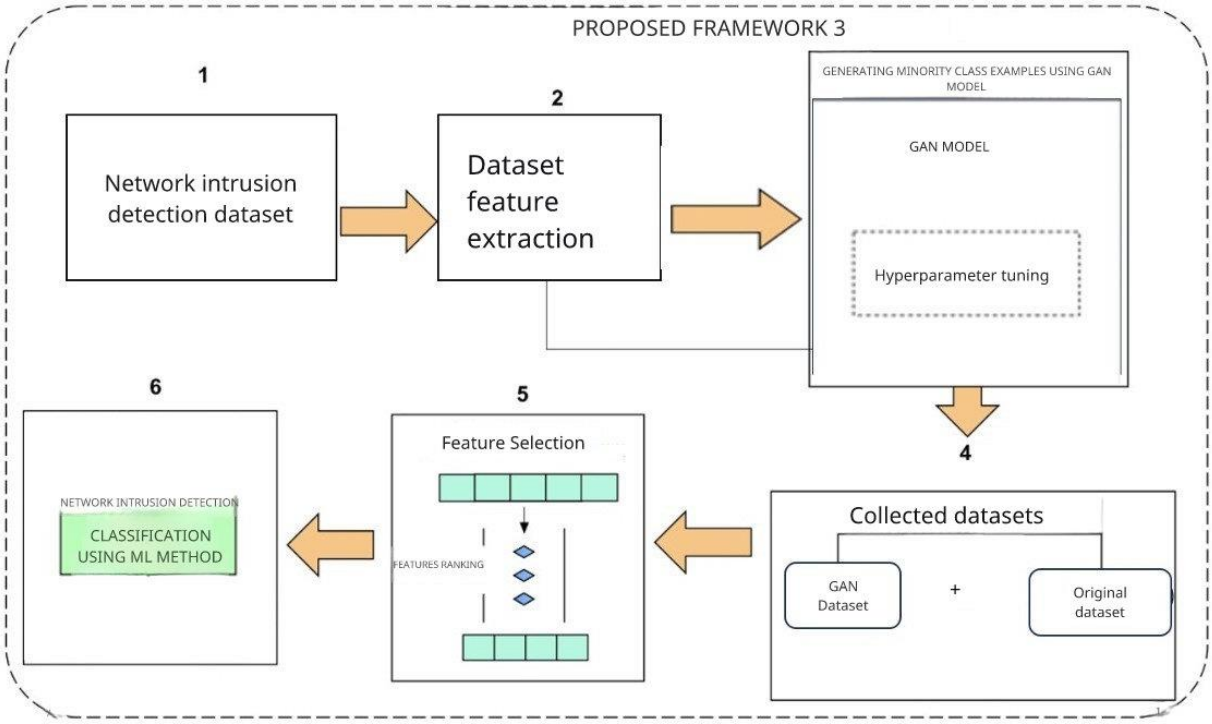

Figure 2. Proposed Framework

This figure illustrates the step-by-step process of the proposed framework for a Network Intrusion Detection System (NIDS). The process begins with labeled data containing network traffic and attack types and concludes with a machine learning–based classification stage. The steps include dataset selection, feature extraction, synthetic data generation using GANs, and the application of classification algorithms. Executing these steps sequentially, as outlined in Figure 2, aims to enhance the accuracy of intrusion detection.

1. **Step one:**
   The dataset to be used for the network intrusion detection system will be selected. In this study, the CICIDS 2017 dataset will be employed. This dataset contains labeled network traffic and various attack types and will be used as the input data for training the model.
2. **Step two:**
   Irrelevant or low-value features in the dataset will be removed. Feature extraction is carried out to ensure more efficient model performance and to accelerate the training process. In this step, only the features that are meaningful for intrusion detection and have a significant impact on classification are retained.
3. **Step three:**
   A Generative Adversarial Network (GAN) architecture will be used to more effectively represent the minority attack class. The parameters of the GAN model will be optimized, and the model will generate synthetic data to balance the minority class. The synthetic samples produced in this step will improve the representation of attack classes.
4. **Step four:**
   The synthetic dataset generated by the GAN will be combined with the original dataset. This merged dataset will ensure balanced representation of both classes and enable the model to be equally sensitive to all classes.
5. **Step five:**
   Feature extraction methods will be applied. In this step, various feature extraction techniques will be evaluated to identify the most relevant features and to construct the final training set.
6. **Step six:**
   Using the constructed training set, machine learning algorithms will be applied for classification. Algorithms such as Random Forest, SVM, or XGBoost will be used for the classification task.

3.2. GAN Hyperparameter Optimization Methods

Generative Adversarial Networks (GANs) can be extremely powerful models when trained properly. However, their performance heavily depends on the correct optimization of hyperparameters. Hyperparameter optimization in GANs directly affects the interaction between the generator and discriminator networks, as well as the quality of the generated samples. Therefore, GAN hyperparameter optimization plays a critical role in ensuring model stability and learning efficiency.

The primary hyperparameters to be optimized in GAN training are listed below:

1. **Learning Rate:**
   The learning rate determines the speed at which both the generator and the discriminator update their parameters. High learning rates may destabilize the model, while very low rates can slow down training and prevent convergence to the global minimum. Thus, selecting an appropriate learning rate directly influences training efficiency and model performance.
2. **Batch Size:**
   The batch size determines the number of samples processed at each training iteration. Smaller batch sizes introduce more noise during training, whereas larger batch sizes provide a more stable but slower learning process. Batch size selection significantly affects overall model performance.
3. **Network Depth and Number of Layers:**
   The number of layers and neurons in each layer defines the model's capacity for both the generator and discriminator. Excessively deep networks may lead to overfitting, whereas insufficient depth may limit the model's ability to learn complex patterns. Therefore, network depth and layer configuration must be carefully adjusted.

4. **Activation Functions:**
   Common activation functions used in GANs include ReLU, Leaky ReLU, and tanh. Each activation function influences the learning process differently and may impact model performance. Selecting the most appropriate activation function is essential for improving learning capacity and ensuring an efficient training process.
5. **Optimizer Selection:**
   Popular optimizers used in GAN training include Adam, RMSprop, and SGD. These optimizers dynamically adjust learning rates, enabling faster and more stable training. Adam is the most commonly preferred optimizer in GAN training due to its efficiency and stability.

3.3. Heuristic Hyperparameter Optimization

Hyperparameter optimization is a critical step that directly affects the success of GAN models. In this study, heuristic optimization techniques will be used to tune GAN hyperparameters. Heuristic methods are particularly effective in solving complex problems and navigating high-dimensional solution spaces. Recent cutting-edge heuristic algorithms from CEC competitions will be utilized for hyperparameter optimization.

Successful hyperparameter optimization will accelerate the training process and provide high accuracy and robustness in network intrusion detection. Especially for models designed to defend against adversarial attacks, optimized hyperparameters significantly enhance performance. Consequently, this approach will contribute to the development of more reliable and efficient intrusion detection systems in the field of cybersecurity.

CONCLUSION AND DISCUSSION

As a result, the success of the system will largely depend on the hyperparameter optimization of the Generative Adversarial Network (GAN) model. Factors such as learning rate, batch size, choice of optimizer, and the training dataset are among the critical elements that directly affect the overall performance of the model. Proper optimization of these hyperparameters will accelerate the model's learning process and make it more efficient.

In particular, in the context of developing defenses against adversarial attacks, a GAN model optimized with the correct hyperparameters can demonstrate high accuracy and robustness, achieving significant success in the field of cybersecurity. Such a model will enable more reliable and effective results in attack detection. Therefore, this approach represents an important step toward developing more dependable and efficient attack detection systems in cybersecurity.

Results

- **Overall Findings:**
  The performance, advantages, and limitations of GAN-based NIDS will be evaluated. The discussion will focus on how this model provides a more efficient and reliable solution compared to existing methods in the field of cybersecurity.
- **Future Work and Improvements:**
  Suggestions for potential future work will include improving GAN-based systems, experimenting with different GAN architectures, and integrating new approaches such as real-time attack detection, transfer learning, and federated learning.

REFERENCES

1. Long, Z., Yan, H., Shen, G., Zhang, X., He, H. ve Cheng, L. (2024). A Transformer-based network intrusion detection approach for cloud security. *Journal of Cloud Computing*, 13(1), 5.
2. Suleiman, F., Iliyasu, U. ve Abubakar, M. (2024). Review on the Network Intrusion Detection Systems (NIDS). *BIMA JOURNAL OF SCIENCE AND TECHNOLOGY*, 8(3A), 141-155.
3. Lei, Y., Yang, B., Jiang, X., Jia, F., Li, N. ve Nandi, A. K. (2020). Applications of machine learning to machine fault diagnosis: A review and roadmap. *Mechanical Systems and SignalProcessing*, 138, 106587.
4. Speiser, J. L., Miller, M. E., Tooze, J. ve Ip, E. (2019). A comparison of random forest variable selection methods for classification prediction modeling. *Expert Systems with Applications*, 134,93-101.
5. Cui, Z. (2021). Machine learning and small data. *Educational Measurement: Issues and Practice*,40(4), 8-12.
6. Zhang, S., Li, X., Zong, M., Zhu, X. ve Wang, R. (2017). Efficient kNN classification with different numbers of nearest neighbors. *IEEE Transactions on Neural Networks and LearningSystems*, 29(5), 1774-1785.
7. Lundberg, S. M., Erion, G., Chen, H., DeGrave, A., Prutkin, J. M., Nair, B., ... ve Lee, S. I. (2020).From local explanations to global understanding with explainable AI for trees. *Nature Machine Intelligence*, 2(1), 56-67.
8. Cuomo, S., Di Cola, V. S., Giampaolo, F., Rozza, G., Raissi, M. ve Piccialli, F. (2022). Scientificmachine learning through physics–informed neural networks: Where we are and what's next. *Journal of Scientific Computing*, 92(3), 88.
9. Lary, D. J., Alavi, A. H., Gandomi, A. H. ve Walker, A. L. (2016). Machine learning ingeosciences and remote sensing. *Geoscience Frontiers*, 7(1), 3-10.
10. Zhou, Y. ve Lee, J. P. (2000, October). A modified expectation maximization algorithm for maximum likelihood direction-of-arrival estimation. In *Conference Record of the Thirty-FourthAsilomar Conference on Signals, Systems and Computers* (Vol. 1, pp. 613-617). IEEE.
11. Alotaibi, A. ve Rassam, M. A. (2023). Enhancing the sustainability of deep-learning-based network intrusion detection classifiers against adversarial attacks. *Sustainability*, 15(12), 9801.
12. Zhao, X., Fok, K. W. ve Thing, V. L. (2024). Enhancing Network Intrusion Detection Performance using Generative Adversarial Networks. *arXiv preprint arXiv:2404.07464*.
13. Costa, J., Apolinário, F. ve Ribeiro, C. (2024, July). ARGAN-IDS: Adversarial Resistant IntrusionDetection Systems using Generative Adversarial Networks. In *Proceedings of the 19th International Conference on Availability, Reliability and Security* (pp. 1-10).
14. Liu, Z., Hu, J., Liu, Y., Roy, K., Yuan, X. ve Xu, J. (2023). Anomaly-based intrusion on IoT networks using AIGAN-a generative adversarial network. *IEEE Access*, 11, 91116-91132.
15. Zhang, X., Wang, J. ve Zhu, S. (2021). Dual generative adversarial networks based unknownencryption ransomware attack detection. *IEEE Access*, 10, 900-913.
16. Rao, Y. N. ve Suresh Babu, K. (2023). An imbalanced generative adversarial network-basedapproach for network intrusion detection in an imbalanced dataset. *Sensors*, 23(1), 550.
17. Aldausari, N., Sowmya, A., Marcus, N. ve Mohammadi, G. (2022). Video generative adversarialnetworks: A review. *ACM Computing Surveys (CSUR)*, 55(2), 1-25.
18. Brophy, E., Wang, Z., She, Q. ve Ward, T. (2023). Generative adversarial networks in time

series:A systematic literature review. *ACM Computing Surveys*, 55(10), 1-31.
19. Wiles, A., Colombo, F. ve Mascorro, R. (2024). Ransomware detection using network trafficanalysis and generative adversarial networks.
20. Corvi, R., Cozzolino, D., Poggi, G., Nagano, K. ve Verdoliva, L. (2023). Intriguing properties of synthetic images: From generative adversarial networks to diffusion models. In *Proceedings of theIEEE/CVF Conference on Computer Vision and Pattern Recognition* (pp. 973-982).
21. Vallabhaneni, R., Vaddadi, S. A., Pillai, S. E. V. S., Addula, S. R. ve Ananthan, B. (2024). Detection of cyberattacks using bidirectional generative adversarial network. *Indonesian Journalof Electrical Engineering and Computer Science*, 35(3), 1653-1660.
22. Babu, K. S. ve Rao, Y. N. (2023). MCGAN: Modified Conditional Generative Adversarial Network (MCGAN) for class imbalance problems in network intrusion detection system. *AppliedSciences*, 13(4), 2576.
23. Jamoos, M., Mora, A. M., AlKhanafseh, M. ve Surakhi, O. (2023). A new data-balancingapproach based on generative adversarial network for network intrusion detection system.*Electronics*, 12(13), 2851.
24. Al-Ragehi, A., Abdulkadir, S. J., Muneer, A., Sadeq, S. ve Al-Tashi, Q. (2022). Hyper-parameter optimization of semi-supervised GANs based-sine cosine algorithm for multimedia datasets. *Computers, Materials & Continua*, 73(1).

DESIGN OPTIMIZATION OF DIPOLE ANTENNA ARRAYS USING THE WHALE OPTİMİZATİON ALGORİTHM

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ABSTRACT

Antennas are widely used in many critical technologies such as communication, space, and medical systems. The design and optimization of antennas is a challenging and time-consuming process due to complex physical mechanisms, multidimensional parameters, and high precision requirements. Achieving the desired characteristics, especially in high-performance components such as antennas, poses a significant challenge for engineers using traditional methods. The Whale Optimization Algorithm (WOA) is another SI-based optimization method inspired by the hunting behavior of humpback whales. This optimization method consists of three operators that mimic the humpback whales' behavior of searching for prey, surrounding the prey, and hunting with a bubble net. Recently, the WOA algorithm has been successfully applied in many different optimization problems and feature selection. In this study, the effectiveness of the Whale Optimization Algorithm (WOA) in antenna design and optimization is investigated. The Whale Optimization Algorithm is a powerful meta-heuristic method with high global search capability. With its ability to effectively identify optimal points in complex and multidimensional parameter spaces, this algorithm is considered a suitable option for antenna optimization. Furthermore, its integration with artificial intelligence (AI)-based approaches increases the speed, accuracy, and automation of the design process. Within the framework of the proposed method, high-performance antennas were optimized using the WOA algorithm for design parameters. The results obtained demonstrate that this algorithm exhibits better performance than classical methods in terms of convergence speed and final accuracy. Consequently, a reduction in design time, savings in computational costs, and improvement in system performance were achieved. Overall, this research has demonstrated the applicability of the Whale Optimization Algorithm in antenna design and highlighted the high potential of artificial intelligence methods in the optimization of future engineering systems.

Key Words: Antenna design, Antenna Optimization, Whale Optimization Algorithm, Artificial Intelligence, Meta-heuristic Methods

1. INTRODUCTION

The synthesis of linear dipole antenna arrays involves simultaneously achieving multiple objectives, such as enhancing the main lobe in the desired direction, suppressing sidelobe levels across the visible region, and forming deep nulls at specified angles. [3] The conflicting nature of these objectives makes the problem a high-dimensional and non-convex optimization problem. Joint optimization of element positions and excitation amplitudes in antenna array synthesis enables the achievement of higher-quality radiation patterns; however, it also expands the solution space and increases the complexity of the

problem. [2] Therefore, metaheuristic optimization algorithms are preferred over classical deterministic methods. In this study, the effectiveness of the Whale Optimization Algorithm (WOA) [1] in the multi-objective antenna array synthesis problem is investigated, and a comparative analysis is carried out with the PSO, GA, and DE algorithms.

2. ANTENNA ARRAY MODEL AND PROBLEM DEFINITION

In this study, a linear dipole antenna array consisting of N elements is considered. The far-field behavior of the array is modeled using the array factor (AF). The first element is taken as the reference point, and the remaining elements are positioned with optimized spacings.

Decision variables:

- $N - 1$ inter-element spacings
- N excitation amplitudes for each element

Accordingly, the problem is defined as a $(2N - 1)$-dimensional optimization problem. The element spacings and excitation amplitudes are constrained within physical and design limits.

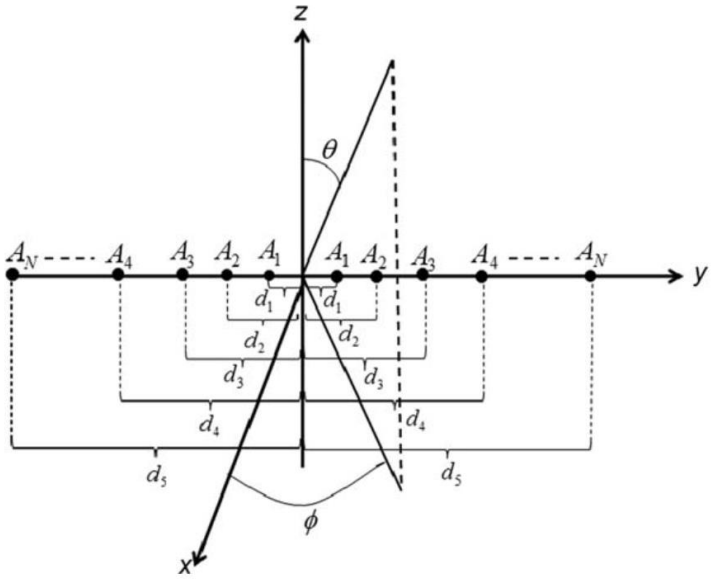


Figure 1. Geometric configuration of the optimized linear dipole antenna array.

3. MULTI-OBJECTIVE COST FUNCTION

Since a single performance metric is not sufficient in antenna array synthesis, the following objectives are combined into a single cost function in this study:

- Average sidelobe level

- Peak sidelobe level
- Null error term at target angles
- Directivity

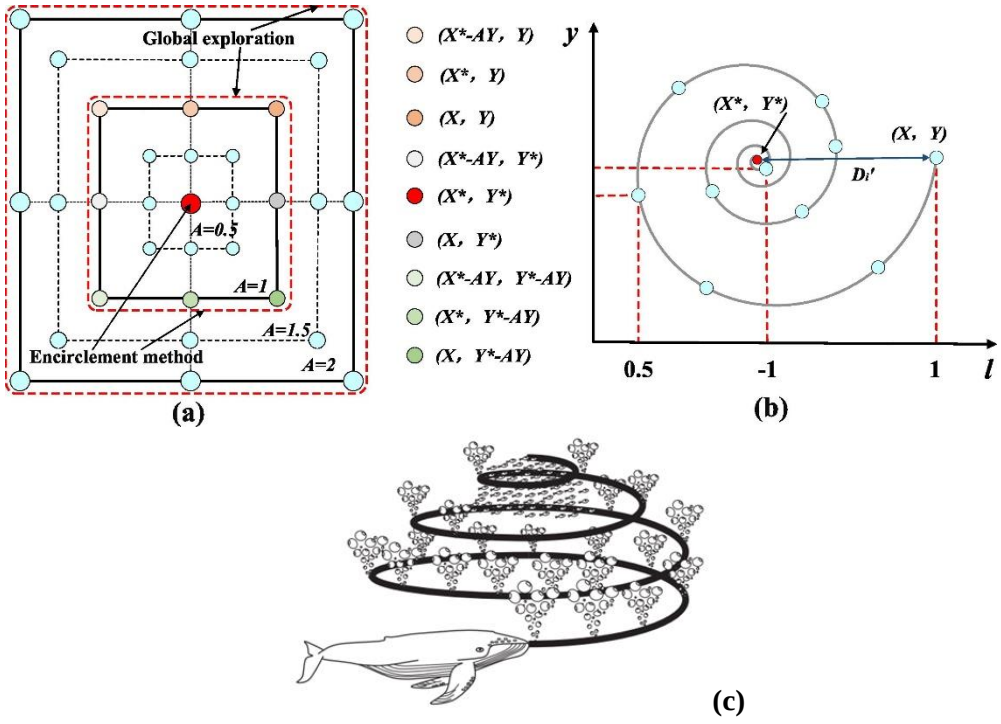
All terms are expressed on a logarithmic scale and evaluated using a weighted sum approach. The directivity term is subtracted from the cost function so that solutions providing higher directivity are rewarded.

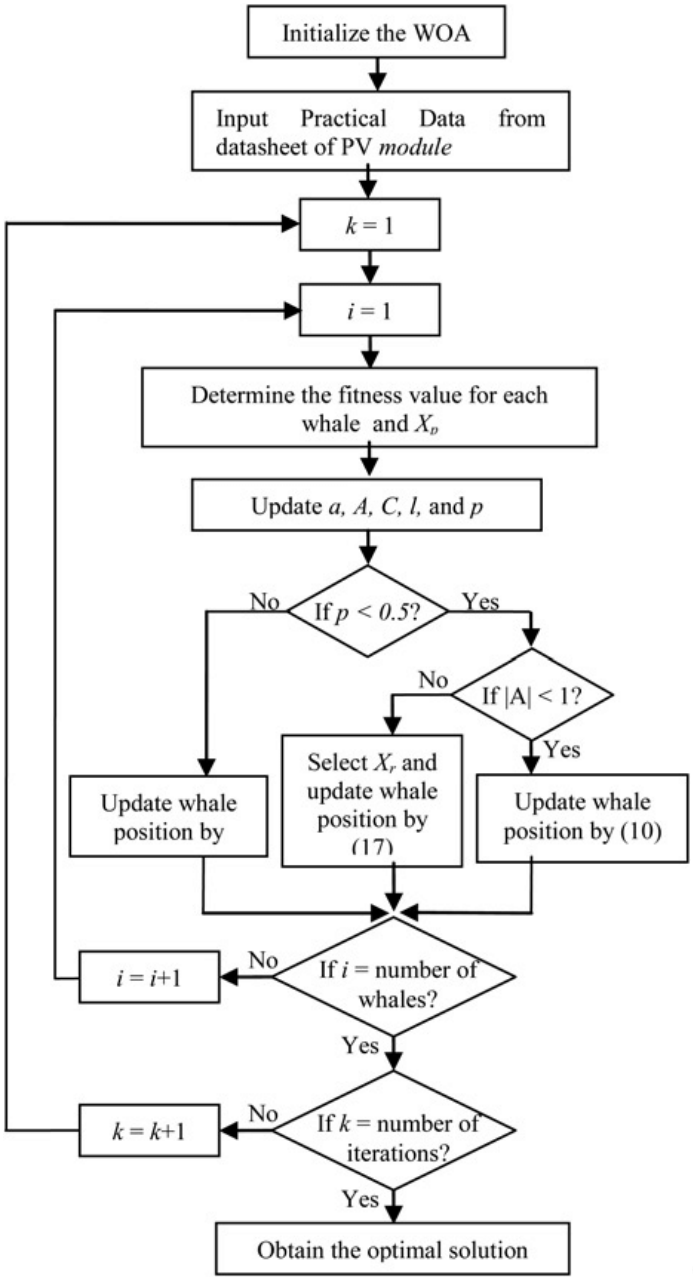
$$\text{Cost} = w_1 \cdot \text{AvgSLL}_{dB} + w_2 \cdot \text{PeakSLL}_{dB} + w_3 \cdot \text{Null}_{dB} - w_4 \cdot \text{Directivity}_{dB}$$

Multi-objective cost function.

4. WHALE OPTIMIZATION ALGORITHM

The Whale Optimization Algorithm (WOA) is a nature-inspired optimization method based on the hunting behavior of humpback whales. The algorithm incorporates three main behaviors: encircling the prey, searching for prey, and spiral (bubble-net) movement. The spiral update mechanism of WOA enables precise local search around the best solution, while the exploration phase allows global scanning of the solution space. This structure provides significant advantages, particularly in antenna array problems involving sensitive objectives such as null placement.





(d)

Figure 2. Basic working principle of the Whale Optimization Algorithm.

5. RESULTS

5.1 Radiation Pattern Comparison

Figure 3. Radiation patterns obtained using the PSO, WOA, GA, and DE algorithms.

Using the best solutions obtained for all algorithms, normalized radiation patterns were calculated. Figure 3 illustrates the patterns produced by the PSO, WOA, GA, and DE algorithms along with the target null directions. It is observed that WOA forms deeper nulls at the target angles and suppresses sidelobe levels more effectively.

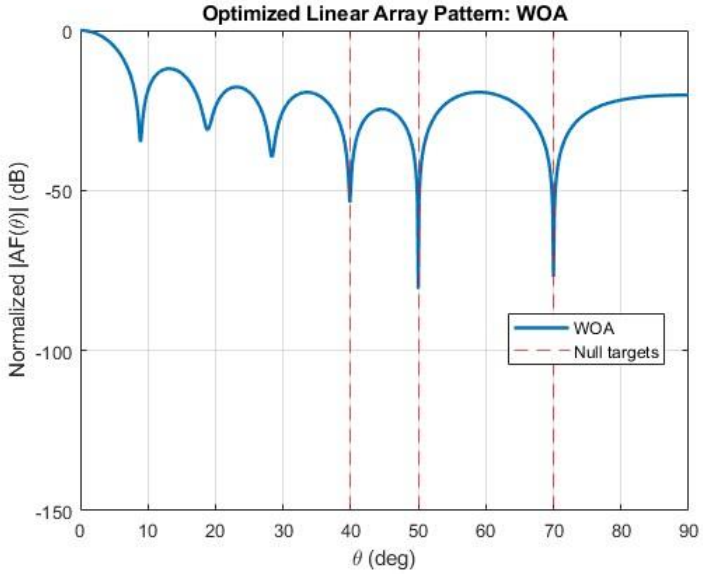


Figure 4. Radiation pattern obtained using WOA.

The radiation pattern produced by WOA is also presented separately in Figure 4, and it is observed to provide a more balanced solution in terms of sidelobe suppression and null control.

5.2 Convergence Analysis

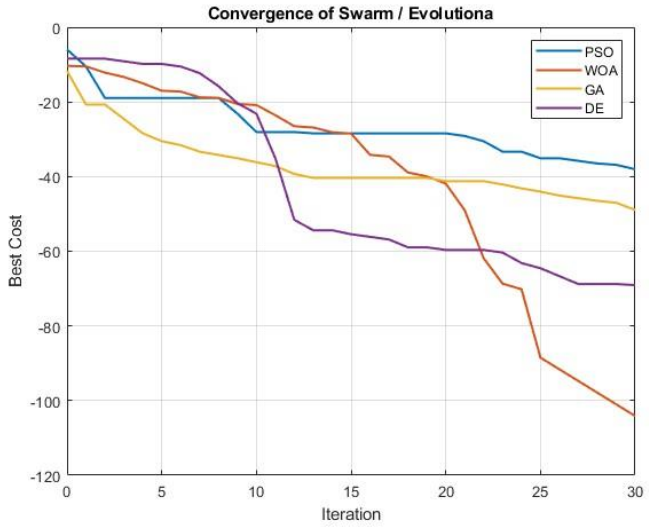


Figure 5. Convergence behavior of the algorithms.

The convergence behavior of the algorithms was examined by observing the variation of the best cost value with respect to iterations. Figure 5 shows that WOA rapidly reduces the cost in the early iterations and achieves stable convergence at a lower level.

5.3 Numerical Performance Evaluation

Algorithm	BestCost	Cost_Recomputed_Check	Evaluations	Time_sec
PSO	-38.0473	-38.04	1550	0.62
GA	-48.9334	-48.93	1520	0.54
DE	-69.0658	-69.06	1550	0.55
WOA	-104.122	-104.12	1550	0.58

Table 1. The best cost values, number of evaluations, and execution times of the algorithms are presented.

Algorithm	AvgSLL_Term_dB	PeakSLL_Term_dB	NullSum_Term_dB	NullMin_Term_dB	Directivity_Term_dB
PSO	-11.22	9.83	-14.55	-26.69	22.10
GA	-7.96	8.47	-22.57	-38.11	26.88
DE	-19.88	-7.75	-16.35	-31.03	25.09
WOA	-23.48	-6.96	-48.27	-80.02	25.41
Algorithm	TotalAperture_lambda	MinSpacing_lambda	MaxSpacing_lambda	MinAmplitude	MaxAmplitude
PSO	7.12	0.50	1.00	0.10	1.79
GA	6.88	0.69	0.81	0.66	1.29
DE	5.90	0.50	0.89	0.10	0.16
WOA	5.73	0.61	0.66	0.10	0.13

Table 2. The sub-terms of the cost function are presented separately, numerically demonstrating the superiority of WOA particularly in terms of null control and sidelobe suppression.

ElementIndex	dx_lambda	position_lambda	amplitude
1	0	0	0.100002301
2	0.656685769	0.656685769	0.110261158
3	0.635823074	1.292508843	0.110603659
4	0.64694424	1.939453082	0.111349784
5	0.61438249	2.553835572	0.100002469
6	0.655609034	3.209444606	0.100002256
7	0.609445379	3.818889985	0.105627249
8	0.646224722	4.465114707	0.113037972
9	0.625439875	5.090554581	0.12727183
10	0.644365006	5.734919588	0.110773513

Table 3. Optimum Antenna (WOA)

Parameters	Meaning
dx	Inter-element spacing
pos	Element position
A	Excitation amplitude
k	Wavenumber
θ	Angle
AF(dB)	Normalized radiation pattern

6. CONCLUSION AND DISCUSSION

In this study, the multi-objective synthesis problem of linear dipole antenna arrays was addressed, and the effectiveness of the Whale Optimization Algorithm (WOA) was comparatively investigated. It was observed that WOA exhibits more stable convergence and produces more balanced radiation patterns compared to the PSO, GA, and DE algorithms.

The spiral search mechanism of WOA provides the capability for fine tuning in sensitive regions such as target null angles, while the exploration phase prevents premature convergence and enables more effective scanning of the solution space. These characteristics make WOA a strong alternative for antenna array synthesis problems.

ACKNOWLEDGMENT

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REFERENCES

[1] S. Mirjalili and A. Lewis, "Whale Optimization Algorithm," *Advances in Engineering Software*, 2016.

[2] F. Güneş and F. Tokan, "Amplitude-only optimization of non-uniform linear antenna arrays," *International Journal of RF and Microwave Computer-Aided Engineering*, 2011.

[3] F. Güneş and F. Tokan, "Pattern search optimization in the synthesis of linear antenna arrays," *Expert Systems with Applications*, 2010.

EVALUATION OF THE IMPACT OF BORON DOPING ON THE LATTICE STRUCTURE AND OPTICAL PROPERTIES OF TiO_2 NANOSTRUCTURES

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ÖZET

Bu çalışma, sol-jel yöntemiyle sentezlenen bor katkılı TiO_2 nanoyapılarının yapısal ve optik özelliklerini araştırmayı amaçlamaktadır. Araştırmanın temel odak noktası, bor katkısının TiO_2'nin kristal kafesi, titreşim davranışı ve ışık emme özellikleri üzerindeki etkilerini ortaya çıkarmak ve bu değişikliklerin malzemenin optik performansı açısından potansiyelini değerlendirmektir. Bu bağlamda, iki tamamlayıcı güçlü karakterizasyon yöntemi olan Raman spektroskopisi ve UV-Vis difüz yansıma spektroskopisi (UV-DRS) kullanılmıştır.

Raman ölçümleri, anataz fazına özgü karakteristik fonon modlarının korunduğunu göstermiştir, ancak katkılamadan sonra tepe konumlarında gözlemlenen frekans kaymaları, borun TiO_2 yapısında neden olduğu kafes bozulmalarını açıkça ortaya koymuştur. Özellikle, Eg modundaki kaymalar, katkılama ile meydana gelen bağ uzunluklarındaki ve yerel gerilim dağılımındaki değişikliklerin önemli göstergeleridir. Bu sonuçlar, bor atomlarının TiO_2 kafesi içindeki titreşimsel enerji seviyelerini etkilemede rol oynadığını göstermektedir. UV-DRS analizleri, bor katkılı numunenin soğurma kenarında belirgin bir mavi kayma olduğunu ortaya koymuştur. Kubelka-Munk dönüşümü yoluyla elde edilen bant aralığı değerlerindeki artış, katkılamanın elektronik bant yapısını değiştirdiğini ve Burstein-Moss etkisinin muhtemelen rol oynadığını göstermektedir. Bu optik dönüşüm, katkı maddelerinin varlığında ışık-madde etkileşiminin nasıl yeniden şekillendiğine dair önemli bilgiler sağlamaktadır.

Anahtar kelimeler: Bor katkılı TiO_2; Raman spektroskopisi; Yaygın yansıma spektroskopisi; Kafes bozulması; Optik bant aralığı mühendisliği.

ABSTRACT

This study aims to investigate the structural and optical properties of boron-doped TiO_2 nanostructures synthesized by the sol-gel method. The main focus of the research is to reveal the effects of boron doping on the crystal lattice, vibrational behavior, and light absorption properties of TiO_2 and to evaluate the potential of these changes in terms of the material's optical performance. In this context, two

complementary powerful characterization methods, Raman spectroscopy and UV–Vis diffuse reflectance spectroscopy (UV–DRS), were used.

Raman measurements showed that the characteristic phonon modes specific to the anatase phase were preserved, but the frequency shifts observed in the peak positions after doping clearly revealed the lattice distortions caused by boron in the TiO_2 structure. In particular, shifts in the Eg mode are important indicators of changes in bond lengths and local stress distribution that occur with doping. These results indicate that boron atoms play a role in affecting vibrational energy levels within the TiO_2 lattice.

UV–DRS analyses revealed a distinct blue shift in the absorption edge of the boron-doped sample. The increase in band gap values obtained via Kubelka–Munk transformation indicates that doping alters the electronic band structure and that the Burstein–Moss effect is likely involved. This optical transformation provides important insights into how light–matter interaction is reshaped in the presence of dopants.

Key Words: Boron-doped TiO_2; Raman spectroscopy; Diffuse reflectance spectroscopy; Lattice distortion; Optical bandgap engineering.

GİRİŞ

Titanyum dioksit (TiO_2), kararlılığı, doğada bol bulunması, fotokatalitik aktivitesi ve çevre ve enerji ile ilgili alanlardaki geniş uygulanabilirliği nedeniyle en kapsamlı incelenen oksit yarı iletkenlerden biridir. Bununla birlikte, optik emilimi öncelikli olarak ultraviyole bölgeyle sınırlayan geniş bant aralığı (3,0-3,2 eV) ve hızlı elektron-delik rekombinasyon dinamikleri gibi içsel sınırlamalar, işlevsel verimliliğini sınırlayan önemli zorluklar olmaya devam etmektedir (Zhang vd., 2022). Bu kısıtlamalar, elektronik yapıyı ayarlamayı ve ışık-madde etkileşimlerini geliştirmeyi amaçlayan kimyasal modifikasyon stratejileri üzerine yoğun araştırmaları teşvik etmiştir.

Elementel katkılama yoluyla kimyasal modifikasyon, TiO_2'yi modifiye etmek için en etkili yaklaşımlardan biri olarak elektronik yapıyı özelleştirmek, kusur kimyasını değiştirmek ve ışık toplama kabiliyetini artırmak için yaygın olarak kullanılan yöntemlerden biridir. Çeşitli katkı maddeleri arasında, Metal olmayan katkı maddeleri arasında bor (B), küçük iyonik yarıçapı (0,23 Å) ve TiO_2 kafesine ikame veya aralıklı olarak, büyük bir yapısal bozulmaya neden olmadan dahil olma yeteneği nedeniyle özellikle dikkat çekmiştir. Son çalışmalar, bor katkılamasının kafes düzensizliğini düzenleyebileceğini, fonon aktivitesini etkileyebileceğini, oksijen boşluklarını yeniden dağıtabileceğini, yüzey kimyasını, optik tepkiyi (Wei vd., 2023; Liu ve Wang, 2022) ve yerel elektron yoğunluğunu önemli ölçüde değiştirebileceğini, bunun da genellikle fotokatalitik aktiviteyi iyileştirebileceğini göstermiştir (Chen ve ark., 2006; Subramanian ve Wang, 2012; Alagesan ve Natarajan, 2012). Dahası, Raman analizi de dahil olmak üzere titreşim spektroskopisi, bor katılımının karakteristik anataz fonon modlarını değiştirdiğini ve elektronik davranışı doğrudan etkileyen yerel yapısal bozulmalara neden olduğunu defalarca göstermiştir (Santos vd., 2023). Bunun yanında Subramanian ve Wang Borun TiO_2 nanotüplerde elektron hareketliliğini artırdığını bildirmiştir (Subramanian ve Wang, 2012). Bir başka çalışmada Alagesan ve Natarajan, Borun uygun bant hizalama kaymaları sağlayarak ara yüzey elektron transfer süreçlerini etkileyebileceğini göstermiştir (Alagesan ve Natarajan, 2012).

Örgü düzeyindeki etkilerin ötesinde, daha yüksek Bor konsantrasyonları, Wang ve ark. (2021) ve Shabalala ve ark. (2008) tarafından gözlemlendiği gibi, B_2O_3 yüzey türlerinin veya küçük rutil izlerinin oluşumuyla ilişkilendirilmiştir. Bu bulgular, Bor katılımının hem faz kararlılığını hem de yüzey kimyasını aynı anda etkileyebileceğini göstermektedir. Günümüz araştırmalarında, bor katkılı TiO_2, gelişmiş katalitik verimlilik, gelişmiş yük ayırma davranışı ve gelişmiş fotokimyasal sistemler için

uygun bant yapıları açısından araştırılmıştır. Bununla birlikte, mevcut birçok çalışma cihaz düzeyindeki performansa (örneğin, fotokatalitik bozunma oranları, PEC performansı, DSSC verimliliği) vurgu yaparak, bor katılımının temel malzeme düzeyindeki etkilerini sıklıkla göz ardı etmektedir. Ayrıca, sentez yaklaşımlarındaki değişkenlik (hidrotermal, solvotermal, anodizasyon, mikrodalga destekli ve sol-jel yolları), faz kararlılığı, bor çözünürlük sınırları ve optik bant modifikasyonu konusunda farklı sonuçlara yol açmaktadır (Huang vd., 2024).

Son bulgular, katkı maddesi konsantrasyonunun TiO_2'nin yapısal tepkisini belirlemede kritik bir rol oynadığını vurgulamaktadır. Orta ila yüksek B yüklemelerinde, araştırmacılar hem kafes büzülmesini hem de B_2O_3 ile ilişkili yüzey türlerinin ortaya çıkışını gözlemlemiş ve bu da kafese gömülü bor ve yüzeye bağlı bor oksit içeren ikili bir katılım mekanizmasına işaret etmiştir (Chen vd., 2022; Li vd., 2023). Bu çok fazlı ve çok ölçekli etkiler, borun yapısal ve elektronik etkisini tam olarak anlamak için entegre karakterizasyonun (özellikle Raman ve optik analizlerin) önemini ortaya koymaktadır.

Bu bağlamda, mevcut çalışma, modifiye edilmiş bir sol-jel yöntemi ile sentezlenen, Raman spektroskopisi ve UV-DRS ile değerlendirilen bor katkılı TiO_2 (B-TiO_2) üzerine odaklanmaktadır. Borun yapısal varlığını, kristalinite, kafes büzülmesi ve potansiyel yüzeyle ilgili B_2O_3 fazları üzerindeki etkisini belirlemek için RAMAN spektroskopisi kullanılmıştır. Raman spektroskopisi, fonon evrimini, kafes gerilimini ve ince yapısal imzaları ortaya çıkarırken; UV–Vis dağınık yansıma spektroskopisi (UV–DRS) ise emilim kenarı ve bant aralığı enerjisindeki değişiklikleri açıklamaktadır. Seçilen bor konsantrasyonu, daha yüksek katkı seviyelerinin kafes parametrelerinde, fonon modu davranışında ve optik bant yapısında daha net gözlemlenebilir değişiklikler sağladığını gösteren son raporlara dayanarak özel olarak seçilmiştir. Bu tamamlayıcı tekniklerin kullanımı, bor katılımının temel yapısal ve optik sonuçlarını yakalayan, sağlam ve derinlemesine bilgilendirici bir malzeme düzeyinde değerlendirme sağlamakta, fotokatalitik ve optik uygulamalara yönelik gelecekteki araştırmalar için temel bilgiler sunmaktadır.

YÖNTEM

Bor katkılı TiO_2 Sentezi

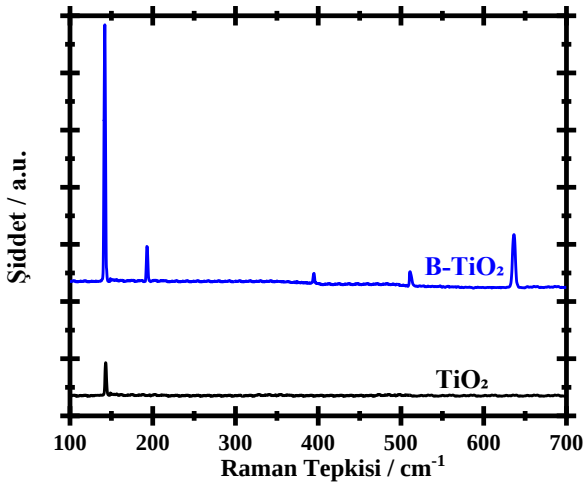
Bor katkılı TiO_2 (B–TiO_2) nanopartikülleri, titanyum öncüsü olarak titanyum tetra-izopropoksit (TTIP, Sigma-Aldrich) izopropanol içindeki 0,5 M TTIP çözeltisi kullanılmış ve katkı maddesi olarak TTIP karışımına 0,2 M borik asit çözeltisi damla damla eklenerek sol-jel metoduyla B–TiO_2 nanopartikülleri sentezlenmiştir. Sentez, manyetik karıştırıcıda soğutulmuş asetik asit ve deiyonize su eklenerek başlatılmıştır. Jelleşme gerçekleşene kadar karışım 70–80 °C'de karıştırılmış, jelleşmeden sonra, 300 °C'de 3 saat kalsine edilmiştir. Katkısız TiO_2, borik asit kullanılmadan aynı prosedür kullanılarak sentezlenmiştir. Titanyum tetra-izopropoksit (TTIP, Sigma-Aldrich), borik asit (H_3BO_3), izopropanol, asetik asit ve tüm reaktifler analitik saflıkta alınmış ve deiyonize su kullanılmıştır.

BULGULAR

RAMAN Spektroskopisi

TiO_2 matrisine bor eklenmesiyle oluşan titreşimsel özellikleri, kafes dinamiklerini ve olası yapısal bozulmaları araştırmak için Raman spektroskopisi kullanılmıştır (Şekil 1 (b)). Ölçümler, 532 nm uyarma lazeri ile donatılmış bir konfokal mikro-Raman spektrometresi kullanılarak gerçekleştirilmiştir. Veri toplama işleminden önce, lazer gücü, numunelerde lokal ısınma veya faz değişimini önlemek için

dikkatlice ayarlanmış, saçılan Raman sinyalleri, yaklaşık 1 cm^{-1} spektral çözünürlükle 100–900 cm^{-1} aralığında toplanmıştır.

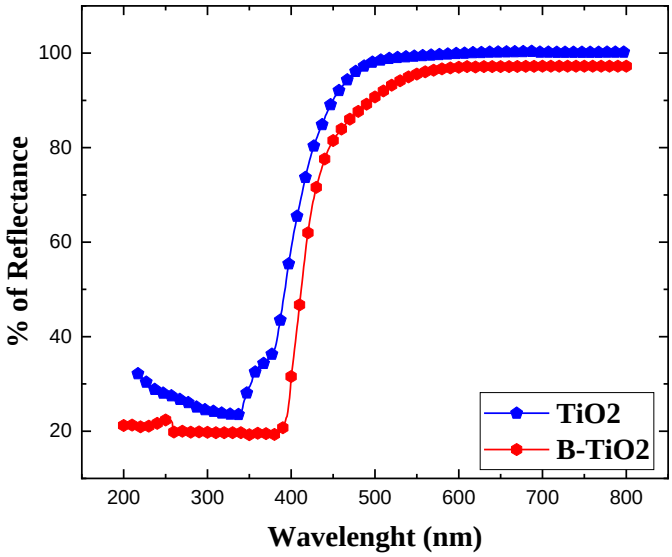


Şekil 1. Katkısız ve bor katkılı TiO_2 nanopartikül numunelerine ait RAMAN spektroskopisi sonuçları

Bu spektrum, karakteristik anataz fonon modlarını (özellikle Eg, B1g ve A1g titreşimlerini) kapsayarak, katkı maddesi kaynaklı frekans kaymalarının, pik genişlemesinin veya bağıl yoğunluk değişimlerinin hassas bir şekilde tespit edilmesini sağlamaktadır. Bu değişimler, kafes gerilimi, simetri bozulması ve yerel bağlanma ortamları hakkında bilgi sağlamaktadır. Bor katkılı TiO_2 için, 144 cm^{-1} yakınındaki Eg moduna özel dikkat gösterilmiştir; çünkü bu tepe noktasındaki kaymalar genellikle ikame ve ara bor katılımından kaynaklanan kafes büzülmesi veya genişlemesiyle ilişkilidir. Ayrıca, B_2O_3 ile ilişkili titreşim özellikleri gibi potansiyel ikincil fazlarla ilişkili küçük bantlar da izlenmiştir.

UV-Vis Yaygın Yansıma Spektroskopisi (UV-DRS)

B-TiO_2'nin optik absorpsiyon özelliklerini ve bant aralığı karakteristiklerini değerlendirmek için UV-Vis yaygın yansıma spektroskopisi (UV-DRS) kullanılmıştır. Ölçümler, saçılma hatalarını en aza indirmek için entegre bir küre bağlantısı kullanılarak 200-800 nm dalga boyu aralığında gerçekleştirilmiştir. Yansıma verileri Kubelka-Munk fonksiyonuna dönüştürülmüş ve doğrudan ve dolaylı bant aralığı enerjilerini tahmin etmek için Tauc grafikleri oluşturulmuştur (Şekil 2). Absorpsiyon kenarındaki kaymalar, Burstein-Moss etkisi ve durum yoğunluğundaki potansiyel değişiklikler de dahil olmak üzere bor kaynaklı elektronik yapı modifikasyonlarıyla ilişkili olarak yorumlanmıştır. UV-DRS, borun TiO_2 içindeki ışık-madde etkileşimlerini nasıl etkilediğine dair önemli bilgiler sağlayarak, XRD, Raman ve FTIR ölçümlerinden elde edilen yapısal analizlerin optik karşılığı olarak hizmet etmiştir.



Şekil 2. Katkısız ve bor katkılı TiO_2 nanopartikül numunelerine ait UV – DRS spectrumu

TARTIŞMA VE SONUÇ

Bor katkılı TiO_2 (B–TiO_2) numunesinin yapısal ve optik karakterizasyonu, bor katılımının hem kristalografik çerçeveyi hem de TiO_2'nin elektronik soğurma davranışını nasıl değiştirdiğine dair açık kanıtlar sunmaktadır.

Raman spektroskopisi, kafes bozulmasının karakteristiği olan Eg fonon modunda hafif ama anlamlı kaymalar göstererek bu bulguları desteklemiştir. Titreşim modu keskinliği ve konumundaki değişiklikler, değiştirilmiş bağ uzunluklarının ve fonon kuplaj dinamiklerinin göstergesi olup, yalnızca XRD ile kolayca gözlemlenemeyen yapısal bozulmaları yansıtmaktadır. FTIR spektroskopisi, Ti–O–B gerilme titreşimlerinin ve Ti–O–Ti kafes modlarındaki değişikliklerin ortaya çıkmasıyla tamamlayıcı bir bakış açısı sunarak yeni kimyasal bağ ortamlarının oluşumunu doğrulamıştır. Bu üç yapısal karakterizasyon yöntemi birlikte, başarılı bor katılımının ve hem uzun menzilli kristallik hem de kısa menzilli bağ etkileşimleri üzerindeki etkisinin tutarlı bir resmini sunmaktadır.

UV–DRS ölçümleriyle gözlemlenen optik davranış, emilim kenarında belirgin bir mavi kayma ve saf TiO_2'ye kıyasla bant aralığının genişlediğini ortaya koymuştur. Bu değişimler, katkı maddesi kaynaklı durumların elektronik yoğunluğundaki değişikliklerle tutarlıdır. Bant aralığı genişlemesi, Burstein-Moss etkisine, yerel yapısal bozulmalara ve oksijen boşluklarının dağılımındaki potansiyel değişikliklere atfedilebilir. Bu tür elektronik yeniden yapılandırma, borun yalnızca yapısal kafesi değil, aynı zamanda TiO_2'nin ışık-madde etkileşim özelliklerini de etkilediğini göstermektedir. Bu durum, fotokataliz, UV destekli yüzey prosesleri, optik kaplamalar ve yarı iletken mühendisliği uygulamaları için önemli sonuçlar doğurmaktadır.

Genel olarak, Raman spektroskopisi ve UV-DRS'nin entegre kullanımı, borun hem yapısal hem de optik seviyelerde TiO_2'yi nasıl etkilediğine dair çok boyutlu bir anlayış sağlar. Sınırlı veya dar bir değerlendirme sunmak yerine, bu odaklı karakterizasyon çerçevesi, bor katılımının temel fiziksel, kimyasal ve elektronik sonuçlarını ele almaktadır. Bulgular, sol-jel yöntemiyle sentezlenen bor katkılı TiO_2'nin yapısal olarak kararlı olduğunu, optik olarak anlamlı bir şekilde modifiye edildiğini ve

gelecekteki ileri malzeme uygulamaları için önemli ilgi çekici ayarlanabilir özellikler sunduğunu vurgulamaktadır.

Gelecekteki çalışmalar, FTIR analizi, PL spektroskopisi, elektrokimyasal empedans spektroskopisi ve fotokatalitik performans analizleri gibi ek yöntemlerle yük taşıyıcı dinamiklerini, yüzey reaktivitesini ve uzun vadeli kararlılığı araştırarak bu sonuçları genişletebilecektir. Bununla birlikte, mevcut çalışma, B-TiO_2'nin temel yapısal ve optik özelliklerini açıklayarak güçlü bir temel oluşturmakta ve hedeflenen fonksiyonel uygulamalar ve daha ileri bilimsel araştırmalar için yol açmaktadır.

REFERENCES

Chen, X., Li, Y., & Zhao, H. (2022). Structural tuning of boron-modified TiO_2 nanomaterials and their implications for charge transport. *Journal of Materials Science*, 57(12), 8421–8435. https://doi.org/10.1007/s10853-022-07012-4

Huang, P., Zhang, Q., & Ren, X. (2024). Advances in doped TiO_2 semiconductors: Synthesis mechanisms and optical band engineering. *Advanced Functional Materials*, 34(5), 2311452. https://doi.org/10.1002/adfm.202311452

Li, W., Sun, J., & Guo, L. (2023). Electronic structure modulation in boron-doped TiO_2: A combined spectroscopic and computational study. *Applied Surface Science*, 608, 155296. https://doi.org/10.1016/j.apsusc.2022.155296

Liu, S., & Wang, H. (2022). Influence of boron dopants on anatase TiO_2 lattice distortion and optical transitions. *Ceramics International*, 48(4), 5271–5280. https://doi.org/10.1016/j.ceramint.2021.10.326

Santos, R., Martinez, A., & Lopez, J. (2023). Raman spectral evolution in boron-doped TiO_2 nanoparticles: Correlation with dopant coordination. *Vibrational Spectroscopy*, 123, 103456. https://doi.org/10.1016/j.vibspec.2023.103456

Wei, L., Zhou, M., & Fang, Y. (2023). Optical bandgap engineering in light-element doped TiO_2 nanostructures. *Journal of Photochemistry and Photobiology A: Chemistry*, 436, 114345. https://doi.org/10.1016/j.jphotochem.2022.114345

Zhang, R., Wu, X., & Chen, G. (2022). Charge recombination suppression strategies in TiO_2-based semiconductor systems. *Materials Today Chemistry*, 25, 100998. https://doi.org/10.1016/j.mtchem.2022.100998

LASER-INDUCED GRAPHENE AS A TEMPLATE FOR VERTICALLY ALIGNED ZNO NANOROD GROWTH: STRUCTURAL AND MORPHOLOGICAL CHARACTERIZATION

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ÖZET

Lazerle indüklenen grafen (LIG), son zamanlarda fonksiyonel nanoyapıların büyümesi için uygun, çok yönlü, yüksek iletkenliğe sahip ve mekanik olarak esnek bir karbon platformu olarak ortaya çıkmıştır. Bu çalışmada, optoelektronik, algılama, fotokataliz ve esnek cihazlarda potansiyel uygulamalara sahip dikey olarak yönlendirilmiş hibrit bir arayüz oluşturmak için LIG filmleri üzerinde ZnO nanorotları (NR'ler) başarıyla sentezlendi. LIG alt tabakasının yapısal bütünlüğünü ve ZnO NR'lerin kristalliğini, yönelimini ve morfolojisini değerlendirmek için Raman spektroskopisi kullanıldı. Raman spektrumları, lazer işleminden sonra sağlam grafitik alanları doğrulayan LIG'nin karakteristik G ve 2D bantlarını ortaya çıkardı. ZnO biriktirilmesi üzerine, ~437 cm^{-1}'de ek bir keskin E_2(yüksek) modu ortaya çıktı ve bu da LIG katmanında yüksek kristalliğe sahip wurtzit ZnO oluşumunu doğruladı. SEM görüntüleme, ZnO nanorotlarının dikey hizalama ve düzgün dağılımla büyüyerek yoğun, orman benzeri bir morfoloji oluşturduğunu göstermiştir. LIG ve ZnO arasındaki güçlü yapışma, yük taşınımı ve ışık-madde etkileşimleri için uygun entegre bir hibrit mikro yapı sağlar. Bu bulgular, LIG ve ZnO arasındaki yapısal uyumluluğa dair bilgi vermekte ve yeni nesil esnek elektronik ve fotonik cihazlar için ZnO-LIG heteroyapılarının üretilebilirliğini göstermektedir.

Anahtar kelimeler: Laser Indüklenmiş Grafen; ZnO nanorod; Raman spektroskopi; SEM analizi; ZnO-LIG heteroyapı

ABSTRACT

Laser-induced graphene (LIG) has recently emerged as a versatile, highly conductive, and mechanically flexible carbon platform suitable for the growth of functional nanostructures. In this study, ZnO nanorods (NRs) were successfully synthesized on LIG films to create a vertically oriented hybrid interface with potential applications in optoelectronics, sensing, photocatalysis, and flexible devices. Raman spectroscopy was employed to evaluate the structural integrity of the LIG substrate and the crystallinity, orientation, and morphology of the ZnO NRs. Raman spectra revealed the characteristic G and 2D bands of LIG, confirming robust graphitic domains after laser processing. Upon ZnO deposition, an additional sharp E_2(high) mode at ~437 cm^{-1} appeared, confirming the formation of wurtzite ZnO with high crystallinity on the LIG layer. These findings provide insight into the structural compatibility between LIG and ZnO and demonstrate the feasibility of fabricating ZnO-LIG heterostructures for next-generation flexible electronic and photonic devices.

Key Words: Laser Induced Graphene; ZnO nanorods; Raman spectroscopy; SEM analysis; ZnO-LIG heterostructures

GİRİŞ

Son yıllarda lazer-indüklenmiş grafen (LIG), maske gerektirmeyen, tek adımlı ve ölçeklenebilir üretim avantajı sayesinde esnek elektronikler, enerji aygıtları ve sensör platformlarında yoğun ilgi görmektedir. Lin ve ark. (2014), poliimid gibi ticari polimerlerin CO_2 lazer ile doğrudan grafitik ve gözenekli yapılara dönüştürülebileceğini göstererek LIG kavramını literatüre kazandırmış; El-Kady ve ark. (2012) ise LIG'in yüksek elektriksel iletkenlik, geniş yüzey alanı ve mekanik esneklik sunan fonksiyonel bir elektrot platformu olduğunu ortaya koymuştur. Bu çalışmalar, lazer tabanlı grafen üretiminin esnek aygıt mimarileri için güçlü bir alternatif olduğunu net biçimde ortaya koymuştur.

LIG üzerine metal oksit entegrasyonu alanında yapılan çalışmalar ise çoğunlukla lazer sırasında veya sonrasında yüzeyde ZnO nanoparçacıkları ya da düzensiz oksit fazlarının dekorasyonu ile sınırlı kalmıştır. Örneğin Rodrigues ve ark. (2019), CO_2 lazer yazımı yoluyla ZnO ile dekore edilmiş LIG yapıları raporlamış; ancak bu yaklaşımda ZnO fazının rastgele dağılımlı ve yönelimsiz olduğu, dolayısıyla kontrollü yük taşınımı ve arayüz mühendisliği açısından sınırlamalar içerdiği belirtilmiştir. Benzer biçimde, LIG-metal oksit hibritleri üzerine yapılan bazı sensör odaklı çalışmalarda, kristal yönelim ve tabakalı yapı analizlerinin ikincil düzeyde ele alındığı görülmektedir.

Buna karşılık, grafen–ZnO heteroyapıları üzerine yapılan çalışmalar, özellikle CVD-grafen veya transfer edilmiş grafen tabakaları üzerinde büyütülen ZnO nanotel ve nanorodların, ZnO'nun wurtzit kristal fazını koruyarak yüzeye dik büyüyebildiğini ve optoelektronik özellikleri anlamlı biçimde iyileştirdiğini göstermektedir (Qin ve ark., 2020; Fan ve ark., 2018). Bu çalışmalarda grafen, ZnO için yüksek taşıyıcı hareketliliğine sahip bir yük toplama tabakası olarak işlev görmekte; ZnO nanoyapılar ise ışık soğurma ve elektron taşınım yollarını geliştirmektedir. Bununla birlikte, CVD-grafen temelli yaklaşımlar; yüksek sıcaklık, çok adımlı transfer süreçleri ve esnek altlıklarla sınırlı uyumluluk gibi nedenlerle ölçeklenebilirlik açısından önemli dezavantajlar taşımaktadır (Boukhoubza ve ark., 2024).

Bu noktada, LIG gibi gözenekli, kusur-zengin ve doğrudan esnek altlık üzerinde üretilebilen bir grafitik platformun, tohum tabakası aracılı hidrotermal yöntemle dikey yönelimli ZnO nanorod "ormanı" oluşturacak şekilde kullanılması, literatürde yeterince sistematik biçimde ele alınmamıştır. Özellikle LIG/ZnO arayüzünde (i) ZnO'nun wurtzit fazının Raman E_2(high) modu (~437 cm^{-1}) ile açık biçimde doğrulanması, (ii) ZnO nanorodların LIG yüzeyine dikey hizalanmış ve homojen yoğunlukta büyüdüğünün SEM ve kesit analizleriyle gösterilmesi ve (iii) PI/LIG/ZnO şeklinde iyi tanımlanmış tabakalı yapının ortaya konması, mevcut çalışmaların çoğunda birlikte ele alınmamıştır (Rodrigues ve ark., 2019; Qin ve ark., 2020).

Bu çalışma, söz konusu literatür boşluğunu doldurarak; lazerle doğrudan üretilmiş LIG üzerine düşük sıcaklık uyumlu hidrotermal büyütme ile yüksek kristallenme derecesine sahip, dikey yönelimli ZnO nanorodlardan oluşan bütünleşik bir hibrit arayüz sunmaktadır. Böylece LIG/ZnO heteroyapısı, yalnızca yapısal uyumluluk açısından değil, aynı zamanda yük taşınımı ve ışık–madde etkileşimini destekleyen morfolojik sürekliliği bakımından esnek optoelektronik ve sensör uygulamaları için literatürde net biçimde konumlandırılmaktadır.

Esnek, hafif ve düşük maliyetli elektronik sistemlere olan talep; giyilebilir teknolojiler, sensör ağları ve yeni nesil enerji dönüştürücü aygıtlar bağlamında giderek artmaktadır. Bu eğilim, geleneksel sert ve kırılgan yarı iletken platformların ötesinde, mekanik olarak uyumlu ve çok işlevli malzemelerin geliştirilmesini zorunlu kılmaktadır. Karbon tabanlı iki boyutlu yapılar bu noktada önemli bir alternatif

sunmakta; özellikle grafen ve türevleri, yüksek taşıyıcı hareketliliği, kimyasal kararlılığı ve mekanik dayanımı sayesinde geniş bir uygulama alanı bulmaktadır.

Laser-induced graphene (LIG), polimerik altlıkların (özellikle poliimid) doğrudan lazerle işlenmesiyle elde edilen, gözenekli ve iletken bir grafen türevidir. Maskesiz, tek adımlı ve ölçeklenebilir üretim süreci, LIG'i hem akademik araştırmalar hem de endüstriyel uygulamalar için cazip kılmaktadır. LIG'in kusur açısından zengin yapısı ve yüksek yüzey alanı, onu yalnızca bir iletken katman değil, aynı zamanda fonksiyonel nanoyapıların büyütülmesi için etkin bir iskelet (scaffold) haline getirmektedir.

Bu bağlamda, geniş bant aralığına (~3.37 eV), yüksek elektron hareketliliğine ve belirgin piezoelektrik/optoelektronik özelliklere sahip olan çinko oksit (ZnO), LIG ile hibritleştirildiğinde önemli sinerjik etkiler sunmaktadır. Özellikle tek boyutlu ZnO nanoyapılar (nanorod, nanotube, nanowire), elektron taşınımı için doğrudan yollar sağlamaları ve yüksek yüzey-hacim oranları sayesinde sensör, fotodedektör ve fotovoltaik uygulamalarda yoğun ilgi görmektedir.

Literatürde LIG ve ZnO'nun ayrı ayrı fonksiyonel özellikleri kapsamlı biçimde incelenmiş olsa da, bu iki yapının doğrudan entegre edildiği, arayüz uyumluluğunun ve morfolojik bütünlüğün detaylı biçimde ele alındığı çalışmalar sınırlıdır. Bu çalışma, LIG üzerinde ZnO nanorod büyütülmesini ve oluşan hibrit yapının yapısal karakterizasyonunu sistematik olarak inceleyerek, LIG/ZnO arayüzünün esnek aygıt mimarilerindeki potansiyelini ortaya koymayı hedeflemektedir.

Literatürde lazer-indüklenmiş grafen (LIG) yaklaşımı, polimer yüzeylerin CO_2 lazer ile tek adımda gözenekli ve iletken grafitik ağlara dönüştürülmesi sayesinde, esnek elektroniklerde hızlı prototipleme ve ölçeklenebilir üretim açısından kritik bir eşik olarak değerlendirilmektedir (Lin ve ark., 2014). Lazer yazım tabanlı karbon/graphene türevli elektrotların enerji depolama ve esnek aygıt mimarilerinde kullanılabilirliği de erken dönemden itibaren gösterilmiştir (El-Kady ve ark., 2012). LIG üzerine metal oksit entegrasyonu tarafında ise, Rodrigues ve ark. (2019) PI üzerine Zn/ZnO öncülü kaplayıp CO_2 lazer ile tek aşamada "ZnO ile dekore LIG" üretimini raporlayarak, LIG–ZnO arasında yük transfer süreçlerine işaret eden sonuçlar sunmuş; ancak bu yaklaşımda ZnO'nun daha çok parçacık/dekoratif morfolojide ve rastgele dağılımlı şekilde oluştuğu görülmüştür. Öte yandan graphene–ZnO heteroyapıları için CVD-grafen tabanlı üretim ve ZnO nanotel/nanorod büyütmeye dayalı çalışmalar, arayüz etkileşiminin ZnO'nun optik/elektronik özelliklerini değiştirebildiğini ve ZnO'nun grafen üzerinde wurtzit yapıda, yüzeye dik büyüyebildiğini göstermektedir (Boukhoubza ve ark., 2024). Buna karşın, LIG gibi gözenekli, kusur-zengin ve esnek bir grafitik platform üzerinde, tohum tabakası aracılı hidrotermal büyütme ile dikey yönelimli ZnO nanorod "ormanı" oluşturulmasına ve bu hibrit arayüzün Raman/SEM ile sistematik biçimde doğrulanmasına odaklanan çalışmalar sınırlıdır. Bu çalışma; LIG'in doğrudan lazer yazımı ile üretilmesi, ardından düşük sıcaklık uyumlu hidrotermal süreçle ZnO nanorodların dikey hizalanmış ve homojen yoğunlukta büyütülmesi üzerinden, LIG/ZnO arayüzünde kristal faz doğrulaması (E_2(high) ~437 cm^{-1}) ve tabakalı yapının kesit morfolojisiyle gösterilmesi bakımından literatürdeki boşluğu doldurarak esnek optoelektronik ve sensör uygulamalarına yönelik "yük taşınımı + ışık–madde etkileşimi" açısından sağlam bir hibrit platform önermektedir.

YÖNTEM

Bu çalışmada, lazer-indüklenmiş grafen (LIG) tabanlı esnek bir platform üzerinde ZnO nanorod (NR) yapılarının kontrollü olarak büyütülmesini mümkün kılan, düşük sıcaklık uyumlu ve ölçeklenebilir bir

üretim yaklaşımı benimsenmiştir. Yöntemsel tasarımda, LIG'in yüksek iletkenliği, gözenekli morfolojisi ve kusur açısından zengin yüzey yapısı; ZnO nanorodların çekirdeklenmesi ve dikey yönelimli kristal büyümesini destekleyecek şekilde değerlendirilmiştir. Bu doğrultuda, poliimid altlık üzerinde doğrudan lazer yazımıyla LIG sentezlenmiş, ardından hidrotermal yöntem kullanılarak ZnO nanorodlar LIG yüzeyi üzerine entegre edilmiştir. Seçilen üretim parametreleri, hem LIG/ZnO arayüzünde güçlü mekanik ve yapısal bağlanma sağlamak hem de esnek optoelektronik uygulamalar için uygun kristal kalite ve morfolojik bütünlük elde etmek amacıyla optimize edilmiştir.

Laser-induced graphene (LIG) yapıları, poliimid (PI) filmler (Kapton® HN, kalınlık: 50 μm) üzerinde bir CO_2 lazer sistemi (Epilog Laser Fusion Pro 24, dalga boyu $\lambda = 10.6$ μm, maksimum güç 30 W) kullanılarak üretilmiştir. Lazer yazım işlemi öncesinde PI altlıklar, yüzey kontaminasyonlarını gidermek amacıyla sırasıyla izopropanol ve deiyonize su içerisinde ultrasonik banyoda temizlenmiş ve azot gazı altında kurutulmuştur.

LIG desenleri, optimize edilmiş lazer parametreleri kullanılarak kare biçimli alanlar (10 mm × 20 mm) şeklinde oluşturulmuştur. Lazer gücü %65, tarama hızı %50 ve çözünürlük 500 DPI olarak ayarlanmış; bu koşullar altında PI yüzeyinde yüksek gözenekliliğe ve iyi elektriksel iletkenliğe sahip grafen ağlarının oluşumu sağlanmıştır. Lazer işlemi sonucunda PI'nin lokal karbonizasyonu ile çok katmanlı, kusur açısından zengin ve süreklilik gösteren LIG yapıları elde edilmiştir.

ZnO nanorodların LIG yüzeyi üzerinde kontrollü büyütülmesi için öncelikle bir ZnO tohum tabakası hazırlanmıştır. Bu amaçla, 2.195 g çinko asetat dihidrat ($Zn(CH_3COO)_2 \cdot 2H_2O$) ve 0.6 mL monoetanolamin, 40 mL metanol içerisinde çözülmüş ve homojen bir çözelti elde edilene kadar 5 saat boyunca manyetik karıştırıcıda karıştırılmıştır. Hazırlanan öncül çözelti, Spincoat G3P-8 döner kaplama cihazı kullanılarak LIG yüzeyi üzerine iki adımlı bir spin-coating prosesi ile kaplanmıştır (750 rpm'de 6 s, ardından 5000 rpm'de 30 s). Kaplanan numuneler 100 °C'de 30 dakika boyunca kurutulmuş ve ardından ZnO tohum tabakasının kristallenmesini sağlamak amacıyla 150 °C'de 6 saat süreyle tavlanmıştır.

ZnO nanorod büyütme işlemi, düşük sıcaklık uyumlu bir hidrotermal yöntemle gerçekleştirilmiştir. Büyütme çözeltisi, 0.1 M çinko asetat dihidrat ve 1 M hekzametilentetramin (HMTA) içerecek şekilde 100 mL deiyonize su içerisinde hazırlanmış ve 1 saat boyunca karıştırılmıştır. Çözelti, Teflon kaplı paslanmaz çelik bir otoklava aktarılmış; LIG kaplı numuneler çözelti içerisinde yatay konumda yerleştirilmiştir. Hidrotermal büyütme işlemi 90 °C'de 3 saat boyunca gerçekleştirilmiştir.

Büyütme sürecinin ardından numuneler oda sıcaklığına kadar soğutulmuş, deiyonize su ile iyice durulanmış ve azot gazı altında kurutulmuştur. Son olarak, ZnO nanorodların kristal kalitesini ve arayüz stabilitesini artırmak amacıyla elektrotlar 150 °C'de 30 dakika süreyle tavlanmıştır. Bu işlem sonucunda, LIG yüzeyi üzerinde dikey yönelimli, homojen dağılımlı ve yüksek kristallenme derecesine sahip ZnO nanorodlardan oluşan hibrit bir LIG/ZnO yapı elde edilmiştir.

ARAŞTIRMA VE BULGULAR

LIG Üretimi ve ZnO Nanorod Büyütülmesi

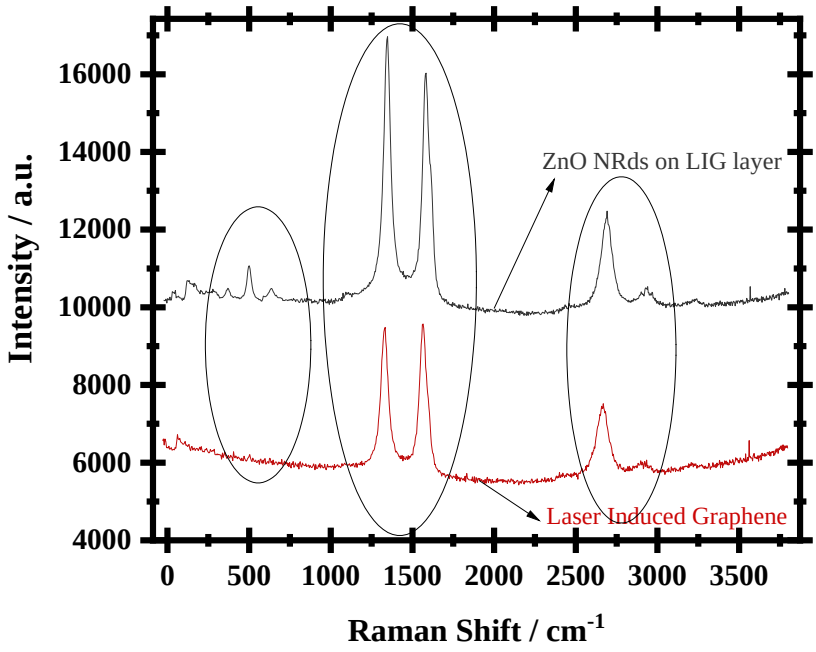
LIG filmler, poliimid (PI) altlıklar üzerinde CO_2 lazer kullanılarak doğrudan yazım yöntemiyle elde edilmiştir. Lazer parametreleri, yüzeyde yüksek iletkenliğe sahip, gözenekli ve süreklilik arz eden grafitik bir ağ oluşturacak şekilde optimize edilmiştir. Lazer işlemi sırasında PI'nin lokal olarak karbonize olması, sp^2 ağırlıklı bir grafen benzeri yapı oluşumunu sağlamıştır.

ZnO nanorodlar ise, LIG yüzeyi üzerine öncelikle ZnO tohum tabakası oluşturulmasının ardından hidrotermal yöntemle büyütülmüştür. Düşük sıcaklıkta (≤90 °C) gerçekleştirilen bu süreç, esnek altlıklarla uyumluluğu korurken ZnO'nun kontrollü ve yönelimli kristal büyümesine olanak tanımıştır.

Raman Spektroskopisi Analizi

LIG yapısının Raman spektrumunda ~1580 cm^{-1} civarında belirgin G bandı ve ~2700 cm^{-1} civarında 2D bandı gözlenmiştir. G bandı, sp^2 bağlı karbon atomlarının düzlem içi titreşimlerini temsil ederken, 2D bandının varlığı lazer işlemi sonrası çok katmanlı grafitik domenlerin başarıyla oluştuğunu göstermektedir. D bandının göreli şiddeti, LIG'in kusur ve kenar bakımından zengin doğasını yansıtmaktadır; bu durum ZnO büyütülmesi için aktif çekirdeklenme noktaları sağlaması açısından avantajlıdır.

ZnO nanorod büyütülmesini takiben Raman spektrumuna ~437 cm^{-1} civarında keskin bir E_2(high) modu eklenmiştir. Bu mod, wurtzit ZnO'nun karakteristik bir titreşim bandı olup yüksek kristallenme kalitesine işaret etmektedir. LIG'e ait G ve 2D bantlarının korunması, ZnO büyütme sürecinin grafitik altyapıya zarar vermediğini göstermektedir.



Şekil 1. LIG ve LIG/ZnO kompozit numunelerine ait RAMAN spektroskopisi sonuçları

TARTIŞMA VE SONUÇ

Bu çalışmada, lazer-indüklenmiş grafen (LIG) üzerine ZnO nanorodların düşük sıcaklık uyumlu bir yöntemle başarıyla büyütülebildiği ve ortaya çıkan LIG/ZnO hibrit yapının yüksek yapısal bütünlük sergilediği gösterilmiştir. Raman ve SEM analizleri, hem LIG altyapının grafitik karakterini koruduğunu hem de ZnO nanorodların yüksek kristallenme derecesi ve dikey yönelimle büyüdüğünü doğrulamıştır. Özellikle LIG–ZnO arayüzünde gözlenen güçlü bağlanma ve iyi tanımlanmış tabakalı yapı, bu hibrit

sistemin esnek optoelektronik aygıtlar, sensörler, fotokatalitik platformlar ve ileri fotonik uygulamalar için uygun bir temel sunduğunu ortaya koymaktadır.

Elde edilen bulgular, LIG'in yalnızca bir iletken elektrot değil, aynı zamanda fonksiyonel oksit nanoyapıların entegrasyonu için etkin bir iskelet olduğunu göstermektedir. Gelecek çalışmalarda, bu hibrit arayüzün elektriksel, optik ve elektrokimyasal performansının cihaz seviyesinde değerlendirilmesi; özellikle esnek ve çok işlevli sistemlerdeki rolünün daha da netleştirilmesi beklenmektedir.

REFERENCES

Boukhoubza, I., Achehboune, M., Derkaoui, I., Apostol, M. M., Basyooni, M. A., Khenfouch, M., Nedelcu, L., Enculescu, I., & Matei, E. (2024). The interface structural, electronic and optical properties of ZnO nanowires/graphene nanohybrid (ZnO NWs/G): Experimental and theoretical DFT investigations. Journal of Alloys and Compounds, 976, 173109. https://doi.org/10.1016/j.jallcom.2023.173109

El-Kady, M. F., Strong, V., Dubin, S., & Kaner, R. B. (2012). Laser scribing of high performance and flexible graphene-based electrochemical capacitors. Science, 335(6074), 1326–1330. https://doi.org/10.1126/science.1216744

Fan, Z., Zhu, Y., Li, C., Zhang, M., & Xu, C. (2018). Size-controlled graphene nanodot arrays/ZnO hybrids for high-performance optoelectronic devices. Advanced Functional Materials, 28(37), 1802938. https://doi.org/10.1002/adfm.201802938

Lin, J., Peng, Z., Liu, Y., Ruiz-Zepeda, F., Ye, R., Samuel, E. L. G., Yacaman, M. J., Yakobson, B. I., & Tour, J. M. (2014). Laser-induced porous graphene films from commercial polymers. Nature Communications, 5, 5714. https://doi.org/10.1038/ncomms6714

Qin, H., Li, Y., Wang, X., Zhang, Y., & Xu, C. (2020). Position- and morphology-controlled ZnO nanostructures grown on graphene layers for optoelectronic applications. Journal of Materials Chemistry C, 8(10), 3272–3281. https://doi.org/10.1039/C9TC06663A

Rodrigues, J., Zanoni, J., Gaspar, G., Fernandes, A. J. S., Carvalho, A. F., Santos, N. F., Monteiro, T., & Costa, F. M. (2019). ZnO decorated laser-induced graphene produced by direct laser scribing. Nanoscale Advances, 1(8), 3252–3268. https://doi.org/10.1039/C8NA00391B

CAM ERGİTME FIRINI İÇİN ORGANİK RANKİNE ÇEVRİMİ VE ÇALIŞMA AKIŞKANI PERFORMANS ANALİZİ

ORGANIC RANKINE CYCLE AND WORKING FLUID PERFORMANCE ANALYSIS FOR A GLASS MELTING FURNACE

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ÖZET

Bu çalışma kapsamında, bir cam fabrikasında yüksek enerjiyle çalışan cam ergitme fırınından elde edilen atık ısının geri kazanımı amacıyla Organik Rankine Çevrimi'ne (ORC) dayalı bir elektrik üretim sistemi tasarlanmıştır. Tasarlanan sistemin performansı, ıslak, izantropik ve kuru tip akışkan olmak üzere etanol, aseton ve benzene çalışma akışkanları için karşılaştırmalı olarak incelenmiştir. Her bir akışkan için termodinamik performans değerleri hesaplanmış; türbin giriş sıcaklığının çevrim üzerindeki etkileri değerlendirilmiştir.

Analiz sonuçları, cam ergitme fırınının referans çalışma koşullarında etanolün en yüksek ısıl verim (%15,71) ve ekserji verimi (%47,11) sağlayan akışkan olduğunu göstermiştir. Ayrıca türbin giriş sıcaklığının, akışkanın kritik sıcaklığına yakın ancak bu değerin çok üzerine çıkmayan bir aralıkta seçilmesinin optimum çevrim debisi, türbin basıncı ve çevrim verimi sağladığı belirlenmiştir. Kritik sıcaklığın oldukça üzerindeki sıcaklıklarda ise akışkanın termofiziksel kararlılığının azalması nedeniyle çevrim performansında düşüş gözlenmiştir.

Çalışma sonucunda elde edilen değerlendirmeler, cam endüstrisinde açığa çıkan atık ısının ORC tabanlı sistemler aracılığıyla elektrik üretiminde kullanılabilir bir kaynak olduğunu ve özellikle çalışma akışkanı seçimi ile yakınsama sıcaklığının çevrim performansını doğrudan etkilediğini göstermektedir.

Anahtar sözcükler: (ORC)Organik rankine çevrimi, cam ergitme fırını, atık ısı geri kazanımı, çalışma akışkanı seçimi, elektrik üretimi

ABSTRACT

In this study, an electricity generation system based on the Organic Rankine Cycle (ORC) was designed to recover waste heat released from a high-energy-intensive glass melting furnace operating in a glass manufacturing facility. The performance of the proposed system was comparatively evaluated for three different working fluids—ethanol, acetone, and benzene—representing wet, isentropic, and dry fluid characteristics, respectively. For each working fluid, thermodynamic performance parameters were calculated, and the influence of turbine inlet temperature on cycle performance was systematically investigated.

The results indicate that, under the reference operating conditions of the glass melting furnace, ethanol provides the highest thermal efficiency (15.71%) and exergy efficiency (47.11%) among the considered working fluids. Furthermore, it was determined that selecting the turbine inlet temperature within a range close to, but not significantly exceeding, the critical temperature of the working fluid yields optimal cycle mass flow rate, turbine inlet pressure, and overall cycle efficiency. At turbine inlet temperatures well above the critical point, a noticeable decline in cycle performance was observed due to reduced thermophysical stability of the working fluid.

Overall, the findings demonstrate that the waste heat potential available in the glass industry can be effectively utilized for electricity generation through ORC-based systems, and that both working fluid selection and pinch temperature play a decisive role in determining the overall cycle performance.

Key Words: ORC(Organic Rankine Cycle, glass melting furnace, waste heat recovery, working fluid selection, electricity generation.

1.GİRİŞ

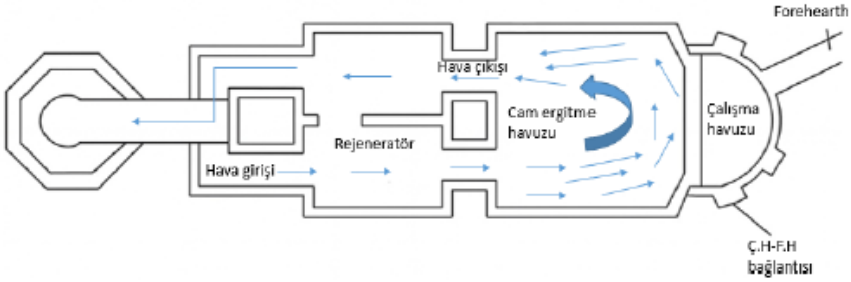
Cam üretim süreçleri, prosesin doğası gereği yüksek sıcaklık gereksinimi nedeniyle sanayi sektörleri arasında en yoğun enerji tüketimine sahip alanlardan biri olarak değerlendirilmektedir. Ergitme fırınlarında cam hammaddesinin yaklaşık 1550–1600 °C (Atzori vd., 2023) sıcaklıklara kadar ısıtılması için önemli miktarda yakıt enerjisi harcanmakta; bu süreç sonucunda oluşan baca gazları ile atmosfere atılan ısı, sistem açısından kayda değer bir enerji kaybı oluşturmaktadır. Bu nedenle baca gazı kaynaklı atık ısının geri kazanımı, enerji kullanım etkinliğinin artırılması ve işletme giderlerinin azaltılması açısından büyük önem taşımaktadır.

Düşük ve orta sıcaklık seviyelerindeki atık ısı kaynaklarından elektrik enerjisi üretimine olanak sağlayan Organik Rankine Çevrimi (ORC), düşük kaynama sıcaklıklarına ve elverişli termofiziksel özelliklere sahip organik çalışma akışkanları sayesinde cam endüstrisi uygulamaları için uygun bir alternatif olarak öne çıkmaktadır (Megaprastio vd., 2023; Quoilin vd., 2013). Literatürde ORC sistemlerinin farklı endüstriyel atık ısı kaynaklarına entegrasyonu yaygın biçimde incelenmiş olmakla birlikte, cam ergitme fırınlarına yönelik ve birden fazla çalışma akışkanının karşılaştırmalı olarak ele alındığı çalışmaların sınırlı olduğu görülmektedir. Bu bağlamda, çalışma akışkanı seçimi çevrim performansının ve sistem davranışının belirlenmesinde temel bir tasarım parametresi olarak önem kazanmaktadır.

Bu çalışmada, bir cam ergitme fırınından açığa çıkan atık ısının ORC tabanlı bir elektrik üretim sistemi aracılığıyla değerlendirilmesine yönelik bir termodinamik analiz gerçekleştirilmiştir. Farklı organik çalışma akışkanlarının çevrim performansı üzerindeki etkileri karşılaştırmalı olarak incelenmiş; ayrıca türbin giriş sıcaklığının sistem verimi üzerindeki rolü detaylı biçimde analiz edilmiştir. Elde edilen sonuçlar, cam üretim tesislerinde ORC teknolojisinin uygulanabilirliğini ortaya koymakta ve atık ısıdan enerji geri kazanımına yönelik mühendislik tasarımlarına katkı sağlamaktadır.

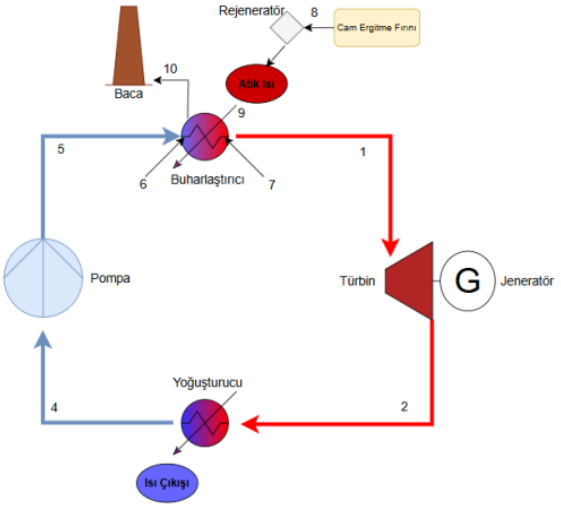
2.ARAŞTIRMA VE BULGULAR

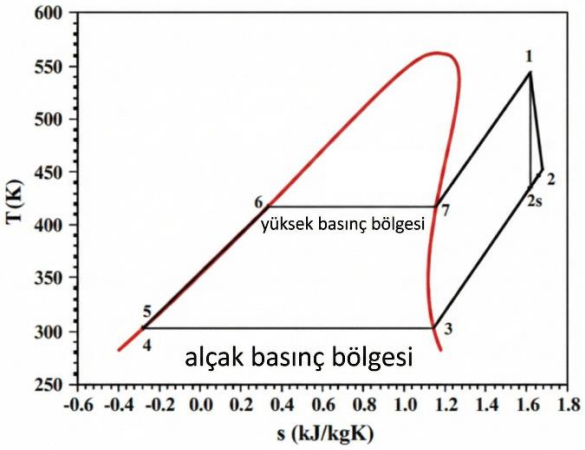
Cam üretiminde kullanılan ergitme fırınları, hammaddenin yüksek sıcaklıklarda ergitilmesi yoluyla cam banyosunun oluşturulduğu, kesintisiz çalışan ve yüksek enerji talebine sahip endüstriyel sistemlerdir. Ergitme işlemi için gerekli sıcaklıklar çoğunlukla 1300–1600 °C aralığında olup, bu değer camın optik özellikleri, uygulanan üretim yöntemi, hammadde bileşimi, kullanılan kırık cam oranı ve fırının işletme süresi gibi çeşitli parametrelere bağlı olarak değişkenlik göstermektedir. Söz konusu sıcaklık seviyelerine ulaşabilmek amacıyla doğal gaz, fuel-oil veya LPG gibi fosil yakıtlar kullanılmakta; yanma için gerekli oksijen ise yakma havası fanları aracılığıyla sisteme sağlanmaktadır.



Şekil 1. Rejeneratif bir cam ergitme fırınının içerisinde ısı dağılımı (İzmirlioğlu, 2001)

Rejeneratif tip cam ergitme fırınlarında, yanma sonucu oluşan yüksek sıcaklıktaki gazlar, gözenekli ve kırıklı yapıya sahip refrakter tuğlalardan oluşan rejeneratör bölgesinden geçirilerek bu yapıların ısınması sağlanmaktadır (Varshneya, 1994). Ardından, fan yardımıyla fırına alınan taze yakma havası bu ısıtılmış yüzeyler üzerinden yönlendirilerek 1400 °C sıcaklıklara kadar ön ısıtılmaktadır(GlasssTech Refractory, 2024). Bu yöntem, yakıt tüketiminin azaltılmasına ve fırının genel enerji verimliliğinin artırılmasına önemli katkı sağlamaktadır. Bununla birlikte, rejeneratif ön ısıtmaya rağmen baca yoluyla sistemden uzaklaştırılan gazların sıcaklığı genellikle 200–500 °C seviyelerinde kalmakta ve bu durum, değerlendirilebilir nitelikte önemli bir atık ısı potansiyelinin varlığına işaret etmektedir.



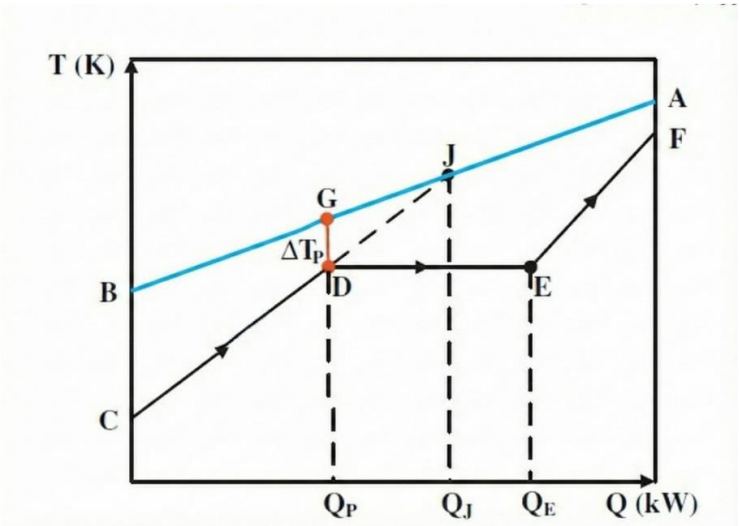


Şekil 2.a Bir cam ergitme fırını için sistem tasarımı Şekil 2.b Çevrimin sıcaklık, entropi diyagramı (Chen vd., 2012)

Şekil 2.a'da cam ergitme fırınından elde edilen atık ısının kullanıldığı Organik Rankine Çevrimi (ORC) süreci görülmektedir. Rejeneratörden çıkan yüksek sıcaklıklı baca gazı(9) buharlaştırıcıda çalışma akışkanını buharlaştırır(7). Buharlaştırıcıdan gelen yüksek basınçlı buhar(1) türbinde genişleyerek jeneratörü döndürür ve elektrik üretir. Türbinden çıkan buhar (2) yoğuşturucuda yoğunlaştırılır (2->4) ve pompa yardımıyla tekrar basınçlandırılarak(4->5) çevrime geri döner. Böylece sistem kapalı bir çevrimde atık ısıyı elektrik enerjisine dönüştürür.

Şekil 2.b ise aynı ORC sisteminin T–s diyagramını göstermektedir. Kırmızı doygunluk eğrileri çalışma akışkanının faz sınırlarını temsil ederken siyah çizgiler çevrimin termodinamik aşamalarını ifade etmektedir. 1–2 arası genleşme (türbin), 2–4 arası yoğuşma, 4–5 arası sıkıştırma (pompa) ve 5–1 arası

ısıtma-buharlaştırma süreçleridir. Bu diyagram, çevrimin faz değişimi ve basınç seviyelerine göre nasıl ilerlediğini göstermektedir.



Şekil 3. ORC çevrimi ile evaporatör (buharlaştırıcı) arasındaki sıcaklık-ısı transferi şeması (Chen vd., 2012).

Şekil 3. ORC sisteminde buharlaştırıcıda gerçekleşen ısı transfer sürecinin sıcaklık–ısı transfer (T–Q) bağıntısını göstermektedir. Şekilde, çalışma akışkanının doymamış sıvı, faz değişimi (buharlaşma) ve aşırı kızdırma bölgeleri ile sıcak kaynak olan baca gazının giriş ve çıkış sıcaklıkları sunulmuştur. Isı kaynağı olarak kullanılan baca gazı ile Organik Rankine Çevrimi çalışma akışkanı arasındaki minimum sıcaklık farkı, pinch point (yakınsama noktası, ΔT_p) olarak tanımlanır. Şekilde yer alan C,D,E,F noktaları; çevrimdeki 5-6-7 ve 1 noktalarını ifade etmektedir. A noktası, egzoz gazının girişini, B noktası egzoz gazının çıkışını ifade etmektedir. G noktası, sıcaklık farkının minimum olduğu alandaki egzoz gazı sıcaklığını ifade etmektedir. J noktası ise, CD doğrusunun devamına sanal olarak çizilen doğru üzerinde ve egzoz gazının sıcaklık değişimini ifade eden AB doğrusu üzerindeki bir noktadadır.

$\dot{m}_{egz}$, $T_{egz,gir}$ ve $T_{egz,çık}$ değerleri bilindiğinde, buharlaştırıcı(veya tüm sistem) tarafından alınan toplam ısı miktarı aşağıdaki gibi ifade edilir:

$$Q_{egz} = \dot{m}_{egz} c_{p,egz} (T_{egz,gir} - T_{egz,çık}) \quad (1)$$

Burada $c_{p,egz}$ baca gazının özgül ısısının, sıcaklık aralığının ortalamasına göre 0.5($T_{egz,gir} + T_{egz,çık}$) alınmış değeridir. Özgül ısının sıcaklığa bağlı değişimi ihmal edildiğinde, ısı transfer süreci Şekil 3'teki gibi AB doğrusu ile temsil edilen doğrusal bir davranış sergiler. Bu AB doğrusu aşağıdaki bağıntı ile tanımlanır.

$$Q = \dot{m}_{egz} c_{p,egz} (T - T_{egz,çık}) \quad (2)$$

Bu çalışmada izlenen çözüm yaklaşımı iki ana aşamadan oluşmaktadır. İlk aşamada, belirli bir türbin giriş sıcaklığı için, buharlaştırıcıda sağlanması gereken minimum pinch sıcaklık farkı koşulunu karşılayacak uygun türbin giriş basıncı belirlenmektedir. İkinci aşamada ise, farklı türbin giriş sıcaklıkları için çevrim performansı değerlendirilerek optimum çalışma koşulları tespit edilmektedir.

Bu aşamada türbin giriş basıncı başlangıçta bilinmediğinden, başlangıçta bir P_1 değeri varsayılır. Daha sonra, türbin girişindeki organik çalışma akışkanının entalpisi $h_1 = h_1(P_1, T_1)$ ifadesiyle CoolProp kütüphanesinden bulunur.

ORC çalışma akışkanının kütlesel debisi ise aşağıdaki bağıntı yardımıyla belirlenmektedir:

$$Q_{egz} = \dot{m}_{ORC}(h_1 - h_5) \tag{3}$$

Denklem 3'teki h_5 değeri, pompa basınçlandırma sürecindeki entalpi artışı görmezden gelinerek $h_4 \approx h_5$ kabulü yapılmaktadır. h_4'ün doymuş sıvı hal özellikleri kullanılarak CoolProp kütüphaneden elde edilebilir. Buna bağlı olarak, C–D bölgesine ait ısı transferi aşağıdaki şekilde ifade edilebilir:

$$Q = \dot{m}_{ORC} c_{p,ORC}(T - T_5) \approx \dot{m}_{ORC} c_{p,ORC}(T - T_4) \tag{4}$$

Burada $c_{p,ORC}$, organik çalışma akışkanının sıvı fazdaki özgül ısısını ifade etmektedir. Isı kaynağını temsil eden A–B doğrusu ile çalışma akışkanına ait C–D doğrusu, T–Q diyagramı üzerinde Şekil 3'te gösterilen J noktasında birbiriyle kesişmektedir. Bu birleşim noktasının konumu, Eşitlik (2) ve Eşitlik (4)'ün eş zamanlı olarak çözülmesiyle belirlenmektedir. Baca gazı ile organik çalışma akışkanı arasındaki en düşük sıcaklık farkı, diğer bir ifadeyle pinch noktası, Şekil 3'te G–D doğrusu ile tanımlanmıştır. Söz konusu sıcaklık farkı, buharlaştırıcı tasarımında ısı transfer kapasitesini doğrudan etkileyen kritik bir parametre olarak değerlendirilmektedir. G–D–J ve B–C–J noktaları arasında oluşan geometrik benzerlikten yararlanılarak aşağıdaki bağıntıya ulaşılmaktadır:

$$\frac{|GD|}{|BC|} = \frac{|JD|}{|JC|} = \frac{|JD|\cos\alpha}{|JC|\cos\alpha} \tag{5}$$

Burada α açısı, C–D doğrusunun ısı transfer ekseni (Q ekseni) ile yaptığı açıyı ifade etmektedir. Eşitlik (5), aşağıdaki şekilde yeniden düzenlenebilir:

$$\frac{\Delta T_P}{T_{egz,çık} - T_5} = \frac{\Delta T_P}{T_{egz,çık} - T_4} = \frac{Q_J - Q_P}{Q_J} \tag{6}$$

Eşitlik (6)' da yer alan, Q_J değeri bilindiğinden, bu bağıntı kullanılarak D noktasına karşılık gelen Q_P değeri belirlenmektedir. Elde edilen Q_P değeri Eşitlik (4)'te yerine yazıldığında, D noktasının düşey eksendeki karşılığı olan sıcaklık T_6 hesaplanır. T_6'ya karşılık gelen doyma sıcaklığına göre, yeni bir

buharlaşma basıncı P_6 tayin edilir. D–E aralığının yatay uzunluğu, organik çalışma akışkanının kütlesel debisi göz önünde bulundurularak buharlaşma sürecinde aktarılan gizli ısıyı temsil etmekte olup aşağıdaki eşitlikle ifade edilmektedir:

$$Q_E - Q_P = \dot{m}_{ORC} h_{lg,ORC} \tag{7}$$

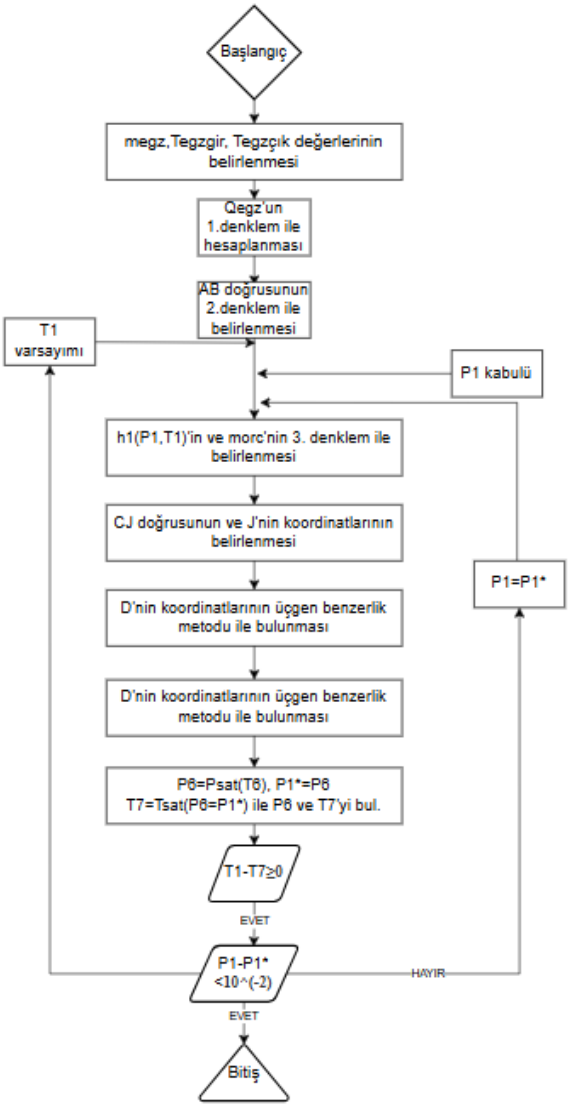
Burada $h_{lg,ORC}$, organik akışkanın buharlaşma gizli ısısını tanımlamaktadır. Eşitlik (7), E noktasının konumunu belirler.

Bu aşamada, yeni türbin giriş basıncımın eski sistemimin buharlaştırıcının 6 noktasındaki basıncına eşit olduğu (P_1' = P_6) unutulmamalıdır. Yeni hesaplanan türbin giriş basıncı P'_1, bir önceki P_1 basıncından farklı olabilir. Bu doğrultuda, türbin giriş basıncı için hesaplanan değerlerin tutarlılığı sağlanıncaya kadar çözüm adımları yinelemeli olarak sürdürülmektedir. Yakınsamanın sağlandığı durum, aşağıda verilen koşul ile tanımlanmaktadır:

$$\left|P_1 - P_1'\right| < 10^{-2} \tag{8}$$

Burada P1' , mevcut iterasyonda elde edilen türbin giriş basıncını ifade etmektedir. Şekil 4'te sunulan akış diyagramından da görülebileceği üzere, her yeni iterasyonda türbin giriş sıcaklığı (T1) basınçtan önce belirlendiği için sabit tutulmaktadır.

Hesaplamaların ilerleyen aşamasında, farklı türbin giriş sıcaklıklarının çevrim davranışı üzerindeki etkileri değerlendirilmiş ve bu doğrultuda optimum çalışma parametreleri belirlenmiştir. Şekil 4'te verilen blok akış diyagramı, çalışmada izlenen çözüm yaklaşımını özetlemektedir. Çalışmada seçilen tüm akışkanlar için basınç farkı 10^{-2}'den küçük oluncaya denk akış diyagramı takip edilir.



Şekil 4.Yapılan iterasyon yaklaşımının akış diyagramı (Chen vd., 2012).

Tablo 1, ORC sisteminin termodinamik analizinde kullanılan temel giriş parametrelerini ve sınır şartlarını göstermektedir. Baca gazı giriş ve çıkış sıcaklıkları ile debisi, buharlaştırıcıya aktarılan ısı miktarını tanımlarken; türbin ve pompa izantropik verimleri gerçek sistem davranışının modellenmesi amacıyla belirlenmiştir. Soğutma suyu çıkış sıcaklığı kondenser koşullarını, türbin giriş basıncı ise çevrimin üst basınç seviyesini ifade etmektedir.

Tablo 1. Cam ergitme fırınımın ve ORC sistemimdeki parametrelerimizin kabulleri

Parametreler	Değer	Birim
Egzoz gazı giriş sıcaklığı	550	K
Egzoz gazı çıkış sıcaklığı	383,15	K
Egzoz gazı debisi	9,5	kg/s
Türbin izantropik verimi	87	%
Pompa izantropik verimi	90	%
Soğutma suyu çıkış sıcaklığı	303,15	K
Türbin giriş basıncı	20	bar

3.SONUÇLAR

Organik Rankine Çevrimi (ORC) analizinde, türbin giriş basıncının (P1) iterasyon yöntemiyle hesaplanması, her çalışma akışkanının çevrim koşullarına uyumunu ve termodinamik kararlılığını değerlendirmek açısından kritik öneme sahiptir. Tablo üzerinde yeşil renkle işaretlenen değerler, her bir akışkan için tanımlanan çalışma aralığında yakınsama sağlanan iterasyon adımını ve $|P_1 - P_6| < 10^{-2}$ değerinin kaçıncı denemede sağlandığını, ayrıca denemeler boyunca elde edilen türbin giriş basınçlarının değerlerini göstermektedir.

Tablo 2. T1=508K ve P1=20 bar ile başlayan iterasyon denemeleri ve yakınsamanın sağlandığı iterasyonlar

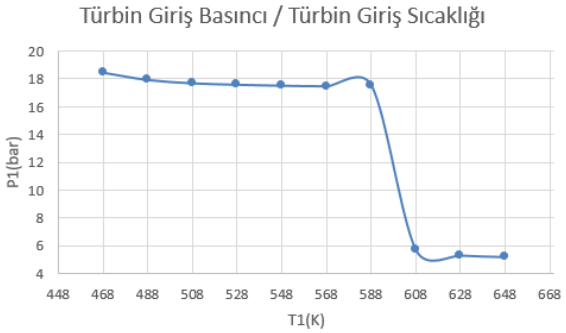
Akışkanlar	Yapılan İterasyon Sayısı							
	Başlangıç P1(bar)	2.(bar)	3.(bar)	4.(bar)	5.(bar)	6.(bar)	7.(bar)	8.(bar)	9(bar)
Ethanol	20	17,930	17,721	17,700	**17,699**	17,699			
Aseton	20	21,965	22,356	22,439	22,456	**22,460**	22,461		
Benzen	20	10,751	9,877	**9,816**	9,812				

Tablo 2'de görülebileceği gibi, ethanol için yapılan 5. İterasyonda P1 ile P6(P1') arasındaki basınç farkı 10^{-2}'den küçük olduğundan iterasyon yaklaşımı tamamlanmıştır.

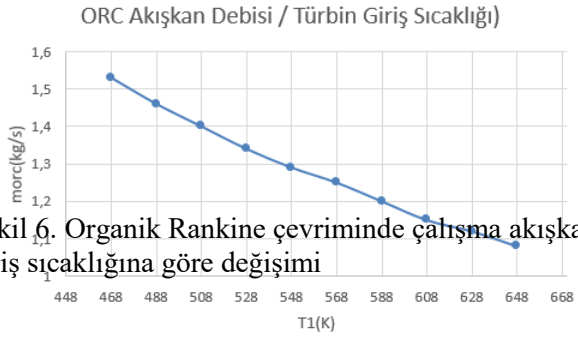
İterasyon sonucu elde ettiğimiz basınçlar için akışkanların performans analizleri yapılmış ve Tablo 3'te paylaşılmıştır.

Tablo 3. Çevrim akışkanlarımın performans analizleri (T1=508 K)

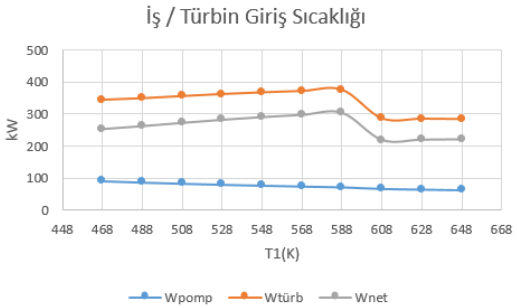
Akışkan	P1(bar)	morc(kg/s)	Wpomp(kW)	Wtürb(kW)	Wnet(kW)	Isıl Verim(%)	Ekserji Verimi(%)
Ethanol	17,69	1,40	83,39	356,06	272,67	15,71	47,11
Aseton	22,46	2,15	111,43	350,03	238,60	13,74	41,94
Benzen	9,81	2,44	99,48	326,10	226,62	13,05	39,54



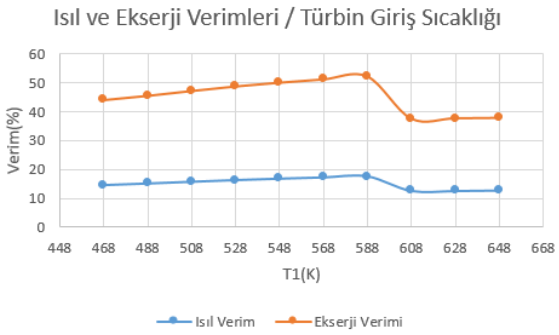
Şekil 5. Türbin giriş basıncının türbin giriş sıcaklığındaki değişime bağlı olarak gösterdiği eğilim



Şekil 6. Organik Rankine çevriminde çalışma akışkanı kütlesel d
giriş sıcaklığına göre değişimi



Şekil 7. Pompa tarafından tüketilen iş, türbin çıkışında elde edilen iş ve net çevrim işinin türbin giriş sıcaklığına bağlı değişimi



Şekil 8. Isıl verim ile ekserji veriminin, türbin giriş sıcaklığının b
olarak gösterimi.

Şekil 5'te, her bir türbin giriş sıcaklığı için çevrim basıncı yeniden optimize edildiğinde, türbin giriş sıcaklığı arttıkça türbin giriş basıncının azaldığı görülmektedir. Etanolün kritik sıcaklığı olan 514 K'nin aşılmasıyla birlikte bu azalma belirgin hâle gelmekte, kritik sıcaklığın oldukça üzerine çıkıldığında ise türbin giriş basıncında ani ve keskin bir düşüş gözlenmektedir.

Şekil 6'da, türbin giriş sıcaklığının artmasına bağlı olarak çevrim akışkan debisinin ($\dot{m}$ORC) sürekli olarak azaldığı görülmektedir. Bu durum, daha yüksek giriş sıcaklıklarında pompa tarafından çevrime kazandırılması gereken akışkan miktarının azaldığını ve dolayısıyla pompa güç ihtiyacının düştüğünü göstermektedir.

Şekil 7'de pompa işi, türbin işi ve net işin türbin giriş sıcaklığına bağlı değişimi sunulmaktadır. Türbin giriş sıcaklığı arttıkça pompa işinin azaldığı, türbinden elde edilen işin 588 K seviyesine kadar arttığı, bu sıcaklıktan sonra ise belirgin şekilde düştüğü görülmektedir. Buna bağlı olarak net güç de referans çalışma koşulları için 588 K'ye kadar artmakta, bu sıcaklıktan sonra ani bir düşüş eğilimi göstermektedir.

Şekil 8'de, türbin giriş sıcaklığının artışıyla birlikte ısıl ve ekserji verimlerinin 588 K seviyesine kadar yükseldiği, bu noktadan sonra ise keskin bir düşüş sergilediği ve daha yüksek sıcaklıklarda yaklaşık yatay bir eğilim izlediği görülmektedir. Bu sonuçlar, etanol için kritik sıcaklık bölgesine yakın değerlerde çevrim performansının optimum seviyeye ulaştığını göstermektedir.

Bu çalışmada, cam ergitme fırınından çıkan ve giriş sıcaklığı yaklaşık 550 K olan baca gazına ait atık ısı potansiyelinin Organik Rankine Çevrimi (ORC) ile değerlendirilmesine yönelik bir termodinamik model geliştirilmiştir. Model kapsamında, çevrimde kullanılabilecek farklı çalışma akışkanlarının

performans üzerindeki etkileri incelenmiştir. Elde edilen sonuçlar, çalışma akışkanı seçiminin ve temel tasarım parametrelerinin çevrim performansını doğrudan etkilediğini; akışkan türünün ve türbin giriş sıcaklığının belirleyici parametreler olduğunu göstermektedir.

- İncelenen üç çalışma akışkanı arasında, tanımlanan proses koşulları için en yüksek ısıl verim %15,71 ile etanol kullanılması durumunda elde edilmiştir. Benzer şekilde, en yüksek ekserji verimi de %47,11 değeriyle etanol için hesaplanmıştır. Buna karşılık, söz konusu proses şartları altında en düşük ısıl verim %13,05 ile benzen için bulunmuş; benzen aynı zamanda %39,54 ile en düşük ekserji verimine sahip çalışma akışkanı olarak belirlenmiştir.
- Islak karaktere sahip olmasına rağmen, referans çalışma koşulları altında en yüksek ısıl ve ekserji verimleri etanol kullanılarak elde edilmiştir. İzantropik özellik gösteren aseton, referans şartlarda ıslak akışkana kıyasla daha düşük verim değerlerine sahip olmakla birlikte, benzer bir performans eğilimi sergilemiştir. Kuru akışkan sınıfında yer alan benzen ise incelenen çalışma koşulları için en düşük net iş, ısıl verim ve ekserji verimi değerlerine sahip akışkan olarak öne çıkmıştır.
- Bu çalışma kapsamında, etanol çalışma akışkanı için türbin giriş sıcaklığının ORC çevrimi performansı üzerindeki etkileri incelenmiştir. Elde edilen bulgular, türbin giriş sıcaklığının çevrim performansını belirleyen temel tasarım parametrelerinden biri olduğunu ortaya koymaktadır.
- Türbin giriş sıcaklığındaki artışın, türbin giriş basıncı ile organik çevrim akışkan debisinin azalmasına neden olduğu görülmüştür. Buna karşılık, net iş, ısıl verim ve ekserji verimi kritik sıcaklığın hemen üzerindeki belirli bir optimum sıcaklık aralığına kadar artış göstermekte; bu aralığın aşılması durumunda ise akışkanın termofiziksel özelliklerindeki değişimlere bağlı olarak söz konusu performans göstergelerinde belirgin bir düşüş eğilimi ortaya çıkmaktadır. Bu sonuçlar, türbin giriş sıcaklığı ile çevrim performansı arasında doğrusal bir ilişki bulunmadığını; maksimum çevrim veriminin akışkanın kritik sıcaklığına yakın ve bu değerin biraz üzerindeki sıcaklık aralığında elde edildiğini göstermektedir. Kritik sıcaklığın altında ve oldukça üzerinde kalan türbin giriş sıcaklıklarında ise çevrim performansının azaldığı gözlenmiştir.

Elde edilen bulgular, cam endüstrisindeki atık ısı potansiyelinin ORC sistemleri ile elektrik üretiminde etkin biçimde değerlendirilebileceğini ve çalışma akışkanı seçimi ile yakınsama sıcaklığının sistem performansı üzerinde belirleyici etkiye sahip olduğunu ortaya koymaktadır.

KAYNAKLAR

Atzori, Dario, Simone Tiozzo, Michela Vellini, Marco Gambini, and Stefano Mazzoni. 2023. Industrial Technologies for CO_2 Reduction Applicable to Glass Furnaces. Thermo 3 (4): 682-710. https://doi.org/10.3390/thermo3040039

Chen, Quicheng; Xu, Jinliang; Chen, Hongxia. 2012. A New Design Method for Organic Rankine Cycles with Constraint of Inlet and Outlet Heat Carrier Fluid Temperatures Coupling with the Heat Source. Beijing, China.

GlassTech Refractory. “Cam Fırını Mühendisliği Dünyasından İçgörüler: Yenilikler ve Sektörel Gelişmeler.” Erişim tarihi: 13 Aralık 2025. https://glasstechrefractory.com/en/about-us/blog/cam-firini-muhendisligi-dunyasindan-icgoruler-yenilikler-ve-sektorel-gelismeler

İzmirlioğlu, E.Burak. 2001. “Cam Ergitme Fırını Rejeneratör Üst Yapı Refrakterleri İçin Testler.” İstanbul Teknik Üniversitesi.

Megaprastio, Bayu, Ahmad Murtadlo Zaka, Rifda Salsabila Zahra, Nyayu Aisyah, and Hifni Mukhtar Ariyadi.

“Design of the Organic Rankine Cycle (ORC) System Using R600 and R600a as Working Fluid.” E3S Web of Conferences 85 (2023): 04004. https://doi.org/10.1051/e3sconf/20238504004

Quoilin, Sylvain, Martijn van den Broek, Sébastien Declaye, Pierre Dewallef, and Vincent Lemort. “Techno-economic survey of Organic Rankine Cycle (ORC) systems.”Renewable and Sustainable Energy Reviews 22 (2013): 168–186.

Varshneya, Arun K. Fundamentals of Inorganic Glasses. New York: Academic Press, 1994.

ZIRH ÇELİĞİ ÜRETİM PROSESLERİNİN İNCELENMESİ

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ABSTRACT

The importance given to increasing the ballistic protection and survivability levels of defense industry vehicles is increasing day by day. Vehicles with high ballistic protection can perform main combat scenarios more easily with their reliable field capability in the main battlefield. For this reason, with increased protection levels, the thickness and hardness level of the materials used (composite, ceramic, armor steel), especially armor steel, also increases. As thickness and hardness increases, its suitability for manufacturing decreases.

Armor steel is in the high strength and low alloy steel group and its surface hardness is between 400-700 HB. Especially in stand-alone structures, bending and weldability decrease as the thickness increases. For this reason, optimum parameters are obtained by working on the welding and bending process. During bending, each area that will create a design-based notch effect must be ground, the bending line must be lubricated with grease, and the armor steel must be preheated to 120C°. At the same time, bending can be done at an angle of 10 times the thickness of the armor steel. While sufficient melting temperature is required for welding, armor steel loses its armor properties when exposed to heat above 180 °C. Obtaining optimum values to ensure both sufficient melting temperature and sufficient strength in the welding areas is indispensable for the process to proceed smoothly. Some of the parameters; Preheating the welding is like controlling the amperage and current values. For each area with welding input, it is necessary to strengthen or cover the welds with armor steel with the same protection level.

Despite all bending parameters, if the armor steel is not stored at room temperature, obvious fractures may occur. The armor steel should be at room temperature when applying optimum parameters. It is necessary to ensure sufficient strength in the welding parameters and to protect the resulting weaknesses. At the same time, according to the referenced STANAG 4569 AEP 55 Vol 1((NATO Standardization Agreement covering the standards for the "Protection Levels for Occupants of Logistic and Light Armored Vehicles"), one of the vehicle acceptance principles is that the vehicle's ballistic protection is over 90%.

Key Words: Armor Steel, Bending, Welding, STANAG 4569 AEP 55 Vol 1

ÖZET

Savunma sanayi araçlarının balistik koruma ve beka seviyelerinin artırılmasına verilen önem her geçen gün artmaktadır. Yüksek balistik korumaya sahip araçlar, ana muharebe sahasındaki güvenilir saha kabiliyetleriyle ana muharebe senaryolarını daha kolay yerine getirebilmektedir. Bu nedenle, artan koruma seviyeleriyle birlikte kullanılan malzemelerin (kompozit, seramik, zırh çeliği), özellikle de zırh çeliğinin kalınlık ve sertlik seviyesi de artmaktadır. Kalınlık ve sertlik arttıkça imalata uygunluğu azalmaktadır.

Zırh çeliği, yüksek mukavemetli ve düşük alaşımlı çelik grubunda yer almakta olup, yüzey sertliği 400-700 HB arasındadır. Özellikle tek başına çalışan yapılarda, kalınlık arttıkça büküm ve kaynaklanabilirlik azalır. Bu nedenle kaynak ve büküm işlemi üzerinde çalışılarak optimum parametreler elde edilir. Büküm sırasında, tasarıma dayalı çentik etkisi yaratacak her bölge taşlanmalı, bükme hattı gresle yağlanmalı ve zırh çeliği 120°C'ye kadar önceden ısıtılmalıdır. Aynı zamanda, zırh çeliğinin kalınlığının 10 katı açıyla büküm yapılabilir. Kaynak için yeterli ergime sıcaklığı gerekirken, zırh çeliği 180°C'nin üzerindeki ısıya maruz kaldığında zırh özelliklerini kaybeder. Kaynak bölgelerinde hem yeterli ergime sıcaklığını hem de yeterli mukavemeti sağlamak için optimum değerlerin elde edilmesi, işlemin sorunsuz ilerlemesi için vazgeçilmezdir. Parametrelerden bazıları; Kaynağın ön ısıtılması, amper ve akım değerlerinin kontrol edilmesine benzer. Kaynak girişi olan her bölge için, kaynakların aynı koruma seviyesine sahip zırh çeliği ile güçlendirilmesi veya kaplanması gerekir.

Tüm büküm parametrelerine rağmen, zırh çeliği oda sıcaklığında saklanmazsa, belirgin kırılmalar meydana gelebilir. Optimum parametreler uygulanırken zırh çeliğinin oda sıcaklığında olması gerekir. Kaynak parametrelerinde yeterli mukavemetin sağlanması ve ortaya çıkan zayıflıkların korunması gerekir. Aynı zamanda, atıfta bulunulan STANAG 4569 AEP 55 Vol 1 (Lojistik ve Hafif Zırhlı Araçların Yolcuları için Koruma Seviyeleri standartlarını kapsayan NATO Standardizasyon Anlaşması)'na göre, araç kabul prensiplerinden biri aracın balistik korumasının %90'ın üzerinde olmasıdır.

Anahtar Kelimeler: Zırh Çeliği, Büküm, Kaynak, STANAG 4569 AEP 55 Vol 1

GİRİŞ

Ülkelerin beka seviyeleri ile birlikte savunma sanayi araçlarına verilen önem her geçen gün artmaktadır. Araçların balistik korumaları muharebe alanlarındaki senaryoları yerine getirmeleri için kritik bir role sahiptir. Bu kritik koruma rollerini üstlenen, yaygın balistik koruma malzemeleri kompozitler, seramikler ve zırh çelikleri araç ağırlık ve saha senaryosuna göre seçilmektedir.

Özellikle balistik korumalı askeri araçlarda yaygın bir kullanıma sahip olan zırh çelikleri, farklı karakterli mermilerin çoklu darbesine karşı kırılmaya direnç göstermek ve balistik koruma sağlamak amacı ile üretilen yüksek sertliğe sahip çeliklerdir. Kırılmaya karşı direnç göstermek için sertleştirme (östenitleştirme ve su verme) ile temperleme aşamalarından geçen bu çelikler yüksek mukavemet, tokluk elde ederler. Ancak yüksek mekaniksel özellikler aynı zamanda düşük kaynaklanabilirlik ve büküm gibi dezavantajlar getirir.

Zırh çeliklerinin 450-500-600 HB yüksek sertlikte olması imalat süreci de oldukça zordur. Stand alone ve add on olmak üzere iki tip konfigürasyon çeşidi bulunmakta ve ağırlık efektif olarak add on tercih edilmektedir. Stand alone yekpare bir çelik olup tüm gövde kaynaklı imalat ile gerçekleştirilmeli, add on çözümde ise burçlar ile cıvatalı bağlantı yapılmaktadır. Kaynak ve büküm işlemlerinde öncesi ve sonrası olacak şekilde yapılacak gerekli prosesler mevcuttur. Örneklendirmek gerekirse bükümde zırh çeliği kalınlığının 10 katı Radius ile gerçekleştirilmeli ve büküm çizgisine ve kalıp yüzeyine yağlama işlemi yapılmaktadır. Kaynaklı imalat sürecinde karbon eşleniği yüksek olması sebebiyle kaynak sonrası çatlak vb kaynak hatası olması oranı yüksektir. Kaynak hatasını en aza indirmek adına prosesler adım adım ve kontrollü yapılmaktadır.

Kaynak ve büküm de ortak referans malzeme sıcaklığının sabit olmasıdır. Aynı zamanda kaynaktaki yüksek ısı girdisi sebebiyle kabin içerisinde kaynak noktaları zaafiyet bölgeleri olarak yer alır. zırh çeliklerinin balistik kabindeki kaynaklı birleştirme işleminde, ısı tesiri altında kalan bölgeler ve kaynak bölgelerinden ileri gelen mikroyapısal değişimlerin bir sonucu olarak, esas metale nazaran daha düşük mukavemet ve sertlik görülebilir. Bu da zırh malzemelerinde kaynak bölgelerinin mekanik, metalurjik ve kimyasal açıdan araştırılması gerektiğini göstermektedir. Bu düşük mukavemet kaynak girdisi olan (HAZ) her bir alan için zaafiyet olup koruma yüzdesini düşürmektedir. STANAG 4569 AEP 55 Vol 1 e (NATO Standardization Agreement covering the standards for the "Protection Levels for Occupants of Logistic and Light Armored Vehicles") göre balistik koruma seviyesi %90 üzerinde olmalıdır.

ARAŞTIRMA VE BULGULAR

1. KURAMSAL ÇERÇEVE

1.1 Zırh Çeliklerinde Kaynak

Zırh çelikleri yüksek mekaniksel ve balistik özelliklere sahip olsa da araç gövdesine montajının yapılabildiği durumda işlevini yerine getirebilir. Bu sebeple zırh çeliklerinin montajı için en uygun yöntem olan kaynaklı imalat yöntemi kullanılır. Ancak kaynak sonrasında zırh çeliğinde özellikle ısıdan etkilenen bölgede sertlik değişimi ve makro görüntüde hatalar saptanır.

1.2 Zırh Çeliklerinde Büküm

Zırh çeliklerinde büküm sürecinde zırh çeliği kalınlığının 10 katı alınarak büküme uygun Radius elde edilecektir. Aksi durumda malzeme yüksek sertliğine bağlı olarak başlayan yüzey veya kılcal çatlaklar yada gevrek kırılmalar meydana gelir.

2. YÖNTEM

2.1 Kaynak Yöntemi

Akma dayanımı 1500 MPa'ya kadar çıkan ve karbon eşdeğeri 0,7-0,9 aralığında olan Q&T çelikleri, genellikle mermi penetrasyonuna karşı direnç gerektiren muharebe araçlarının imalatında kullanılır. Zırhlı araç imalatında benimsenen ana imalat yöntemi kaynaktır. HAZ'da kaynak sonrası hidrojen kaynaklı soğuk çatlama ve kaynak termal çevrimi nedeniyle HAZ yumuşaması, zırh uygulamalarında kullanıldıklarında balistik performansı engelledikleri için zırh sınıfı Q&T çeliklerinin kaynaklanması sırasında ele alınması gereken iki önemli sorundur[1].

Zırh sınıfı Q&T çeliklerinin HAZ'ında iki tip çatlamanın meydana gelmesi beklenir. Bunlar, HAZ'ın düşük sünekliğinden dolayı yüksek sıcaklıkta oluşan çatlama ve düşük sıcaklıkta belirli bir süre sonra oluşan ikinci tip çatlamadır. Düşük sıcaklıkta oluşan çatlama, hidrojen gevrekliğinden veya kısıtlama çatlamasından kaynaklanabilir [2]. HIC'i aşmanın çözümü , ön ısıtma ve elektrotların pişirilmesi ve östenitik faz oluşturan sarf malzemelerinin kullanımı gibi kaynak sırasında alınan önlemlerdir. Hidrojen kaynaklı çatlamanın başlıca nedenlerinden biri HAZ'daki yüksek sertliktir. Bu nedenle, HAZ sertliğini çatlamaya duyarlı bölgenin altında tutmak için ön ısıtma önerilir [3]. Ön ısıtma değeri zırh çeliğinin balistik özelliğine zarar veren seviye olan 180° altında olmalıdır. Zırh çeliği ön ısıtma işlemleri 120° olarak referans alınır.

Kaynak parametleri belirlenip DT testler ile optimum kaynak parametlerine ulaşılacaktır. Sertlik testi, kimyasal test ve HAZ bölgesi tayini yapılmalıdır. Optimum parametreler ile zırh çeliği UHH 600, gaz altı kaynak yöntemlerinden biri olan MAG (Metal Aktif Gaz) ile 308 L kaynak teli kullanılarak kaynak edilir. Kaynak işleminde yüksek kalite ve verim elde etmek amacı ile v şeklinde kaynak ağızı açılarak başlanıp, 145 Amper akım ile tamamlanır. Kaynak süreci sonrası seri imalatta NDT testleri yapılmalıdır. Penerant çatlak tespiti için yapılması gereken ilk NDT testtir.

2.2 Büküm Yöntemi

Zırh çelikleri yüksek mekaniksel ve balistik özelliklere sahip olsa da şekillendirme ile araç gövdesine montajının yapılabildiği durumda işlevini yerine getirebilir. Kabin formları balistik açıdan değerlendirildiğinde mühimmatın en riskli geliş açısı olan 0° açısını değiştirebilmek adına zırh çeliğini uygun açılarda bükmek gerekir. Aynı zamanda kaynak girdilerinin HAZ bölgesinde zaafiyet oluşturması sebebiyle kaynaklı birleştirme yerine büküm tercih edilmelidir.

Büküm sırasında oluşacak kılcal, yürür ya da gözle görülen çatlaklar zırh çeliğinin yüksek sertliği sebebiyle daha da artacaktır. Büküm öncesinde zırh çeliği NŞA(Normal şartlar altında) bekletilmeli soğuk çatlak oluşumu engellenmelidir. Zırh çeliği kalınlığının 10 katı Radius ile bükülmelidir. Kalıp seçimi bu minvalde;

Büküm işleminde, dört ana faktör belirleyici etkiye sahiptir. İş parçasının haddeleme yönü, kalıp açıklığı, büküm yarıçapı ve levha kalınlığı.

• Kalıp Açıklığı (W)

• Büküm Yarıçapı (R)

• Levha Kalınlığı (t) Büküm işlemi sırasında ihtiyaç duyulan kuvveti yaklaşık olarak tahmin etmek için aşağıdaki formülden faydalanılabilir.

Gerekli kuvvetin belirlenmesi için her zaman deneme testlerinin yapılması önerilir.

Büküm kuvveti, P (ton) Bükülen iş parçası uzunluğu = b (mm) Levha kalınlığı = t (mm) Kalıp genişliği = W (mm) İş parçası çekme mukavemeti = Rm (MPa) Mesnet yarıçapı = Rd (mm) Pres yarıçapı = R(mm)

$$P = \frac{(b \,.\, t^2 \,.\, R_m)}{(W - R_d - R).9800}$$

Belirlenen kuvvete göre abkant seçimi gerçekleştilir. Büküm öncesi yağlama ve 120 ön ısıtma zırh çelikleri için uygun bulunmuştur. Büküm sonrası kalite proseslerinde penetrant testi ile kılcal çatlak tespiti yapılır.

3. BULGULAR

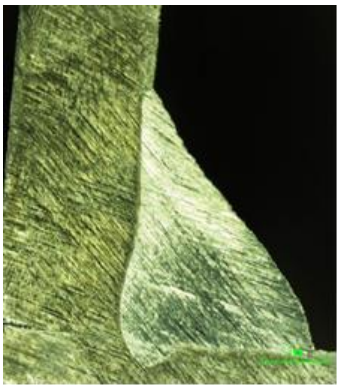
3.1. Zırh Çeliklerinde Kaynak Sonrası NDT ve DT Testler

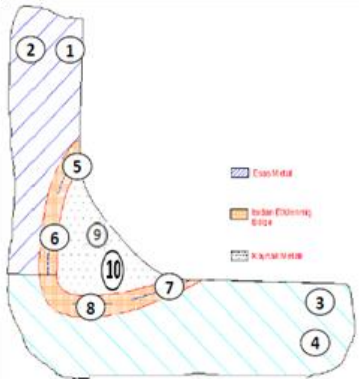
Tahribatsız testler seri üretimde kontrollü bir üretim ve kalite seviyesini yüksek tutmayı hedefler. Tahribatsız testler ile ürün zarar görmeden kalite testleri gerçekleştirilir. Penetrant ve ultrasonik testler bunlardan bazılarıdır. Tahribatlı testlerde sertlik, kimyasal ve çekme testi en yaygın testlerdendir. Yukarı da belirtilen kaynak numunelerine sertlik ve kimyasal testler uygulanmıştır.

Kaynak sonrasında zırh çeliğinde özellikle ısıdan etkilenen bölgede sertlik değişimi ve makro görüntüde hatalar saptanır. Kaynak öncesi numuneye kimyasal analiz yapılarak zırh çeliğinin kimyasal yapı bileşenleri incelendi ve farklılıklar değerlendirildi. Kaynak girdisinin zırh çeliği üzerindeki etkisi ve zırh çeliği kimyasındaki değişiklikler aşağıda yer alan tablo ile öne çıkarıldı.

Spektro analiz	Öngörülen	Bulunan	Onay
%Fe	98	96,5	√
%C	≤0,45	0,13	√
%Si	≤0,35	0,26	√
%Mn	≤0,50	0,88	X
%P	≤0,020	0,002	√
%S	≤0,005	0,001	√
%Ni	≤1,00	0,96	√
%Cr	≤1,20	0,52	√
%Mo	≤0,30	0,36	X
%B	≤0,002	0,002	√

Zırh çeliğinde kaynak öncesi kimyasal analizde molibden ve manganez miktarının öngörülenden az olması sertlik , aşınma direnci ve imalat konusunda eksikliklere sebep olur. Kaynak sırasında kaynaklanabilirlik azalması ve kaynak sonrasında çatlak, sehim ve çarpılma gibi çeşitli kaynak hatalarına sebebiyet vermektedir.





Sertlik Deneyi(Vickers HV10)		
	Ölçüm Yeri	HV
Esas Metal	1	624
Esas Metal	2	620
Esas Metal	3	601
Esas Metal	4	605
Isıdan Etkilenmiş Bölge	5	540
Isıdan Etkilenmiş Bölge	6	550
Isıdan Etkilenmiş Bölge	7	570
Isıdan Etkilenmiş Bölge	8	580
Kaynak Metali	9	200
Kaynak Metali	10	195

Isıdan etkilenen bölgede sertlik farkının esas metalden ısıdan etkilenmiş bölge ve kaynak metaline kadar giderek azaldığı görülmüştür.

Kaynak sonrasında sertlik testinde vickers(HV) cinsinden veriler elde edilmiştir. Bu verilere bağlı olarak esas metal sertliği 624 HV sertliğe sahip iken, ısıdan etkilenmiş bölgede 580-540 HV aralığına kadar azalmış ve kaynak metalinde ise 195 HV ye kadar düşmüştür. Zırh çeliğinin en büyük özelliği olan

sertliğin düşmesi, balistik koruma özelliğinin kaybolmasına yani yapıda zayıf alanların oluşmasına neden olur. Bu zayıf alanlarına koruma kapamaları gibi çözümlerle müdahale edilerek STANAG 4569 AEP 55 içerisinde yer alan araç balistik koruma yüzdesi olan %90 oranını koruma ve hatta oranı %98 gibi yüksek seviyelerde tutulmasına yardımcı olur.

3.2 Zırh Çeliklerinde Büküm ve DT Testler

600 HB sertliğinde zırh çeliği koruma seviyesine bağlı olarak kalınlığı seçilmiş olup kalınlık esaslı büküm kalıp hesapları gerçekleştirildi. Büküm radiusu kalınlığın 10 katı olacak şekilde belirlendi. Büküm sırasında zırh çeliği hadde yönü referans alınarak kalıp bıçağına yerleştirildi. Kademeli olarak vuruşlarla istenilen büküm elde edildi. Çatlak ve kırılma olmaması hedefi ile tüm proseslere uyularak sağlıklı büküm işlemi gerçekleştirildi. Büküm sonrası büküm noktalarına penetrant testi yapılmıştır.

SONUÇ, TARTIŞMA VE ÖNERİLER

Balistik korumaya sahip zırhlı araçların özellikle zırh çeliği ile üretim prosesi kaynak ve büküm ele alınarak incelenmiştir. Kaynak ve büküm öncesi, sonrasında yapılması gereken adımlar ve tahribatlı tahribatsız testler ile proses değerlendirilmiştir.

Kaynak öncesinde ön ısıtma ve kaynak ağzı açmak gibi ön işlemlerle yüksek sertlikteki zırh çeliğinin kaynaklanabirliği arttırılmıştır. Tahribatlı testler ile kaynak girdisinin etkisi incelenirken optimum parametreler belirlenmiştir. Makro analizde elde edilen görüntü ile ısıdan etkilenen bölge, kaynak pasoları, birleştirme şekli, kaynak geometrisi var ise bölgesel çatlakları, birleştirmede ergime ve nüfuziyet azlığı gibi konuları net bir şekilde incelenmiştir. Kaynakta bölgesel çatlak ve nüfuziyet azlığı görülmemiştir. Tahribatsız testler ile kaynak sonrası çatlak vb hataların tespiti yapılmış araç formuna getirilmeden müdahale edilmiştir.

Zırh çeliğinde büküm süreçlerinde 120° ön ısıtma, kalıp ve malzeme büküm çizgisinin yağlanması en kritik ön işlemlerdendir. Bununla birlikte gevrek kırılma olmaması adına zırh çeliğinin oda sıcaklığında olması elzemdir. Büküm sonrası tahribatsız muayene olarak penetrant yapılarak kılcal çatlak tespiti sağlanmıştır.

Bilmekte fayda vardır ki zırh çeliği tüm optimum parametrelere rağmen iç yapısı sebebiyle hataya açık bir çeliktir. Hataları aza indirmek yegane hedeftir ancak zırh çeliği yüksek sertliği ve buna bağlı kırılganlığı sebebiyle %100 kusursuz proses beklenmemeli münferit hatalara açık olunmalıdır.

KAYNAKLAR

1) Metallurgical characteristics of armour steel welded joints used for combat vehicle construction

2) The Weld Cracking Susceptibility of High Hardness Armour Steel. Savunma Bilimi ve Teknoloji Örgütü, Avustralya (1996) , s. 1 – 17 AR No: 009-659

3) Weldability of low carbon structural steel TWI Res. Bul. (1977) , s.209-216

ETKİLİ İNOVASYON İÇİN KURUM İÇİ KONTRASTTAN İSTİFADE ETMEK: ÇEŞİTLİLİK ve KAPSAYICILIK

UTILIZING INTERNAL CONTRAST FOR EFFECTIVE INNOVATION: DIVERSITY AND INCLUSION

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ÖZET

Gelişen küresel iş ortamı ile birlikte, işletmeler gelecekteki yeteneklere etkili bir şekilde hitap edebilmek için politikalarını ve stratejilerini sürekli olarak uyarlamaktadır. Küresel genişleme ve kıt yetenek, kaynak ve pazar payı için artan rekabet ortamında kâr maksimizasyonu hedeflenirken, işyeri çeşitliliği şirketler arasında giderek daha fazla önem kazanmaktadır. Analistler, önümüzdeki yıllarda şirketlerin küresel rekabeti sürdürmek için etkili stratejiler geliştirmeleri ve çeşitlilik programlarına yapılan yatırımların artırılması gerektiğini savunmaktadır. İşyeri çeşitliliği stratejilerine sahip işletmelerin, yetenekli çalışanları çekeceği, işe alımı maksimize edeceği, operasyonel maliyetleri düşüreceği ve diğer faydaları sağlayacağı öngörülmektedir. Ampirik araştırmalar, çeşitliliği benimseyerek çalışan ekiplere sahip şirketlerin kâr marjlarının homojen firmalara göre %35 daha yüksek olduğu göstermiştir (Cletus vd., 2018). Çeşitlilik ve kapsayıcılık vizyonu, farklılıkların gücünden yararlanmayı ve dengeli bir rekabet avantajı sağlamak ve farklı geçmişlere sahip bireylerin aktif olarak katılıp büyüyebileceği bir işyerini teşvik etmeyi benimser (Jain & Lobo, 2012). Demografik özelliklerin ve beceri seti gereksinimlerinin hızlı bir şekilde geliştiği küreselleşme çağında, çeşitliliğe sahip bir iş gücü hayati önem taşımaktadır. Bu çeşitlilik, kullanılmamış pazar segmentlerinin ihtiyaç ve değerlerine hitap eden farklı bakış açıları ve yeni fikirler vaat etmektedir. Ancak yeteneklerdeki salt çeşitlilik öncü inovasyonu garanti edemeyebilir; önemli olan her görüşün kabul edildiği ve farklı fikirlere değer verildiği kapsayıcı bir atmosfer yaratmaktır (Steele & Derven, 2015). Bu bakış açılarını ustalıkla birleştirebilme, yeni çözümleri aktif olarak destekleyen liderliğe ihtiyaç duymaktadır. İnovasyonda üretkenliği artırabilmek için oluşturulacak kültürde çeşitlilik ve kapsayıcılık stratejileri çok önemlidir. Çeşitlilik ve kapsayıcılık fikrine samimi bir bağlılık olmadan işletmeler, daha düşük katılım ve elde tutma oranlarının yanı sıra yeni fikirlerin kaybedilmesi ve inovasyon potansiyelinin sınırlanması nedeniyle kaçırılan fırsatlarla karşılaşabilir.

Anahtar Kelimeler: İnovasyon, çeşitlilik, kapsayıcılık.

ABSTRACT

With the evolving global business environment, businesses are constantly adapting their policies and strategies to effectively cater to future talent. In the face of global expansion and increasing competition for scarce talent, resources, and market share, workplace diversity is becoming increasingly important among companies as they aim for profit maximization. Analysts argue that in the coming years, companies need to develop effective strategies and increase investment in diversity programs to maintain their global competitiveness. Businesses with workplace diversity strategies are expected to attract talented employees, maximize recruitment, reduce operational costs, and provide other benefits. Empirical research has shown that companies with diverse workforces have profit margins 35% higher than homogenous firms (Cletus et al., 2018). The vision of diversity and inclusion embraces leveraging the power of differences to achieve a balanced competitive advantage and fosters a workplace where individuals from diverse backgrounds can actively participate and grow (Jain & Lobo, 2012). In the age of globalization, where demographic characteristics and skill set requirements are rapidly evolving, a diverse workforce is vital. This diversity promises different perspectives and new ideas that address the needs and values of untapped market segments. However, mere diversity in skills may not guarantee pioneering innovation; what matters is creating an inclusive atmosphere where every viewpoint is accepted and different ideas are valued (Steele & Derven, 2015). The ability to skillfully combine these perspectives requires leadership that actively supports new solutions. Diversity and inclusion strategies are crucial in building a culture to increase productivity in innovation. Without a genuine commitment to the idea of diversity and inclusion, businesses may face missed opportunities due to lower engagement and retention rates, the loss of new ideas, and limited innovation potential.

Keywords: Innovation, diversity, inclusion.

GİRİŞ

Küresel iş dünyasının değişen ortamında, çeşitlilik ve kapsayıcılık (Diversity & Inclusion, D&I) açısından zengin bir ortam yaratma zorunluluğu, işletmeler için genel kabul gören bir ilke haline gelmiştir. Artan toplumsal farkındalık ve sosyal adalet çağrıları doğrultusunda, D&I'nin işletmelerde kurumsal sosyal sorumlulukta sadece bir formalite olmaktan çıktığı, inovasyon, çalışan memnuniyeti ve sürdürülebilir büyüme için önemli bir itici güç olduğu fark edilmektedir (Jain & Lobo, 2012).

Son çalışmalar, D&I'yi sadece ahlaki ve etik bir yükümlülük olarak değil, stratejik bir avantaj olarak benimsemenin gerekliliğini güçlendirmektedir. Takımlar içindeki çeşitliliğin, daha fazla yaratıcılığı, yeniliği ve daha geniş bir problem çözme yaklaşımını geliştirdiği ve nihayetinde örgütsel performansı artırdığı gösterilmiştir (Hunt vd. 2018).

İşletmeler, çeşitliliğin azınlık temsilinin ötesine uzandığını fark ederek, çeşitli ekiplerin teşvik edilmesinin işletmelerin değer zincirinin geliştiği bilincindedirler (Bernstein vd. 2020). Çeşitlilik, bireylerin masaya getirdiği çok sayıda bakış açısı, geçmiş deneyimler ve yeteneği kullanarak, organizasyon yapısını içgörüler ve deneyimlerle zenginleştirmektedir. Mevcut çeşitlilik çabalarının evrimi, 1990'larda çeşitlilikle içsel olarak bağlantılı hale gelen kapsayıcılık kavramının ortaya çıkmasına neden olmuştur (Sabharwal, 2015).

İşletmelerin rekabeti ve sürdürülebilirliği sağlayabilmesi için işgücünde çeşitliliğin ve kapsayıcılığın öneminin farkına varmaları gerekmektedir. Çeşitliliği benimsemede başarılı olan işletmeler için, yaratıcılık ve yenilikçiliğe dayalı örgütsel çeviklik ortaya çıkabilir (Cox & Blake, 1991). Bassett-Jones (2005) yaratıcılığın yenilik için bir ön koşul olduğunu ve yaratıcılık ve yeniliğin çeşitliliğin varlığıyla artırıldığını öne sürmektedir. Çağdaş organizasyonel ortamlarda, eşitlik, çeşitlilik ve kapsayıcılık; yenilikçiliği, dayanıklılığı ve sürdürülebilir büyümeyi teşvik etmede temel direkler olarak öne çıkmaktadır. (Atescan-Yuksek vd., 2024).

Farklılıklardan beslenmeyen ve kapsayıcı politika ile uygulamaları teşvik etmeyen işletmelerin, rekabet ortamında geride kalması muhtemeldir. Çeşitlilik uygulamalarının etkin bir şekilde hayata geçirilmesi,

işletmelerde artan karlılık, yaratıcılık, esneklik, piyasa dalgalanmalarına uyum ve bireysel-örgütsel büyüme gibi olumlu sonuçlar doğurabilmektedir (Van De Voorde vd. 2012). Çeşitlilik ve kapsayıcılık konusunda duruş sergilemek, birçok işletme için stratejik konumlandırma meselesi haline gelmiştir. İşletmelerin; azınlıkların sorunlarını benimseme eğilimi giderek artmaktadır; zira bu işletmeler, daha rekabetçi ve yenilikçi olmak amacıyla iş gücünü çeşitlendirmekle ilgilenmektedir. Ancak kurumsal kültür bir gecede değişen bir şey değildir. İşletmenin sorumluluğunu üstlenen çalışanların ataletini kırmak, zihniyetlerini ve eylemlerini dönüştürmek, farklı insanları çekmek ve elde tutmak, böylece çeşitlilik ve kapsayıcılık politikalarının benimsenmesi ve gerçekten uygulamaya konulması gerekmektedir (Souza & Gama 2020, 352).

Çok kültürlülük, özellikle Amerika Birleşik Devletleri (ABD) merkezli iş yerlerinde ve yükseköğretim kurumlarında yaygın olan çeşitlilik ve kapsayıcılık dilinin evrimine öncülük etmiştir. Bu evrim, farklı bireylerin karışımını (çeşitlilik) artırmanın, anlamlı entegrasyon ve katılımı (kapsayıcılık) ya da sosyal gruplar arası güç, kaynak ve erişim eşitsizliklerini (eşitlik) otomatik olarak garanti etmediğini kabul eder (Otten vd., 2022, 185).

Çeşitlilik ve kapsayıcılık bir işletmeun çok sayıda yönüne katkıda bulunmakta olup faydaları çeşitli bölümlere yansıtılmaktadır. Sicola (2024) araştırmasında çeşitli ekiplerin (i) yeniliğe, rekabet avantajına, müşteri memnuniyetine ve pazar genişlemesine katkı sağladığı (ii) organizasyonel ve mali gelişimi artırabildiği (iii) D&I faydalarının kültürel/toplumsal, finansal ve organizasyonel gruplara ayrılabildiği bulgularını ortaya koymuştur. Yenilikçilik ve rekabet avantajı, çeşitli ekiplerin en önemli katkıları olarak belirlenmiş; bunları pazar genişlemesi ve müşteri memnuniyeti izlemiştir. Olumlu organizasyon kültürünün oluşturulmasının, çalışanların güçlü yönlerinin kabul edilmesinin ve yeni yeteneklerin çekilmesinin, organizasyonel gelişime katkıda bulunduğunu ifade etmiştir. Çeşitli ekiplerce yenilikçilik ve yaratıcılığın teşvik edilmesi, çalışan üretkenliğinin artırılması ile rekabet üstünlüğünün güçlendirilmesi, finansal gelişmeyi iyileştirmiştir.

Çeşitlilik ve kapsayıcılık literatürü incelenirken çeşitli zorlukların olabileceği dikkat çekmektedir. Toplumsal normlar, bilinçsiz önyargılar ve eğitim/politika eksikliği, D&I uygulanmasının önündeki başlıca engeller olarak gözlemlenmiştir (Sicola, 2024). Karşılaşılan temel zorluklardan bir diğeri, işletmelerin çeşitli iş gücünde güven ortamı yaratma biçimlerini daha iyi anlamaktır (Purdie-Vaughns vd. 2008). Downey vd. (2015) çeşitlilik uygulamaları ile güven ortamı arasındaki ilişkinin, çalışanların yüksek kapsayıcılık algısı varlığında güçleneceğini öne sürmüşlerdir. Kapsayıcılık burada kritik öneme sahiptir; çünkü çalışanın kendini örgüt içinde "içeriden biri" gibi hissetmesini, önemli ağlara ve karar alma süreçlerine erişimi kolaylaştırmaktadır (Barak, 2008). Dolayısıyla, kendilerini örgütsel karar alma süreçlerine dahil hisseden bireylerin, çeşitlilik uygulamalarının olumlu etkilerine daha açık olacağını öngörülmektedir.

Özetle bu araştırmada çeşitlilik ve kapsayıcılığın işletmeler için önemi vurgulanarak; yine işletmeler için son derece önemli olan inovasyon konusunda etkilerini incelemektir.

İNOVASYON

İnovasyon teriminin literatüründe çok fazla tanımı olmakla birlikte, genel olarak ifadesi; “yeni ürünlerin, hizmetlerin, süreçlerin veya operasyon yöntemlerinin ortaya koyulmasını ve ticarileştirilmesi” şeklindedir (Vorley vd., 2019). Anderson (2012) tarafından yeniliği daha önceki durumdan önemli ölçüde farklı olması, uygun olması, kamuoyuna açık olması ve algılanan bir fayda sağlaması ile ilişkilendirirler; bu yönleriyle, rekabet avantajı hem radikal ürün yeniliği hem de aşamalı sistem ve süreç yniliğiyle ilgilidir. Öte yandan, çeşitliliğin yönetimine ilişkin stratejik hamlelerin, farklı yaklaşımlarla, hem rekabet avantajı sağlamak hem de yenilikçiliği artırmak amacıyla uygulandığı görülmektedir (Bassett-Jones, 2005).

Çeşitliliği ve kapsayıcılığı, yenilikçilikle birleştiren bir bakış açısını benimsemek, çeşitliliğe sahip, çok kültürlü bir toplumda tüm bireylerin yeteneklerinin ve gereksinimlerinin nasıl kabul edilip

karşılanabileceğini anlayabilmek açısından oldukça önemlidir. Bu nedenle, yeni ürün ve hizmetleri geliştirmedeki istikrar, hem inovasyonu hem de D&I'yi gerektirir. Çin'deki Yin ve Yang kavramıyla tasvir edildiği gibi, D&I ve inovasyonun birleşik doğası, her birinin diğerini geliştirmek için etkili bir şekilde kullanılabileceği anlamına gelir (Steele & Derven, 2015).

İnovasyon, fikirlerin hayata geçirilmesi ve mühendislik ve teknolojinin özünde yer alan yeni uygulamaların geliştirilmesi sürecidir. İnovasyon bireylerden veya gruplardan doğar. Bir organizasyon içindeki çeşitlilik iklimi, çeşitli ekiplerin etkinliğini ve bilişsel çeşitliliği kullanma yeteneklerini önemli ölçüde etkileyebilir (Pandey & Pandey, 2025). Grup performansına etkisi açısından, bilişsel çeşitlilik, fikir ve çözüm yelpazesinin artması sayesinde performansı iyileştirebilmektedir.

İnovasyon sistemlerinin hedefleri ve kapsamı son on yılda sürekli olarak değiştirilmiştir. 1990'larda ve 2000'lerin başında politika yapıcılar tarafından bir inovasyon sisteminin birincil sonucu olarak ekonominin rekabet edebilirliğinin artırılmasına odaklanılmışken, son yıllarda vurgu en azından rekabetçiliği tamamlayıcı hedefler olarak toplumsal zorluklara kaydırılmıştır (Mazzucato, 2017; Schot & Steinmueller, 2018). İnovasyon sistemlerinin kapsayıcılığının artırılması, inovasyon sistemlerindeki dışlanma ve eşitsizlik sorunlarının kabul edilmesiyle bilim, teknoloji ve inovasyon politikaları için temel bir hedef haline getirilmiştir (Hekkert vd., 2020). Kapsayıcı inovasyon sistemi ise hem araştırma hem de politika açısından daha zor kavranan bir kavram olarak tanımlanmıştır (Chataway vd. 2014; Kalliomäki vd. 2022). Kapsayıcılık, yenilik süreci, sistemi ve sonuçlarında eşitlik, çeşitlilik ve katılımı merkeze alma eylemi olarak belirlenmiştir. Bu vurgu, inovasyon süreçlerinin desteklenme biçimlerine, politika karışımlarına ve araçlara ile farklı ölçeklerde (yerel, ulusal vb.) bütünsel bakışı gerektirmektedir. Tanımın sistem sonuçlarında eşitliği de kapsayacak şekilde genişletilmesiyle, eşitlik hedefi farklı başlangıç noktalarını ve eşitsizlikleri kabul ederek sistemin herkes için tamamen eşit kılınması amacıyla temel haline getirilmiştir (Kattel vd., 2023).

Bir firmanın inovasyon etkinliği, iyi hazırlanmış bir strateji ile sağlanmaktadır. İnovasyon projelerinin temel amaçlardan yararlanarak kaynaklar ve hedeflerle uyumlu olması gerektiği, bu sayede firmanın yetkinliklerine katkı sağlayacağı ve stratejik amacına ulaşmasında destek olacağı belirtilmiştir. Firmanın organizasyon yapısı ve kontrol sistemleri, yenilikçi fikirlerin üretimi için teşvik edici bir ortam yaratılmasına; bu fikirlerin etkin bir şekilde uygulanmasına yardımcı olunmasına yönelik olarak düzenlenmelidir (Cornel vd. 2021).

Strategos'un 550'den fazla büyük şirketin inovasyon uygulamalarına ilişkin anketinde, her sektördeki katılımcıların ezici çoğunluğu inovasyonun kritik öneme sahip olduğunu belirtmiş ve inovasyonun öneminin gelecekte artacağı ifade edilmiştir. Ancak katılımcıların çoğu, şirketlerinin inovasyon etkinliğini eleştirmiş; yalnızca yüzde 19'u şirketlerinin inovasyon konusunda "faaliyetler yürüttüğünü" belirtmiş ve çoğunluk, şirketlerinin inovasyon etkinliğinin ortalamanın altında olduğunu değerlendirmiştir (Loewe & Dominiquini, 2006, 24).

Sistematik dışlanma ve eşitsizlik gibi konuların ele alınması, inovasyon sistemlerinin daha adil, çeşitli ve kapsayıcı hale getirilmesi zorluğuna dönüşmüştür. Eşitlik, çeşitlilik ve katılıma odaklanan bir inovasyon sistemi gerekliliği dikkat çekmektedir. Aktörlerin heterojenliği ve çeşitliliğinin inovasyon sistemlerinin yenilikçi kapasitelerini artırdığı bilinmektedir (Hemmert vd., 2022). İnovasyon sisteminin kendisini daha adil, çeşitli ve kapsayıcı hale getirmek için misyon odaklı yaklaşım önerilmektedir. Misyon odaklı yaklaşım, politika oluşturma sürecini daha çeşitli paydaşlara açarak, kapsayıcılığı uygulamanın temel dayanağı haline getirmektedir. Bu zorluğun karmaşıklığı, çözümün nasıl ele alınacağına dair önceden tam bir yol haritası çizmenin mümkün olmadığını gösterir. Bu nedenle yaklaşım, misyona ulaşmanın sürecinin tasarımıyla ve sistem genelindeki paydaşların ortak bir anlayış geliştirmesi, işbirliği içinde çalışması ve misyonu ele almak için deneyler yapmasıyla ilgili olduğu kabul edilir. Misyon odaklı yaklaşım, büyük, cesur ve karmaşık hedefleri, paydaşların etrafında yenilik yapabileceği 'misyonlara' veya net hedeflere ayırır (Mazzucato & Dibb, 2019; Wittmann vd. 2021). Bu süreçte, odağı statüko içinde "kimin ne yaptığı" düşüncesinden uzaklaştırarak, ortak bir anlayışla üzerinde ve birlikte çalışılabilecek kolektif sorunlara doğru kaydırılır (Kattel vd. 2023).

ÇEŞİTLİK VE KAPSAYICILIK TEMEL NOKTALAR

Çeşitliliğin bir yönetim kavramı olarak doğmasında, çeşitliliği yönetme kavramının, eşitliği teşvik etmeyi amaçlayan sosyal politikalardan evrimleştiğini ve tarihsel olarak bu politikaların dezavantajlı sosyal gruplar için fırsatlara eşit erişim sağlamaya odaklandığını belirtmekte fayda vardır (Wittmann vd. 2021).

Çeşitlilik kaygıları birçok işletme için hem ahlaki hem de iş bakımından bir odak noktası haline gelmiştir. İşletmeların ırk ve cinsiyet ayrımcılığı kayıtlarına sahip olmasına ve kültürel çeşitlilik eksikliğine rağmen, işyeri çeşitliliğinin gelişmeye başlaması 1960'ların ortalarına kadar mümkün olmamıştır (Castelino & Shinde, 2023). 1964 Sivil Haklar Yasası, çalışanların işe alınması veya yönetilmesi sırasında ırk, renk, din, cinsiyet veya ulusal kökene dayalı ayrımcılığın yasaklanmasıyla önemli bir dönüm noktası olmuştur (Kapoor, 2011).

Kirton & Greene (2000), çeşitlilik paradigmasının, fırsat eşitliği kavramlarıyla yönlendirilen pozitif ayrımcılıktan daha az tehdit edici ve tartışmalı olarak algılandığı için evrimleştiğini öne sürmüşlerdir. Prasad vd. ise (2004), kurumsal girişim ve insan sermayesi teorilerine vurgu yapan çeşitlilik yaklaşımının, fırsat eşitliği politikaları yoluyla dayatılan devlet müdahalesinden daha çok Amerikan bireyciliğiyle uyumlu olduğunu öne sürmüştür. Dahası, ABD ve İngiltere, çeşitliliğin önemli bir yönetim sorunu olduğunu kabul etme konusunda öncü konumdayken, yorumcular diğer Batı ekonomilerinin demografik dengelerinde dramatik değişimlerle karşı karşıya olduğunu ve bu durumun çeşitliliğin etkin yönetimini yönetim gündeminde üst sıralara taşıyacağını belirtmişlerdir. Birleşmiş Milletler, Avrupa nüfusunun 2050 yılına kadar %13 oranında azalabileceğini ve G8 ülkeleri arasında sadece ABD, Kanada ve İngiltere'nin nüfusunun artacağını öngörmektedir. Yüksek bağlılık stratejisine ve büyük ölçüde homojen bir iş gücüne sahip işletmeler, düşük personel devir oranının kültürel ataleti beslediğini ve çeşitliliğin yaratılmasını engellediğini görebilirler. İşletmelerin, çeşitli bir iş gücü içinde yüksek bağlılığı koruma seviyesini belirleyen faktörler, bireysel yöneticilerin tutumları, becerileri ve davranışlarının toplam etkisidir (Bassett-Jones 2005, 170).

Çeşitlilik hakkındaki araştırmalarda önemli bir zorluk, çeşitliliğin tanımlanması ve farklı tanım varyasyonlarının oluşturulmasıdır (Kapoor, 2011; Van Ewijk, 2011; Nair & Vohra, 2015). Çeşitliliğin, "farklı kimlik gruplarının üyelerinin işe yönelik çeşitli bakış açıları ve yaklaşımları" olarak anlaşılması gerektiği belirtilmiştir (Thomas & Ely, 1996). Bassett-Jones (2005), çeşitliliğin "farklı olduğumuz tüm yönlerimiz" anlamına geldiği ifade etmiştir; bu farklılıkların bazıları doğuştan gelir ve değiştirilemez, bizi benzersiz kılan her şeyin bu çeşitlilik tanımının bir parçası olduğu vurgulamıştır. Diğer araştırmacılar, çeşitliliğin çok çeşitli sosyo-kültürel, sosyo-ekonomik ve demografik özelliklere sahip çalışanların varlığını içerdiğini belirtmişlerdir (Wentling & Palma-Rivas, 2000). Bu, çeşitliliğin yaş, cinsiyet, ırk, etnik köken gibi gözlemlenebilir niteliklerdeki ve çalışanlar arasındaki kültürel özellikler gibi fark edilmeyen faktörlerdeki farklılıklarla karakterize edilebileceği görüşünü yansıtır (Kaur & Arora, 2020). 1980'li yıllarda kadınlara ve bireylere yapılan vurgu, çeşitlilik algısının gelişimine katkı sağlamıştır. Renk açısından çeşitlilik kavramı, dini uygulamalar ve cinsel yönelim de dahil olmak üzere daha geniş bir demografik yelpazeyi kapsayacak şekilde gelişmiştir (Ferdman & Sagiv, 2012). Çağdaş bağlamda çeşitlilik, bireyler arasında eğitim geçmişi, işlevsel uzmanlıklar, çalışma-düşünme stilleri ve hatta kişilik özellikleri gibi daha az görünür ayrımları da kapsayacak şekilde genişler. Ek olarak, çeşitliliğe sahip ekipler, bireyleri varsayımlara meydan okuyan ve ufukları genişleten yeni fikir ve deneyimlerle tanıştırarak bir öğrenme ve büyüme kültürü geliştirirler (Hays-Thomas & Bendick, 2013).

Hewlett vd. (2013) doğuştan çeşitliliğin cinsiyeti, ırkı, yaşı, dini geçmişi, sosyoekonomik geçmişi, cinsel yönelimi, engelliliği ve uyruğu kapsadığını belirtmişlerdir. Edinilen çeşitlilik için ise; kültürel akıcılık, nesiller arası anlayış, cinsiyet zekası, sosyal medya becerileri, işlevler arası bilgi, küresel zihniyet, askeri deneyim ve dil yeterliliğini sıralamışlardır (Van Ewijk, 2011).

Kapsayıcılıkla ilgili literatür incelendiğinde, araştırmacılar arasında kapsayıcılığın tanımı konusunda önemli farklılıklar olduğu ortaya çıkmaktadır. Kapsayıcılık, "bir çalışanın başkaları tarafından bir iş sistemi içerisinde içeriden biri olarak kabul edilme ve muamele görme derecesi" olarak

tanımlanmaktadır (Pelled vd. 1999). Kapsayıcılık, sosyal katılımı teşvik etmek için gerekli olan kültürel önkoşullar olarak nitelendirilmektedir. Lirio vd., (2008) çalışanların örgütlere tam katılımının ve katkısının önündeki engellerin kaldırılması olarak ifade etmişledir. Benzer şekilde, Roberson, (2006) işyerinde kapsayıcılığın, "bireylerin aidiyet duygusu hissettiğinde ve herkesin katkısını almak ve değer vermek gibi kapsayıcı davranışlarda bulunduğunda" mevcut olduğu tanımlanmıştır (Sicola, 2024).

Sabharwal (2015), çeşitlilik hedeflerinin örneğin üst düzey pozisyonlara ulaşan kadın sayısına değil, kadınların yönetim rollerinde katılımına ve başarısına yol açacak bir çalışma ortamı oluşturmaya odaklandığını vurgulamıştır. Bu nokta, 'içerme' teriminin çeşitlilikle eşleştirilmesine zemin hazırlamış ancak aynı zamanda çeşitlilikten katılıma kademeli bir geçişle sonuçlanmıştır (Garg & Sangwan, 2021). Bu geçiş gerekli görülmüştür çünkü çeşitlilik çalışanın özelliklerine odaklanırken, kapsayıcılık şirketin özelliklerini vurgulayarak organizasyonel kültür ve iklimi içermektedir. Kapsayıcılık, farklı geçmişlere sahip bireylerin tamamen kabul edilmesini ve eşit bir şekilde ödüllendirilmesini garanti altına almayı amaçlayarak, çeşitliliğe uygun bir ortam yaratmaktadır (Oswick & Noon, 2014).

Kapsayıcılık, yalnızca bireylerin bileşimine odaklanmakla kalmayıp aynı zamanda her çalışanın kurumsal prosedürlere ve kültüre dahil edilmesini vurgulayarak çeşitlilikten ayrılır; işgücü içindeki çeşitlilikten kaynaklanan farklılıkların uygulanmasına yönelik bir araç olarak görülmektedir (Kaur & Arora, 2020).

Zamanla, işyeri çeşitliliği, kapsayıcılık önündeki çeşitli engellerin üstesinden gelecek şekilde ilerlemiştir. Başlangıçta ırksal çeşitliliğe odaklanan bu yaklaşım, kapsamını cinsiyet, cinsel tercih, yaş, etnik köken, din, engellilik ve cinsiyet kimliği gibi unsurları kapsayacak şekilde genişletmiştir.

Çeşitlilik ve kapsayıcılık, farklı olgular olmasına rağmen birbiriyle bağlantılıdır. Çeşitlilik, bir şirketteki bireylerin çeşitliliğini çeşitli özelliklere göre tanımlamayı içerirken kapsayıcılık, örgütsel evrim için işgücü çeşitliliğinden yararlanmayı vurgular (Kaur & Arora, 2020). Kapsayıcılık olmadan çeşitliliğe sahip olmak sınırlı faydalar sağlar. Ancak bir araştırmaya göre, çeşitlilik ve katılım iş birliği içinde çalıştığında işletmelerin yenilikçi olma olasılığı altı kat daha yüksek, kurumsal sonuçlar sekiz kat daha iyi ve finansal hedefleri karşılama veya aşma olasılıkları iki kat daha yüksek olduğu görülmüştür (Bourke, 2016). Bu iki faktör arasındaki sinerji, genel organizasyonel büyüme ve gelişme için çok önemlidir; aslında her iki kavramın entegrasyonu tutarlı bir şekilde işletmelar için daha umut verici sonuçlara yol açmaktadır (Kaur & Arora, 2020; Sicola, 2024). Sonuç olarak, çeşitlilikten yararlanmak, çalışanların takdir edildiğini ve bir işletmea entegre olduklarını hissetmelerini talep ederek katılım yoluyla gerçekleşir (Nair & Vohra, 2015). Bu, farklılıkların kabul edilmesini ve bunların üstesinden gelmek için aktif olarak çalışmayı, işletmeler içindeki ve arasındaki bireyler arasındaki ayrımlara değer vermeyi gerektirir. Çeşitlilik farklılıkları ele alırken, kapsayıcılık daha büyük bir anlam ve işbirliği yaratmak için bu farklılıkları sinerji haline getirmeye odaklanır (Kaur & Arora, 2020).

Farklı ekipler, çeşitli bilgi ve deneyimler getirilerek yenilikçi çözümlere ve daha geniş fikirlere ulaşılmaktadır Farklı bakış açılarının benimsenmesi, işletmelerin değişen müşteri ihtiyaçlarına uyum sağlaması ve rekabet avantajı kazanması için desteklenmektedir (Jones vd. 2020). Kültürel çeşitliliğe değer veren kapsayıcı ortamlar, çalışan refahı ve memnuniyetinin teşvik edilmesiyle üretken bir iş gücünün motive edilmesini sağlamaktadır. Genel olarak kültürel çeşitlilik, modern işyerini şekillendiren güçlü bir güç olarak kabul edilmektedir (Fine vd. 2019).

İş dünyası açısından bakıldığında, kültürel çeşitlilik; etnik köken, ırk, cinsiyet, yaş, din ve dil gibi boyutları içermektedir (Kaplan, 2023). Çalışanlar, çeşitli kültürel uygulamaları, iletişim tarzlarını, iş ahlakını ve problem çözme yaklaşımlarını getirerek yaratıcılık ve işbirliğinin teşvik edilmesine katkı sağlamaktadır. Örneğin, farklı geçmişlere sahip yazılım mühendislerinden oluşan bir ekip, farklı problem çözme yaklaşımları sunarak yeniliğin artırılmasına yardımcı olmaktadır. Bu kültürel çeşitlilik, zorlukların ve etkili çözümlerin kapsamlı bir şekilde analiz edilmesine olanak tanımaktadır. Ayrıca, farklı kültürlerden bireyler, geniş bir müşteri ve paydaş yelpazesiyle iletişimi kolaylaştıran çeşitli dil becerilerine sahip olabilmektedir (Kaplan, 2023).

İşyerinde kültürel çeşitlilik, farklı kökenlerden gelen, farklılıkları tanıyan ve değer veren çalışanların kapsayıcı bir ortamda bir araya gelmesiyle sağlanmaktadır (Brett vd., 2011). Kapsayıcı kültürlerde

eşitlik ve eşit fırsatların teşvik edilmesi, çalışanların gelişimine imkan sunmaktadır (Amaliyah, 2015). Kültürel çeşitliliğin benimsenmesi, bireylerin gerçek kişiliklerini korkmadan ifade edebilecekleri bir kabul atmosferinin oluşturulmasına yardımcı olur. Bu tür kapsayıcılık, çalışanların moralini ve katılımını artırarak, onları ellerinden gelenin en iyisini yapmaya teşvik eder ve üretkenlik ile yenilikçiliğin artırılmasını sağlamaktadır (Cletus vd. 2018).

Kültürel çeşitliliğin bir organizasyon için önemi göz önünde bulundurulduğunda, rekabetçi kalmayı ve farklı müşteri ihtiyaçlarına cevap vermeyi amaçlayan organizasyonlar için bu durumun büyük önem taşıdığı düşünülmektedir (Darby, 2023). Çeşitliliğin benimsenmesi, zengin bir yetenek havuzunun kilidinin açılmasına, yeniliğin teşvik edilmesine ve rekabet avantajının sağlanması için önemli bir etken haline gelmektedir. Bu yaklaşım, çalışanların katılımını ve memnuniyetini artırmanın yanı sıra aidiyet duygusunun güçlendirilmesine ve elde tutmanın geliştirilmesine katkı sağlamaktadır. Farklı geçmişlere sahip çalışanlar, benzersiz bakış açıları sunarak işletmelerin tekliflerinin daha geniş bir kitleye uyarlanmasına olanak tanır. 'Çeşitlilik yönetimi' terimi, işletmelerin çeşitli geçmişlere ve yeteneklere sahip çalışanları işe alma ve elde tutma konusundaki sistematik ve planlı taahhüdünü ifade eder (Betters-Reed & Moore, 1992; Bassett-Jones 2005).

Vurgulandığı gibi, çeşitliliğin çeşitli tanımları, farklı insanlar arasında kabul ve saygıyı kapsayan bir kavramı ortaya koymaktadır. Dahası, bireylerde var olan benzersiz özelliklerin karşılıklı olarak anlaşılmasını ifade etmektedir. Bununla birlikte, ırk, etnik köken, cinsiyet, cinsel yönelim gibi insanların kendine özgü farklılıklarının kabulünü de desteklemektedir. Bu nedenle, kavram, ekonomik durum, yaş, engellilik, dini veya sosyo-politik inançlar ne olursa olsun insanlara karşı hoşgörüyü teşvik eder (Bassett-Jones 2005). Güvenli, olumlu ve destekleyici bir ortamda bireysel farklılıkların araştırılması, çeşitliliğin anlaşılması, hoşgörülmesi ve benimsenmesi işletmelerin geleceği için kritik öneme sahiptir. Dahası, işyeri çeşitliliği, işin geleceği ve uluslararası iş dünyası hakkındaki küresel tartışmalarda tekrar eden bir özellik haline gelmiştir. Bu durum, işyeri çeşitliliği kavramının ve dünya çapındaki firmaların organizasyonel yönetimindeki rolünün ortaya çıkmasını sağlamıştır (Amaliyah, 2015).

ÇEŞİTLİLİK VE KAPSAYICILIK NEDEN ÖNEMLİ?

Yıllar içinde, küresel nüfusun çeşitliliği sosyoekonomik, jeopolitik, çevresel ve teknolojik faktörler tarafından dönüştürülmüştür. Bu dinamikler, sonuç olarak birçok toplumun bileşimini değiştirmiş ve insanların birbirleriyle etkileşim, çalışma veya birlikte yaşama biçimini etkilemiştir. Sonuç olarak, birçok işletme, rekabet avantajını korumak veya rekabet avantajı elde etmek için artan çeşitliliği olumlu yönde kullanma stratejileri araştırmaktadır. Pew Araştırma Merkezi'ne göre, Amerika Birleşik Devletleri'nde tek bir ırksal veya etnik çoğunluğun varlığı 2055 yılına kadar sona erecektir. Diğer çalışmalar, şu anda ABD'de aktif olarak çalışan 20 milyondan fazla kişinin yurt dışında doğduğunu tahmin etmektedir. Sonuç olarak, ABD ve dünya genelindeki birçok ülkenin kısa süre içinde çoğulcu hale geleceği tahmin edilmektedir (Emma L. 2018). Küresel demografik karışımdaki bu paradigma değişimi, yakın gelecekte hem zorluklar hem de fırsatlar sunacaktır.

Çok sayıda işletme, dünyanın dört bir yanından en iyi yeteneklerin işe alınmasını sağlamak için çeşitliliği işe alım süreçlerine aktif olarak entegre etmektedir. Bu nedenle birçok analiz, gelecekteki iş yerlerinin dünyanın çeşitli bölgelerinden gelen farklı insan gruplarından oluşacağını öngörüyor (Patrick & Kumar, 2012). Dike'ye göre (2013), birçok işletme şu anda iş yerinde yaratıcılığı ve açıklığı teşvik etmek için çeşitliliğin benimsenmesini ele almaktadır. Benzer şekilde Christian vd., (2006) iş yeri çeşitliliğinin benimsenmesinin, kurumsal yönetimi, rekabet avantajını iyileştirmek ve karı maksimize etmek için önemli bir kurumsal strateji haline geldiğini belirtmiştir. Amaliyah'a göre (2015), modern işletmelar artık yetenek yönetimi için kurumsal bir strateji olarak çeşitliliği benimseme, yatırım yapma ve uygulama ihtiyacını kritik bir şekilde kabul etmektedir. Bulgular ayrıca çeşitliliğin kurumsal misyon veya vizyon ile genel performans arasında önemli bir bağlantı olabileceğini de ortaya koymaktadır (Amaliyah, A. 2015).

D&I temeli üzerine inşa edilen ekiplerin oluşturulması, yeniliği teşvik etmek için stratejik bir zorunluluk haline gelmiştir. Bu yaklaşım, temsilin ötesine geçerek, farklı yeteneklere ve bakış açılarına sahip bireylerin bir araya getirilmesiyle büyüme ve yenilik için yeni fırsatların açılması amaçlanmaktadır. D&I ile yenilik arasındaki ilişki, bu ilkelerin sunduğu faydaları vurgulayan kanıtlarla desteklenmektedir. Özellikle, potansiyel görüş ayrılıklarına rağmen çeşitli ekiplerin daha yenilikçi ve problem çözme yetenekleri daha gelişmiş olduğu görülmektedir. Bu yenilikçi avantaj, artan patent sayısı ve patent atıfları gibi somut sonuçlarla desteklenerek çeşitlilik ile yaratıcılık arasındaki doğrudan ilişki vurgulanmaktadır (Torchia vd., 2011; Vafaei vd., 2021). Ayrıca, etnik olarak çeşitli yönetim kadrolarına sahip firmaların belirgin şekilde daha yenilikçi olduğu ve yeni ürün ile süreçler sunma olasılıklarının daha yüksek olduğu gözlemlenmektedir; bu durum D&I'nin inovasyon faydalarını daha da güçlendirmektedir (Nathan & Lee, 2013; Atescan-Yuksek vd., 2024).

Çeşitlilik, şirketler ve işletmelar için çalışanlarının çeşitliliğinden yararlanarak iş yeri hedeflerine, görevlerine ve uzun vadeli planlarına ulaşma olanağı sunar. Dahası, Dhuppar (2015), çeşitliliğin, bir işletmetaki çalışanların kolektif güçlü yönlerini ve doğal zayıflıklarını kendi avantajına birleştirme potansiyeline sahip olduğunu ortaya koymuştur. Çalışmanın bulgularına göre, çeşitli geçmişlere sahip çalışanların farklı beceri ve güçlü yönleri, daha iyi performans ve verimlilik için kullanılabilir. Örneğin, bu, çeşitli çalışanların çeşitli teknik, yönetim ve satış güçlü yönlerinin birleştirilmesiyle sağlanabilir. Benzer şekilde (Patrick &Kumar, 2012) kültürlerarası anlayışın, farklı kültürlerden insanlar hakkındaki klişeleri, önyargıları ve yanlış anlamaları ortadan kaldırmada büyük rol oynayabilecek daha iyi bir çalışma ortamını teşvik edebileceğini ortaya koymuştur. Bu nedenle, iş yeri çeşitliliği, farklı geçmişlere sahip insanlar arasındaki bağları birleştirmeye ve güçlendirmeye yardımcı olabilir (Cletus vd., 2018).

Ayrıca, D&I'yi kurumsal değerler ve stratejilerle entegre etmek, yalnızca iç kültürü geliştirmekle kalmaz, aynı zamanda dışarıda marka ve itibarı da güçlendirerek, benzer değerleri paylaşan çeşitli yetenekleri ve müşterileri çeker (Dobbin & Kalev, 2016). Değer zinciri boyunca çeşitli bakış açılarının dahil edilmesi, daha geniş sosyal değişime olan bağlılığı da yansıtır ve işletmeu kapsayıcılık ve eşitliği teşvik etmede lider konumuna getirir (Atescan-Yuksek vd., 2024).

Organizasyonlardaki D&I çabalarına ilişkin gerçekler ve rakamlar, bu yaklaşımların somut faydalarını ortaya koymaktadır. Çeşitli yönetim ekiplerine sahip şirketlerin yaklaşık %43'ünün, bu özellikten yoksun olanlara göre daha yüksek kar elde ettiği görülmektedir. Çeşitlilik sergileyen şirketlerin %35 daha verimli çalıştığı, çeşitlilik içeren ekiplerin karar verme süreçlerinde %87 daha iyi performans gösterdiği belirlenmiştir. Eşit oranda kadın ve erkek çalıştıran işletmelerin %41 daha iyi sonuçlar verdiği, çalışanların çeşitli işletmelerin diğerlerine göre daha rekabetçi olduğuna inandığı ifade edilmektedir. Yüksek düzeyde ırksal çeşitliliğe sahip işletmelerin diğerlerinden 15 kat daha fazla gelir elde ettiği vurgulanmaktadır (Rothwell vd., 2022, 224).

McKinsey & Company'nin 2015, 2018, 2020 ve 2023 yıllarında yayınlanan ve yaklaşık on yıldır devam eden "Çeşitlilik Önemlidir" raporları, yönetici ekiplerinde cinsiyet çeşitliliğinin iş dünyası açısından önemini sürekli olarak takip etmiş ve raporlamıştır. Sonuçlar, yönetici ekiplerinde kadınların temsilinde artış gösteren tutarlı bir yükseliş trendini ortaya koymaktadır (Dixon-Fyle vd. 2023). Özellikle, finansal performansta üstünlük olasılığının artmasıyla eşleştirilen cinsiyet çeşitliliğinin iş dünyası açısından önemi, son on yılda iki katından fazla artmıştır. 2015 raporuna göre, cinsiyet çeşitliliğinde en üst çeyrekte yer alan şirketler, en alt çeyrekte yer alan şirketlere kıyasla %15 daha yüksek finansal performans gösterme olasılığına sahiptir (Hunt vd. 2015). 2019 yılında yapılan ve dünya genelinde 15 ülkedeki 1.039 şirketten elde edilen verileri inceleyen bir çalışma, işyeri çeşitliliği ile finansal performans arasında istatistiksel olarak anlamlı korelasyonlar olduğunu ortaya koymuştur (Dixon-Fyle vd. 2023). Bulgular, yönetim kadrosunda cinsiyet çeşitliliği açısından en yüksek çeyrekte yer alan işletmelerin, dördüncü çeyrekte yer alanlara kıyasla, ortalamanın üzerinde karlılık elde etme olasılığının %25 daha yüksek olduğunu göstermiştir (Sicola, 2024, 33). Benzer şekilde, aynı çalışmada, etnik ve kültürel açıdan çeşitli yönetici ekiplerine sahip en üst çeyrekte yer alan işletmelar, dördüncü çeyrekteki muadillerine göre %36 daha iyi performans göstermiştir. McKinsey'nin araştırması ayrıca, ırksal ve etnik çeşitlilikle ilişkili finansal getirinin sektör ortalamalarına kıyasla %35 daha yüksek olduğunu göstermiştir. Dahası, Amerika Birleşik Devletleri, Birleşik Krallık, Finlandiya ve İsveç gibi yüksek

cinsiyet eşitliğiyle karakterize edilen gelişmiş ekonomilerde, cinsiyet çeşitliliğine sahip yönetici ekiplerine sahip şirketlerin finansal performansta üstünlük sağlama olasılığı %47'ye kadar ulaşmaktadır. Buna karşılık, Brezilya, Hindistan ve Nijerya gibi cinsiyet eşitliğinin daha düşük olduğu gelişmekte olan ekonomilerde, cinsiyet çeşitliliğine sahip şirketlerin finansal performanslarının daha iyi olma olasılığı ortalama %17'dir (Sicola, 2024).

Öte yandan farklı geçmişlere sahip bireyler zorlukların üstesinden gelmek için işbirliği yaptıklarında, çeşitli bakış açıları ve yaklaşımlar ortaya koyarlar ve bu da daha verimli problem çözme ve karar verme süreçleriyle sonuçlanabilmektedir. İnsanların eleştirel düşünme yerine uyuma öncelik verdiği grup düşüncesi, etkili problem çözmeyi engeller. İşletmeler bu riski çeşitlilik ve katılım yoluyla azaltabilir, açık iletişimi ve yapıcı muhalefeti teşvik edebilir. Bu, farklı bakış açılarının kapsamlı bir şekilde araştırılmasını teşvik ederek daha iyi sonuçlara yol açabilir. Kapsayıcı sorun çözme süreçleri işletmelerin etkinliğini arttırır. İşletmeler, çeşitli düzey ve geçmişlerden çalışanları tartışmalara dahil ederek daha geniş bir bilgi ve beceri yelpazesine erişebilir (Hunt vd. 2015).

Ekip çeşitliliğini ve kapsayıcılığını teşvik etmek, çeşitli yollarla müşteri memnuniyetini ve bağlılığını önemli ölçüde artırabilir (Hunt vd. 2018; Norbash & Kadom, 2020). Başlangıçta, müşteri tabanınızla ortak geçmişe veya deneyimlere sahip olabilecek ekip üyelerinin çeşitli içgörülerinden, bilgilerinden ve geri bildirimlerinden yararlanarak müşterileri daha derinlemesine anlamayı sağlar (Jain & Lobo, 2012). Çeşitli bir ekip, işletmeyi farklı geçmişlere sahip bireylere etkili bir şekilde tanıtabilir ve halihazırda işletme iş gücünün bir parçası olanlarla uyum sağlayabilir. Hedef kitleyle benzer geçmişe sahip çalışanlar, işletmeyi ustaca pazarlayabilir. Bu yaklaşım, yalnızca tanıtım etkinliğini artırmakla kalmaz, aynı zamanda farklı demografik gruplar arasındaki farklılıkları anlayarak ve bunlara uyum sağlayarak büyüme fırsatları da açar (Miller, 2020). Ayrıca, ekip üyelerinin çeşitli yaratıcılıklarını, becerilerini ve bakış açılarını kullanarak inovasyonu ve ürün/hizmet geliştirmeyi teşvik eder; bu da müşteri ihtiyaçlarını karşılayan yeni fikirlerin ve çözümlerin üretilmesini sağlar (Hunt vd. 2018).

ÇEŞİTLİLİK VE KAPSAYICILIĞIN İŞLETMELERE FAYDALARI

Çeşitlilik ve kapsayıcılığın faydalarına ilişkin çok sayıda çalışma ve yayınlanmış rapor bulunmaktadır (Shrader vd. 1997; Hewlett vd. 2013; Hunt vd. 2015; Hunt vd. 2018; Norbash & Kadom, 2020; Dixon-Fyle vd. 2023). Sicola (2024) çalışmasında, 3 başlıca faydayı şu şekilde özetlemiştir: Kültürel farkındalığın artırılması, çalışan bağlılığın artması ve çalışanlar arasında güvenin oluşturulmasıdır. Kültürel çeşitlilik, işyeri dinamiklerini önemli ölçüde etkiler ve bu da kültürel çeşitliliğin önemini, zorluklarını ve avantajlarını anlamanın gerekliliğini vurgular. Literatürde belirtildiği gibi, iş yerinde kültürel çeşitliliği benimsemek, bireylerin korkmadan otantik benliklerini ifade edebilecekleri bir kabul ortamı yaratır; sonuç olarak bu kapsayıcılık moral ve bağlılığı artırır, çalışanları en iyi çalışmalarını ortaya koymaya teşvik eder, böylece verimliliği ve yenilikçi problem çözmeyi geliştirir (Brett vd. 2011; Cletus vd. 2018). Çeşitli bağlamlarda yaratıcılığı ve yeniliği teşvik etmek için uygun koşullar, iş rutinlerinin yönetimi ve uygun ekiplerin oluşturulmasıyla ilişkilidir. Bu nedenle, özellikle ekibin yaratıcılığı ve problem çözmeyi sistemleştirme yaklaşımı oldukça gelişmişse, optimal olmayan bir yörünge izleme olasılığı azalır. Literatür, çeşitlilik ne kadar fazla olursa, kolektivist yaklaşımın da o kadar fazla olması gerektiğini öne sürmektedir. Kaplan ve Norton'un dengeli puan kartı (1996) ve 360 derece geri bildirim gibi sistemler, yöneticileri kendi inisiyatifleriyle çalışan fikirlerini uygulamaya yetkilendiren ödül sistemleriyle birleştirildiğinde, etkili sonuç elde etmek için gerekli destekleyici altyapıyı oluşturmaya yardımcı olabilmektedir (Bassett-Jones 2005, 173).

Tek başına hareket eden bir bireye kıyasla ekiplerin daha geniş bir bilgi yelpazesine erişimi olması nedeniyle ekip karar verme süreci, bireysel karar alma sürecinden sıklıkla daha etkilidir (Lionel vd., 2018). Çeşitlilik içeren bir ekipte, her üye başkaları tarafından bilinmeyen benzersiz bilgi ve bakış açılarına katkıda bulunur, ancak bu bilginin ekip performansı üzerindeki etkisi etkili paylaşıma bağlıdır. Ek olarak, bilgi entegrasyonu hayati önem taşımaktadır. Ekiplerin çeşitli yorumları birleştirerek ortak

bir anlayış oluşturmasını sağlar. Bu işbirlikçi süreç, ekip üyelerinin iletişimden daha fazla anlam çıkarmasına olanak tanır (Clover, 2018). Aslında, çeşitli geçmişlere, yaşam tarzlarına ve bakış açılarına sahip bireyleri kapsayan, çeşitlilik ve kapsayıcılığı benimseyen bir çalışma ortamı yaratmak, işletme büyümesi ve küresel arenada rekabetçi kalmak için zorunludur.

Şirket liderleri, rekabet gücünü artırmada ve çeşitli organizasyonel hedeflere ulaşmada çeşitliliğin önemini giderek daha fazla anlamaktadır. Birçok şirket, müşteriler, sektör danışmanları, insan kaynakları yöneticileri ve politika yapıcılar gibi paydaşlardan gelen işyerinde adalet ve eşitliği teşvik etme baskısıyla, çeşitliliği teşvik etmek için insan kaynakları geliştirme girişimleri uygulamaktadır (Cook & Glass, 2014).

İşyeri çeşitliliği, işletmelerde çalışanların büyümesini ve kişisel gelişimini teşvik etme potansiyeline sahiptir. Dünya genelinde işletmelerde ve işyerlerinde artan çeşitlilik ışığında, çalışanlar büyüme ve kişisel gelişim yaşayabilirler. Çalışanların çeşitli kültür, görüş ve fikirlerden oluşan bir ortamda bulunmaları, kişisel gelişimlerini ve beceri gelişimlerini teşvik edebilir. Bu nedenle, farklı özelliklere sahip bireyler, yenilikçi fikirler yaratmak ve test etmek için bir platform sağlayabilir (Cheah vd. 2021). Bu görüş, çeşitliliğin işletmelerde sorun giderme ve problem çözme yaklaşımını geliştirdiğini belirten tarafından da paylaşılmaktadır. Çoklu bakış açıları ve yaklaşımlar sonucunda, çalışanlar çeşitli görevleri veya sorunları etkili bir şekilde ele alabilir, sorunları çözebilir ve işyerinde yenilikçi çözümler üretebilirler. Ayrıca, şirketlerde ve işletmelerde çeşitli geçmişlere sahip kişilerin varlığı, çalışanların farklı koşullara uyum sağlama yeteneğini geliştirir. Bu, çalışanın çalışma ortamındaki kişilik, kültür ve geçmiş farklılıklarıyla başa çıkma yeteneğini de artırabilir (Cletus vd. 2018).

İşyeri çeşitliliği, şirketlerin ve işletmelerin potansiyel iş ortakları, işbirlikçileri ve genel olarak toplum için çekiciliğini artırabilir. Yıllar boyunca, işyerindeki çeşitlilik çalışmaları, çeşitli geçmişlere sahip çalışanları işe alan ve bünyesinde tutan firmaların dünya çapında medya, toplum ve hükümetlerden olumlu ilgi gördüğünü göstermiştir. Robinson & Dechant'a (1997) göre, işyeri çeşitliliğini ve kurumsal kapsayıcılığı teşvik eden şirketler, gelecekteki çalışanlar ve müşteriler için çekiciliklerini artırabilir. Benzer şekilde, McKinsey raporu, işyeri çeşitliliğinin çalışan memnuniyetini ve çalışanlar arasındaki çatışmasız ilişkileri artırdığını ortaya koymuştur. Bu, yalnızca iş birliğini ve sadakati değil, aynı zamanda firmanın potansiyel çalışanlar, iş ortakları ve genel olarak toplum için çekiciliğini de artırır (McKinsey Company, 2018). Uzun vadede, insan merkezli bir yaklaşım, şirketlerin ve işletmelerin hedef demografiyi daha iyi anlamalarına ve ürün teslimatını iyileştirmelerine, karı ve müşteri memnuniyetini en üst düzeye çıkarmalarına yardımcı olur (Cletus vd. 2018).

İŞLETMELERDE ÇEŞİTLİLİK ve KAPSAYICILIKLA İLGİLİ ZORLUKLAR

Kuşkusuz, işyerinde kültürel çeşitlilik yaratma konusunda bazı zorlukların ele alınması gerekmektedir. Dil engelleri, iletişim sorunları ve kültürel çatışmalar etkili ekip çalışmasını engelleyebilir. Kalıp yargılar, önyargılar ve bilinçsiz ayrımcılık kapsayıcılığa zarar verebilir (Darby, 2023; Kaplan, 2023). İnovasyonda çeşitliliğin önündeki engeller ve zorluklar, çeşitlilik girişimlerinin işletmelerde uygulanmasında karşılaşılan temel sorunları yansıtmaktadır. Bilinçsiz önyargılar, Greenwald & Banaji (1995) tarafından işe alım ve terfi kararlarını etkileyerek çeşitliliğin sınırlanmasına neden olduğu belirtilmiştir. Değişime direnç, Dobbin ve Kalev (2016) tarafından birçok çeşitlilik programının işletme liderlerinden gelen direnç nedeniyle başarısız olduğu şeklinde ifade edilmiştir. Kapsayıcı liderliğin eksikliği, Nishii (2013) tarafından çeşitli ekiplerin inovasyonda tam potansiyellerine ulaşmasında zorluk yaşadıkları vurgulanmıştır. Ayrıca, işletmelerin D& I girişimlerinin inovasyon ve performans üzerindeki etkisini ölçmede zorlandıkları, bu durumun ilerlemeyi izlemeyi ve somut getirileri göstermeyi zorlaştırdığı belirtilmiştir (Pandey & Pandey, 2025).

Bununla birlikte işletmeler, kültürel yetkinliği teşvik ederek, çeşitlilik eğitimi sağlayarak ve açık diyaloğu teşvik ederek bu zorlukların üstesinden gelebilir (Podsiadlowski vd. 2013). İletişim engellerini azaltmak, işbirliğini teşvik eder ve farklı ekip üyelerinin kendi farklı içgörülerini paylaşmalarına olanak tanır (Sicola, 2024). Bu zorlukların üstesinden daha ayrıntılı olarak gelmek gerekirse, kültürel farklılıkların üstesinden gelmek için çalışan eğitimine yatırım yapmak aynı zamanda rekabet avantajı da sağlayacak bir seçenektir. Bilinçsiz önyargıları ve ön yargıları ele almak, çeşitlilik ve katılıma yönelik kurumsal bir bağlılığı gerektirir (Darby, 2023; Kaplan, 2023). Fırsat eşitliğini savunan ve bilinçsiz önyargı eğitimi sunan politikalar farkındalığı artırmakta ve etkisini hafifletmektedir. Diğer bir çözüm ise yanlış anlamalara ve önyargılara değinmek amacıyla saygılı, açık diyaloglar ve tartışmalar için güvenli alanlar yaratmaktır; bu ekip üyeleri arasında anlayış ve sempatiyi geliştirecektir (Podsiadlowski vd., 2013). Son olarak, farklı bakış açılarına değer veren bir ortamı teşvik etmek için açık iletişim kanalları oluşturmak ve çalışanları kültürel kimliklerini ifade etmeye teşvik etmek de bir çözüm olabilir (Seidman vd. 2015).

Öte yandan farklı bir bağlamda, temel zorluklardan biri, çeşitlilik ve kapsayıcılık girişimlerinin etkisini etkili bir şekilde ölçmenin zorluğudur. Bernini'nin (2023) belirtildiği gibi, D&I çabalarının doğrudan iş sonuçlarını nicelleştirmek karmaşıktır. Geleneksel ölçütler ve temel performans göstergeleri, yenilikçi bir kültürü teşvik etmek, karar alma süreçlerini iyileştirmek ve çalışan memnuniyetini ve sadakatini artırmak gibi bu uygulamaların sunduğu incelikli faydaları yakalamakta genellikle yetersiz kalmaktadır. Bu ölçüm zorluğu, işletmelerin D&I stratejilerinin gerçek etkinliğini değerlendirme ve bu kritik alanlara devam eden veya artırılan yatırımlar için gerekçe oluşturma yeteneğini zorlaştırmaktadır. Etkili D&I girişimlerinin uygulanması, işgücü demografisi, farklı gruplar arasında temsil, çalışan memnuniyeti ve elde tutma oranları dahil olmak üzere çeşitlilik ölçütlerinin titizlikle izlenmesini gerektirir (Kochan vd. 2003). D&I'nin önemine dair artan kabule rağmen, çeşitli paydaşlardan gelen direnç, bu çabalara önemli bir engel teşkil etmektedir. Bu direncin üstesinden gelmek, şeffaf iletişim, paydaşlarla aktif etkileşim ve kapsayıcılık kültürünü geliştirmeye derinden bağlı güçlü bir liderlik gerektirmektedir (Dobbin & Kalev, 2016). Yapısal engelleri ele almak, örtük önyargılarla yüzleşmek ve kültürel dönüşümü yönlendirmek, D&I girişimlerinin başarılı bir şekilde uygulanması ve sürdürülebilirliği için kritik öneme sahiptir. Son araştırmalar, bu yapısal engellerin önemini vurgulamaktadır (Smith & Turner 2015).

Kurumsal kültürlerdeki direnç, D&I uygulamalarının etkin bir şekilde hayata geçirilmesini engelleyebilir. Liderlik desteğinin yetersiz olması, D&I programlarının anlamlı değişiklikler yaratmasında başarısız olmasına neden olabilir. Ayrıca, işletmelar D&I girişimlerinin inovasyon ve performans üzerindeki doğrudan etkisini ölçmede zorluk yaşayabilir. Gerçekten kapsayıcı bir çalışma ortamının oluşturulması, sistemik engellerin ele alınmasını ve açık diyaloğun teşvik edilmesini gerektirir. Bu zorlukların ele alınması, inovasyon ve kurumsal başarı için uzun vadeli faydalar sağlanması amacıyla kapsamlı politikaların, kapsayıcı liderliğin ve D&I girişimlerinin sürekli değerlendirilmesini zorunlu kılar (Pandey & Pandey, 2025; Rothwell vd., 2022).

Öte yandan, çeşitlilik aynı zamanda iş yerinde yanlış anlama, şüphe ve çatışmaya da neden olabilir; bu da devamsızlık, düşük kalite, düşük moral ve rekabet gücü kaybına yol açabilir. Bu nedenle, rekabet avantajı arayan firmalar paradoksal bir durumla karşı karşıyadır. İş gücü çeşitliliğiyle ilişkili avantajlar ve dezavantajlar, işletmeleri paradoksal bir durumu yönetme konumuna getirir (Bassett-Jones 2005, 169).

ÇEŞİTLİLİK, KAPSAYICILIK VE İNOVASYON ETKİLEŞİMİ

Son yıllarda, inovasyonda çeşitlilik, eşitlik ve kapsayıcılığın rolünde önemli bir evrim yaşanmıştır. D&I son yıllarda önemli bir ilgi görmüş olsa da, kökenleri 1960'ların işyeri ayrımcılığını ele almayı amaçlayan pozitif ayrımcılık politikalarına dayanmaktadır. İlk zorluklara rağmen, günümüz işletmeleri yaratıcılığı ve inovasyonu artırmak için kapsayıcı bir kültür oluşturmanın önemini kabul etmektedir (Hewlett vd., 2013). Google, Microsoft ve IBM gibi modern şirketler, inovasyonu teşvik etmek için D&I

girişimlerine büyük yatırımlar yapmıştır (McKinsey & Company, 2020). Raporlar, çeşitli liderliğe sahip şirketlerin rakiplerinden daha iyi performans gösterdiğini ve D&I 'nin problem çözme, ürün geliştirme ve pazar genişlemesini geliştirdiğini göstermektedir. İlk araştırmalar öncelikle çeşitliliğin ekip çalışması üzerindeki etkisini incelerken, son çalışmalar D&I 'nin patent başvuruları, başarılı ürün lansmanları ve mühendislik atılımları gibi inovasyon sonuçları üzerindeki etkisini nicelleştirmeye odaklanmaktadır (Rock & Grant, 2016).

İşletmelerin başarısı, iş ortamındaki değişen trendlere, yenilik yaparak, uyum sağlayarak ve gelişerek tepki vermeye bağlıdır. Dünya genelinde artan çeşitlilikle birlikte, işletmelerin rekabetçi, ilgili ve en iyi uygulamaları sürdürebilmek için çeşitli yetenek havuzundan yararlanmaları gerekmektedir. Bu durum, yenilik için önemli fırsatlar sunar; çünkü farklı geçmişlere sahip çalışanlar genellikle yenilikçi fikirler ve eleştirel düşünmeyi besleyen çeşitli beceri setleriyle gelirler. Bu görüş, "çeşitlilik inovasyonu doğurur ve inovasyon da çeşitliliği doğurur" özdeyişiyle uygun bir şekilde desteklenmektedir. Ayrıca, çok dilli çalışanlar veya farklı sosyokültürel geçmişe sahip işçiler, şirketlerin uluslararası, ulusal, bölgesel ve yerel pazarlara yayılmasında kritik öneme sahiptir. Bu çeşitlilik, müşteri odaklılığın güçlendirilmesine ve hedef pazarlama ile reklamcılık alanlarının iyileştirilmesine katkı sağlayabilir . Çok dillilik ve sosyokültürel becerilerin inovasyonu, kar maksimizasyonunu ve işyeri çekiciliğini artırabileceği düşünülmektedir. Dahası, çalışanların farklı bakış açıları, deneyimleri, kültürü, cinsiyeti ve yaşı, işyerine yeni bir bakış açısı kazandırabilir (Dhuppar, 2015).

McKinsey ve Şirketi'ne göre (2018) inovasyon ve yaratıcılık işyeri çeşitliliği tarafından katalize edilmektedir. Sonuç olarak, problem çözme yaklaşımında, ideolojik bakış açılarında, yenilikçi fikirlerde ve karar vermede önemli bir çeşitlilik vardır (Hospers, 2003). Ayrıca, araştırmalar, çeşitli grupların genellikle ilgili disiplinlerde çalışan sözde uzmanlardan daha iyi performans gösterdiğini ortaya koymuştur. Ayrı bir çalışmada, Yetenek İnovasyon Merkezi, iyileştirilmiş karar verme ile sosyokültürel çeşitlilik arasındaki korelasyonu doğrulamıştır. Çalışma ayrıca, kapsayıcı liderliğin şirketlerin çeşitliliğin faydalarını en üst düzeye çıkarmalarına ve yeniliği engellediği bildirilen homojen işyerlerinin tuzaklarından kaçınmalarına yardımcı olabileceğini vurguladı (Hewlett vd. 2013). Son olarak, işyeri çeşitliliğine yapılan yatırımlar şirketlerin ve işletmelerin karlılığı en üst düzeye çıkarmalarına ve yeniliği beslemelerine yardımcı olur. Zamanla, bu tür şirketlerin finansal kazançları sadece ulusal ortalamalardan daha yüksek olmakla kalmaz, aynı zamanda onları piyasadaki diğerlerinden rekabetçi bir şekilde farklılaştırır (Cletus vd. 2018).

Kültürel çeşitlilik, ürün tasarımına ve geliştirmeye birden fazla bakış açısını entegre ederek küresel pazar rekabetçiliğini artırır. Hofstede (1980), kültürel geçmişlerin problem çözme yaklaşımlarını şekillendirdiğini ve inovasyon dinamiklerini etkilediğini ortaya koymuştur. Rock ve Grant (2016) daha sonra, çok kültürlü ekiplerin küresel pazarlarda homojen ekiplerden daha iyi performans gösterdiğini ve inovasyonda kültürlerarası işbirliğinin rolünü vurgulamıştır.

Bilişsel ve deneyimsel çeşitlilik, demografik çeşitliliğin ötesinde, yeniliği teşvik etmede hayati roller oynar. Mannix ve Neale (2005), çeşitli uzmanlığın mühendislik ve teknolojiyle ilgili alanlarda daha çığır açan patentlere yol açtığını savunmaktadır. Bu, çeşitli kariyer geçmişine sahip çalışanlara sahip işletmelerin daha yenilikçi çözümler ürettiğini vurgulayan Dunn'ın (2020) bulgularıyla örtüşmektedir.

Bilişsel çeşitlilik hipotezi, çeşitli ekiplerin farklı bakış açıları getirdiğini ve yaratıcılığı ve karar verme süreçlerini geliştirdiğini öne sürmektedir. Rock ve Grant (2016) bilişsel çeşitliliğin grupların karmaşık problemleri homojen ekiplerden daha etkili bir şekilde çözmelerini sağladığını savunmaktadır. Benzer şekilde, Mannix ve Neale (2005), farklı düşünme stillerine sahip bireylerin işbirliği yaptığında inovasyonun geliştiğini ve benzersiz çözümlerin geliştirilmesine yol açtığını vurgulamaktadır.

Sosyal Çeşitlilik ve Grup Performansı Cinsiyet, etnik köken ve kültür farklılıkları gibi sosyal çeşitlilik, ekip performansını ve inovasyonu önemli ölçüde etkiler. Hewlett vd. (2013), çeşitli ekiplerin pazar büyümesi bildirme olasılığının %45, yeni pazarlara girme olasılığının ise %70 daha yüksek olduğunu bulmuştur. Çalışmaları, çeşitliliğin uyarlanabilirliği teşvik ederek daha yaratıcı çözümlere yol açtığını doğrulamaktadır. Dahası, Shore vd. (2011), işletmelar çeşitliliğin yanı sıra kapsayıcılığı da teşvik

ettiğinde, çalışanların yenilikçi süreçlere daha etkili bir şekilde katkıda bulunduğunu vurgulamaktadır (Pandey & Pandey, 2025).

Çeşitli eğitim geçmişleri, teknik alanlarda çeşitli uzmanlık ve problem çözme yaklaşımları getirir. Balsmeier ve Pellens (2016), mühendislerden, iş profesyonellerinden ve tasarımcılardan oluşan ekiplerin homojen ekiplere göre daha fazla patent ürettiğini bulmuştur. Dunn (2020), eğitimsel olarak çeşitli ekiplerin çok disiplinli düşünmeyi teşvik ettiğini ve şirketlerin daha bütünsel ve ölçeklenebilir çözümler geliştirmesine olanak sağladığını belirtmektedir.

Arias-Aranda vd. (2001) yılında yapılan bir çalışma, İspanya'daki mühendislik danışmanlığı ve teknoloji hizmetlerinde firma büyüklüğü ile inovasyon derecesi arasındaki ilişkiyi incelemiştir. Çalışmaları, daha büyük firmaların artan kaynaklar, araştırma yetenekleri ve çeşitli yeteneklere erişim sayesinde daha yüksek bir inovasyon derecesi sergilediğini öne sürmüştür. Benzer şekilde, Miles (2008) hizmet sektörlerindeki inovasyon modellerini araştırmış ve hizmet işletmelerinın inovasyon yapma biçimlerinin geleneksel sektörlerden önemli ölçüde farklı olduğunu belirtmiştir. Çalışma, bazı hizmet işletmelerinın yüksek teknoloji üretim firmaları gibi özellikler sergilediğini ve inovasyon yeteneklerini geliştirmek için çeşitliliği ve uzmanlaşmış bilgiyi kullanma becerisi gösterdiğini ortaya koymuştur (Mannix ve Neale; 2005; Pandey & Pandey, 2025).

IBM ve Coca-Cola gibi şirketler, yalnızca azınlık sahipliğindeki işletmeleri desteklemekle kalmayıp aynı zamanda teknolojik ilerlemeleri de yönlendiren tedarikçi çeşitliliği stratejileri uygulamıştır. IBM'in çeşitli tedarikçilerden tedarik etme taahhüdü, bulut bilişim ve yapay zeka geliştirme alanlarında yenilikçi çözümlere yol açarak, D&I ile teknolojik ilerleme arasındaki simbiyotik ilişkiyi vurgulamıştır (Pandey & Pandey, 2025).

Steele & Derven (2015), rekabet avantajı arayan ileri görüşlü liderlerin, D&I ve inovasyonun karşılıklı faydalarından yararlanabileceği sonucuna varılmıştır. D&I, yeni ürünler, hizmetler ve süreçlerin oluşturulması için kullanılarak büyümenin desteklendiği görülmüştür. Aynı zamanda, D&I'ye yönelik yenilikçi yaklaşımlar, mevcut uygulamaların yetersiz kaldığı alanlarda potansiyel göstermiştir.

DEĞERLENDİRME ve ÖNERİLER

Bu araştırma günümüz, işletmelerinin artan çeşitlilik ve mevcut küresel iş ortamı karşısında etkili bir şekilde rekabet edebilmek ve başarılı olabilmek için uyum sağlamaları gerekliliğini ortaya koymaktadır. Çeşitlilik; çalışanların eleştirel düşünme ve problem çözme becerilerini, gelişimini ve büyümesini, farklı güçlü yönlerin birleştirilmesini, kurumsal çekiciliği ve iş yerinde yenilikçi fikir ve becerileri teşvik etmektedir.

Çalışan kapsayıcılığını aktif olarak teşvik etmeyi amaçlayan işletmeler, etkili çalışma ilişkileri ve artan çalışan performansı ve refahı da dahil olmak üzere yüksek güven ortamının köklü faydalarından yararlanabilirler (Downey vd., 2015).

Belirtilen olasılıklara rağmen, modern organizasyonlarda çeşitlilik konusunda çeşitli zorluklar devam etmektedir. Bir organizasyonda çeşitliliği benimseme ve uygulama önündeki doğal engeller, giderek daha rekabetçi hale gelen yerel ve uluslararası iş dünyasında izole olma riskini göze almalarını gerektirmektedir. Artık sadece iş yeri çeşitliliği sorunlarının nasıl çözüleceği değil, mevcut ve yakın gelecekte hangi adımların, programların ve stratejilerin gerekli olduğu sorusu da gündeme gelmektedir. Bu nedenle, şirketlerin kıt yetenek havuzlarından yararlanmak, verimliliği artırmak, pazar payını artırmak ve gelecekteki karları maksimize etmek için ortaya çıkan sorunları ele almak üzere sürdürülebilir bir yol haritası çizmeleri zorunludur. İş yeri çeşitliliğinin ortaya çıkardığı sorunlar ve konular aşağıdaki adımlara bakılarak çözülebilir. (Cletus vd., 2018).

Bir D&I çabasının uygulanması, kurumsal kültürde bir değişim süreci olarak değerlendirilmektedir. D&I çabalarının etkin bir şekilde hayata geçirilmesi, adım adım ve esnek bir yaklaşımın rehberliğinde gerçekleştirilmesiyle kolaylaştırılmaktadır. Bu süreçte, işletmelerin kendi kültürlerini tanımlaması,

kültürün şekillenmesinde çeşitlilik, eşitlik ve katılımın rolünü netleştirmesi, bu değişimi yönlendirecek yetkinin kimde olduğu belirlenmesi, yetenek havuzunun tanımlanması ve geliştirilmesi, duygular ile ilişki dinamiklerinin yönetilmesi, kurumun yeteneklerinin sergilendiği ve teşvik edildiği ortamların oluşturulması, çalışan kaynak gruplarının geliştirilmesi ve süreçlerin düzenli olarak değerlendirilmesi gerekmektedir (Rothwell vd., 2022).

İşletmelerin, bireylerin iş yerindeki önyargılarını iyimser bir şekilde belirleyecek çeşitlilik eğitimleri ve oryantasyon programları aracılığıyla ayrımcılığı daha iyi anlamaları gerekmektedir (Cletus vd., 2018).

Teknoloji ve mühendislik alanlarında inovasyonu yönlendirmede D&I 'nin tüm potansiyelinden yararlanmak için işletmelerin, D&I girişimlerini iş stratejilerine entegre etmeleri, sürekli eğitim ve öğretim uygulamalarıyla bilinçsiz önyargıları ele almaları, net ölçütler ve sorumluluk sistemleriyle ölçülebilir hedefler oluşturmaları ve yapay zeka ile veri analitiği gibi teknolojik araçlardan yararlanarak eşitsizlikleri belirlemeleri, ilerlemeyi izlemeleri ve karar alma süreçlerini bilgilendirmeleri gerekmektedir (Pandey & Pandey, 2025). Bir D&I çabasının başlatılması ve sürdürülmesi, değişim modeline dayalı bir süreç olarak ele alınmalıdır. Bu süreçte, işletmeun kültürünün tanımlanması, kültürün şekillenmesinde çeşitlilik, eşitlik ve katılımın rolünün netleştirilmesi, kültürü değiştirecek yetkinin kimde olduğu belirlenmesi, yetenek havuzunun tanımlanması ve geliştirilmesi, duygular ile ilişki dinamiklerinin yönetilmesi, kurumun yeteneklerinin sergilendiği ve geliştirildiği ortamların oluşturulması, çalışan kaynak gruplarının geliştirilmesi ve süreçlerin düzenli olarak değerlendirilmesi gerekmektedir (Rothwell vd. 2022).

KAYNAKÇA

Amaliyah, A. (2015). The Importance of Workplace Diversity Management. International Journal of Sciences: Basic and Applied Research, 17(2): 175–182.

Anderson, L. (2012). *Federal solutions to ethnic problems: Accommodating diversity*. Routledge.

April, S. and B.L. Cheah. Why workplace diversity is important for every organisation. Career Guide 2013 6th June 2018]; Available from: https://bit.ly/2JweWEY.

Arias-Aranda, D., Minguela-Rata, B., & Rodríguez-Duarte, A. (2001). Innovation and firm size: an empirical study for Spanish engineering consulting companies. *European Journal of Innovation Management*, *4*(3), 133-142.

Atescan-Yuksek, Y., Patsavellas, J., & Salonitis, K. (2024). Strategic implementation of ED&I: unveiling the multifaceted impact on innovation, governance, and ethical conduct in engineering organizations. *Frontiers in Industrial Engineering*, *2*, 1426631.

Balsmeier, B., & Pellens, M. (2016). How much does it cost to be a scientist?. *The Journal of Technology Transfer*, *41*(3), 469-505.

Barak, M. M. (2008). Social psychological perspectives of workforce diversity and inclusion in national and global contexts. *Handbook of human service management*, 239-254.

Bassett-Jones, N. (2005). The paradox of diversity management, creativity and innovation. *Creativity and innovation management*, *14*(2), 169-175.

Bernstein, A., De Vreese, C., Helberger, N., Schulz, W., Zweig, K., Baden, C., ... & Zueger, T. (2020). Diversity in news recommendations. *arXiv preprint arXiv:2005.09495*.

Betters-Reed, B. L., & Moore, L. L. (1992). Managing diversity: Focusing on women and the whitewash dilemma. *Womanpower: Managing in times of demographic turbulence*, 31-58.

Bernini, F., Punturiero, C., Vevey, M., Blanchet, V., Milanesi, R., Delledonne, A., ... & Strillacci, M. G. (2023). Assessing major genes allele frequencies and the genetic diversity of the native Aosta cattle female population. *Italian Journal of Animal Science*, *22*(1), 1008-1022.

Bourke, J. (2016). Which two heads are better than one. *How diverse teams create breakthrough ideas and make smarter decision. Sydney: Australian Institute of Company Directors*.

Castelino, L. M., & Shinde, R. (2023). A review on evolution and importance of diversity education and inclusion in building an effective organizational culture. *International Journal of Case Studies in Business, IT and Education (IJCSBE)*, *7*(3), 62-89.

Chataway, J., Hanlin, R., & Kaplinsky, R. (2014). Inclusive innovation: an architecture for policy development. *Innovation and Development*, *4*(1), 33-54.

Cheah, I., Teah, M., Lee, S., & Davies, Z. (2021). Straight eye for the queer ad: attitudes, skepticism, inferences of manipulative intent and willingness to buy. *Asia Pacific Journal of Marketing and Logistics*, *33*(5), 1220-1238.

Christian, J., L.W. Porter, and G. Moffitt. (2006). Workplace diversity and group relations: An overview. Group Processes & Intergroup Relations, 9(4): 459-466.

Cletus, H. E., Mahmood, N. A., Umar, A., & Ibrahim, A. D. (2018). Prospects and challenges of workplace diversity in modern day organizations: A critical review. *Holistica Journal of Business and Public Administration*, *9*(2), 35-52.

Clover, D. (2018). Belonging: exploring students' ideas around belonging, comfort and discomfort in library and learning spaces.

Cook, A., & Glass, C. (2014). Do diversity reputation signals increase share value?. *Human Resource Development Quarterly*, *25*(4), 471-491.

Cornel, M. C., Rigter, T., Jansen, M. E., & Henneman, L. (2021). Neonatal and carrier screening for rare diseases: how innovation challenges screening criteria worldwide. *Journal of community genetics*, *12*(2), 257-265.

Cox, T. H., & Blake, S. (1991). Managing cultural diversity: Implications for organizational competitiveness. *Academy of Management perspectives*, *5*(3), 45-56.

Darby, P., & Jeffreson, R. (2023). Beyond the binary: Sex and gender diversity in population projections. *Statistical Journal of the IAOS*, *39*(3), 575-581.

Dhuppar, S. (2015). Managing Workplace Diversity Challenges and Strategies. International Journal of Research, 2(3): 346-351.

Dike, P. (2013). The impact of workplace diversity on organisations. Department of International Business, PhD: 59.

Dixon-Fyle, S., Huber, C., del Mar Martinez Marquez, M., Prince, S., & Thomas, A. (2023). Diversity matters even more: The case for holistic impact. *McKinsey & Company*.

Dobbin, F., & Kalev, A. (2016). Why diversity programs fail. *Harvard Business Review*, *94*(7), 14.

Downey, S. N., Van der Werff, L., Thomas, K. M., & Plaut, V. C. (2015). The role of diversity practices and inclusion in promoting trust and employee engagement. *Journal of Applied Social Psychology*, *45*(1), 35-44.

Emma, L. Advantages and Disadvantages of Diversity in Workplace. Workplace Diversity 2018 06 June 2018]; Available from: https://bit.ly/1jdaWY0

Ferdman, B. M., & Sagiv, L. (2012). Diversity in organizations and cross-cultural work psychology: What if they were more connected?. *Industrial and Organizational Psychology*, *5*(3), 323-345.

Fine, C., & Sojo, V. (2019). Women's value: beyond the business case for diversity and inclusion. *The Lancet*, *393*(10171), 515-516.

Garg, S., & Sangwan, S. (2021). Literature review on diversity and inclusion at workplace, 2010–2017. *Vision*, *25*(1), 12-22.

Greenwald, A. G., & Banaji, M. R. (1995). Implicit social cognition: attitudes, self-esteem, and stereotypes. *Psychological review*, *102*(1), 4.

Hays-Thomas, R., & Bendick Jr, M. (2013). Professionalizing diversity and inclusion practice: Should voluntary standards be the chicken or the egg?. *Industrial and Organizational Psychology*, *6*(3), 193-205.

Hekkert, M. P., Janssen, M. J., Wesseling, J. H., & Negro, S. O. (2020). Mission-oriented innovation systems. *Environmental innovation and societal transitions*, *34*, 76-79.

Hemmert, M., Cho, C. K., & Lee, J. Y. (2024). Enhancing innovation through gender diversity: a two-country study of top management teams. *European Journal of Innovation Management*, *27*(1), 193-213.

Hewlett, S.A., T. Sears, K. Sumberg, and C. Fargnoli. (2013). The Power of "Out" 2.0: LGBT in the Workplace. Center for Talent Innovation: 30.

Hofstede, G. (1980). Culture and organizations. *International studies of management & organization*, *10*(4), 15-41.

Hospers, G.-J. (2003). Creative cities: Breeding places in the knowledge economy. Knowledge, Technology & Policy, 16(3): 143-162.

Hunt, V., Layton, D., & Prince, S. (2015). Diversity matters. *McKinsey & Company*, *1*(1), 15-29.

Hunt, V., Prince, S., Dixon-Fyle, S., & Yee, L. (2018). Delivering through diversity.

Jain, S., & Lobo, R. (2012). Diversity and inclusion: a business imperative in global professional services. In *Globalization of Professional Services: Innovative Strategies, Successful Processes, Inspired Talent Management, and First-Hand Experiences* (pp. 181-187). Berlin, Heidelberg: Springer Berlin Heidelberg.

Kalliomäki, H., Oinas, P., & Salo, T. (2024). Innovation districts as strategic urban projects: the emergence of strategic spatial planning for urban innovation. *European Planning Studies*, *32*(1), 78-96.

Kaplan, R. S., & Norton, D. P. (1996). Linking the balanced scorecard to strategy. *California management review*, *39*(1), 53-79.

Kaplan, G., & Celik, P. (2023, October). Intersectionality of disability and cultural/linguistic diversity in the UK: a literature review. In *Frontiers in Education* (Vol. 8, p. 1239777). Frontiers Media SA.

Kapoor, C. (2011). Defining diversity: The evolution of diversity. *Worldwide Hospitality and Tourism Themes*, *3*(4), 284-293.

Kattel, R., McLaren, J., Sari, V. A., & Maldonado, M. (2023). An equitable, inclusive and diverse innovation system in the UK Towards a mission-oriented framework for No Limits.

Kaur, N., & Arora, P. (2020). Acknowledging gender diversity and inclusion as key to organizational growth: A review and trends. *Journal of critical reviews*, *7*(6), 125-131.

Kirton, G., Greene, A. M., & Dean, D. (2007). British diversity professionals as change agents–radicals, tempered radicals or liberal reformers?. *The International Journal of Human Resource Management*, *18*(11), 1979-1994.

Lirio, P., Lee, M. D., Williams, M. L., Haugen, L. K., & Kossek, E. E. (2008). The inclusion challenge with reduced-load professionals: The role of the manager. *Human Resource Management: Published in Cooperation with the School of Business Administration, The University of Michigan and in alliance with the Society of Human Resources Management*, *47*(3), 443-461.

Loewe, P., & Dominiquini, J. (2006). Overcoming the barriers to effective innovation. *Strategy & leadership*, *34*(1), 24-31.

Mannix, E., & Neale, M. A. (2005). What differences make a difference? The promise and reality of diverse teams in organizations. *Psychological science in the public interest*, *6*(2), 31-55.

Mazzucato, M. (2017). Mission-oriented innovation policy: challenges and opportunities.

Mazzucato, M., & Dibb, G. (2019). Missions: A beginner's guide.

McKinsey and Company. Why diversity matters. McKinsey Insights 2018 [cited 2018 6th June]; Available from: https://mck.co/2lvVXjd.

McKinsey & Company. (2023). Global Parity Alliance: Diversity, Equity and Inclusion Lighthouses 2023. Retrieved from https://www3.weforum.org/docs/WEF Global ParityAlliance 2023.pdf

Miles, I. (2008). Patterns of innovation in service industries. *IBM Systems journal*, *47*(1), 115-128.

Nair, N., & Vohra, N. (2015). Diversity and inclusion at the workplace: a review of research and perspectives.

Nathan, M., & Lee, N. (2013). Cultural diversity, innovation, and entrepreneurship: firm-level evidence from London. *Economic geography*, *89*(4), 367-394.

Norbash, A., & Kadom, N. (2020). The business case for diversity and inclusion. *Journal of the American College of Radiology*, *17*(5), 676-680.

Oswick, C., & Noon, M. (2014). Discourses of diversity, equality and inclusion: trenchant formulations or transient fashions?. *British Journal of Management*, *25*(1), 23-39.

Otten, R., Faughnan, M., Flattley, M., & Fleurinor, S. (2022). Integrating equity, diversity, and inclusion into social innovation education: a case study of critical service-learning. *Social Enterprise Journal*, *18*(1), 182-200.

Pandey, P., & Pandey, S. (2025). The influence of diversity on innovation in technology and engineering.

Patrick, H.A. and V.R. Kumar. (2012). Managing workplace diversity: Issues and challenges. Sage Open, 2(2): 2158244012444615.

Pelled, L. H., Eisenhardt, K. M., & Xin, K. R. (1999). Exploring the black box: An analysis of work group diversity, conflict and performance. *Administrative science quarterly*, *44*(1), 1-28.

Podsiadlowski, A., Gröschke, D., Kogler, M., Springer, C., & Van Der Zee, K. (2013). Managing a culturally diverse workforce: Diversity perspectives in organizations. *International Journal of Intercultural Relations*, *37*(2), 159-175.

Prasad, R., Gupta, V. K., & Kumar, A. (2004). Metallo-tetraazaporphyrin based anion sensors: regulation of sensor characteristics through central metal ion coordination. *Analytica Chimica Acta*, *508*(1), 61-70.

Purdie-Vaughns, V., Steele, C. M., Davies, P. G., Ditlmann, R., & Crosby, J. R. (2008). Social identity contingencies: how diversity cues signal threat or safety for African Americans in mainstream institutions. *Journal of personality and social psychology*, *94*(4), 615.

Roberson, Q. M. (2006). Disentangling the meanings of diversity and inclusion in organizations. *Group & organization management*, *31*(2), 212-236.

Robinson, G. and K. Dechant. (1997). Building a business case for diversity. The academy of management executive, 11(3): 21-31.

Rock, D., Grant, H., & Grey, J. (2016). Diverse teams feel less comfortable—and that's why they perform better. *Harvard Business Review*, *95*(9), 22.

Rothwell, W. J., Ealy, P. L., & Campbell, J. (Eds.). (2022). *Rethinking organizational diversity, equity, and inclusion: A step-by-step guide for facilitating effective change*. CRC Press.

Sabharwal, M. (2015). Book Review: Cultural Competency for Public Administrators.

Shore, L. M., Randel, A. E., Chung, B. G., Dean, M. A., Holcombe Ehrhart, K., & Singh, G. (2011). Inclusion and diversity in work groups: A review and model for future research. *Journal of management*, *37*(4), 1262-1289.

Schot, J., & Steinmueller, W. E. (2018). Three frames for innovation policy: R&D, systems of innovation and transformative change. *Research policy*, *47*(9), 1554-1567.

Seidman, M., Flanagan, M., & Kaufman, G. (2015, January). Failed Games: Lessons Learned from Promising but Problematic Game Prototypes in Designing for Diversity. In *Proceedings of DiGRA 2015 Conference*.

Sicola, V. (2024). Analysis of the benefits of diversity and inclusion in organizations.

Shrader, C. B., Blackburn, V. B., & Iles, P. (1997). Women in management and firm financial performance: An exploratory study. *Journal of managerial issues*, 355-372.

Souza, N. P. R., & Gama, K. (2020). Diversity and inclusion: Culture and perception in information technology companies. *IEEE Revista Iberoamericana de Tecnologias del Aprendizaje*, *15*(4), 352-361.

Smith, C., & Turner, S. (2015). The radical transformation of diversity and inclusion: The millennial influence. *Deloitte University*.

Steele, R., & Derven, M. (2015). Diversity & Inclusion and innovation: a virtuous cycle. *Industrial and Commercial Training*, *47*(1), 1-7.

Thomas, D. A., & Ely, R. J. (1996). Making differences matter. *Harvard business review*, *74*(5), 79-90.

Wentling, R. M., & Palma-Rivas, N. (2000). Current status of diversity initiatives in selected multinational corporations. *Human Resource Development Quarterly*, *11*(1), 35-60.

Wittmann, F., Hufnagl, M., Lindner, R., Roth, F., & Edler, J. (2021). Governing varieties of mission-oriented innovation policies: A new typology. *Science and Public Policy*, *48*(5), 727-738.

van de Voorde, T. F., van der Putten, W. H., & Bezemer, T. M. (2012). Soil inoculation method determines the strength of plant–soil interactions. *Soil Biology and Biochemistry*, *55*, 1-6.

Van Ewijk, A. R. (2011). Diversity and diversity policy: diving into fundamental differences. *Journal of Organizational Change Management*, *24*(5), 680-694.

Vorley, T., Lawton Smith, H., Coogan, T., Owalla, B., & Wing, K. (2020). Supporting diversity and inclusion in innovation. *Innovation Caucus*.

NUMERICAL MODAL ANALYSIS OF CARBONFIBER BICYCLE FRAME REINFORCED WITH POLYURETHANE FOAM

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ABSTRACT

This study investigates the effect of Polyurethane (PU) Foam infill reinforcement on the natural frequencies and damping ratios of a Carbon Fiber (CF) composite bicycle frame, aiming to analyze the dynamic behavior of modern racing bicycle frames. The methodology involved first creating a three-dimensional solid model of the racing bicycle frame using SolidWorks software, followed by performing modal analysis under free-free boundary conditions using ANSYS Workbench. The analysis comprised two main scenarios: (1) The reference Carbon Fiber frame, and (2) The reinforced frame with Polyurethane Foam infill added inside the Carbon Fiber frame profiles. The hybrid structure exhibited an upward shift in the natural frequencies ranging from 0.50% to 9.18% across the first six modes, despite the added mass. This confirms that the structural stiffening provided by the core outperforms the inertial effect. The fundamental natural frequency was established at 84.03 Hz, which remains significantly higher than the primary excitation frequency of pedaling cadence. The damping ratios were estimated utilizing the Modal Strain Energy (MSE) method, assigning constant loss factors of $\eta_{CF} = 0.005$ and $\eta_{PU} = 0.5$ to the respective domains. The results indicate that the integration of the foam core yields a non-linear improvement in damping performance, dependent on the strain energy distribution. While the fundamental mode showed a marginal damping increase, higher-order modes exhibiting significant shear deformation, specifically Modes 3 and 5, demonstrated damping ratios of 1.13% and 1.21%, respectively. These findings underscore the potential of lightweight reinforcement materials like foam infill to not only influence the mass-to-stiffness ratio in frame design but also to potentially enhance riding comfort through increased damping.

Keywords: Racing Bicycle Frame, Carbon Fiber, Polyurethane Foam, Modal Analysis, Modal Strain Energy, Finite Element Analysis.

INTRODUCTION

The design of road racing bicycles is one of the most challenging areas of modern engineering, as it aims to simultaneously meet conflicting performance requirements such as lightness, stiffness, and riding comfort (Lauda & Donadon, 2011). The frame is central to these requirements and plays a crucial role in efficiently transferring pedal force to the wheels (Mahadev et al., 2022; Suthahar et al., 2023). Therefore, a detailed analysis of the static and dynamic loads (pedaling cycle, road impacts, braking) acting on the frame is vital for product safety and athlete performance (Akhyar et al., 2019; Covill et al., 2016; Huňady & Beliško, 2015; Satrijo et al., 2022).

In the literature, Finite Element Analysis (FEA) is widely used to investigate the structural behavior of bicycle frames (Kumar Mishra & Chaturvedi, 2021; Satrijo et al., 2022). Studies have determined the stress distribution (von-Mises) and maximum displacement amounts (ranging from 0.018 to 0.23 mm) of the frame under various loading conditions, including static start-up, steady-state pedaling, and vertical/horizontal loading (Akhyar et al., 2019; İnce & Gül, 2023). Specifically, the seat beam and joint points have been identified as critical regions subjected to the highest stresses (Akhyar et al., 2019; Bulej et al., 2022; Satrijo et al., 2022).

Material selection is another significant factor directly affecting frame performance. Carbon fiber composites have become the dominant material in modern racing bicycles due to their superior strength-to-weight ratio, high fatigue life, and the advantage of being shaped aerodynamically (Mahadev et al.,

2022; Mahanthesh et al., 2018). Nevertheless, conventional materials (aluminum alloys and steel) continue to be explored for their cost-effectiveness and durability (Crequy et al., 2016; Suthahar et al., 2023). Furthermore, some research has explored the potential of Aluminum matrix composites (SiC reinforced) or Titanium alloys (Panchal & Sunil, 2022; Suthahar et al., 2023).

Modal analysis is a critical tool for evaluating dynamic performance and riding comfort (Deshpande & Gaikwad, 2016; Mahanthesh et al., 2018). Determining the natural frequencies of the structure is essential to prevent potential resonance conditions caused by external excitation frequencies (road surface vibrations and cadence) acting on the bicycle-rider system. Studies in this field indicate that frame frequencies are much higher than the excitation frequencies (1.5–2.5 Hz) and generally range above 80–100 Hz (Mahanthesh et al., 2018; Sani et al., 2016). For example, one study identified modes in the 5–50 Hz range for an aluminum/carbon-fork bicycle, emphasizing that speed and rider mass significantly influence the natural frequencies (Crequy et al., 2016).

In this study, the dynamic effect of polyurethane foam reinforcement added inside the frame profiles is investigated while maintaining the structural advantages provided by carbon fiber. The potential of foam infills to improve damping properties with their low density makes such reinforcement studies valuable. Within this scope, the first six vibration modes of the carbon fiber frame model, designed in the SolidWorks environment, were analyzed under free-free boundary conditions using ANSYS Workbench. The numerical effects of the foam reinforcement on the natural frequencies and the dynamic behavior of a hybrid structure. The modal damping ratios were calculated using the Modal Strain Energy (MSE) method, which relates the global damping of the system to the proportion of elastic strain energy stored in each constituent material. This work contributes to the literature by quantitatively demonstrating the effect of added mass on the structural stiffness-to-mass ratio in bicycle frame design.

MATERIALS AND METHOD

In the preliminary stage of the study, the geometric architecture of the bicycle frame was established for subsequent analysis. A detailed three-dimensional (3D) solid model was constructed using the SolidWorks software suite, adhering to the widely accepted design conventions of the commercial road racing market. The resulting geometry was configured to represent a prototypical performance bicycle, meticulously replicating standard specifications such as tube cross-sections, angular configurations, and macroscopic dimensions (Figure 1). Thickness of the frame is 2 mm.

The modal analysis was conducted on two distinct frame variations to assess the impact of structural reinforcement. The initial scenario, labelled the **Reference Case**, utilized standard Carbon Fiber composite material properties to simulate a typical professional racing frame. The subsequent scenario, the **Reinforced Case**, incorporated Polyurethane (PU) Foam as an infill material within the frame's tubular sections (Figure 2). This approach was strategically adopted to potentially improve the frame's damping capabilities and dynamic behavior without significantly compromising its lightweight characteristics. The total mass of the hybrid system is dominated by the carbon fiber structure (0.96 kg) while the PU foam layer contributes only 0.062 kg. This configuration results in a foam-to-substrate mass ratio of approximately 0.065, indicating a minimal weight addition to the primary structure. The mechanical properties for both the carbon fiber and polyurethane foam materials used in these simulations are presented in Table 1.

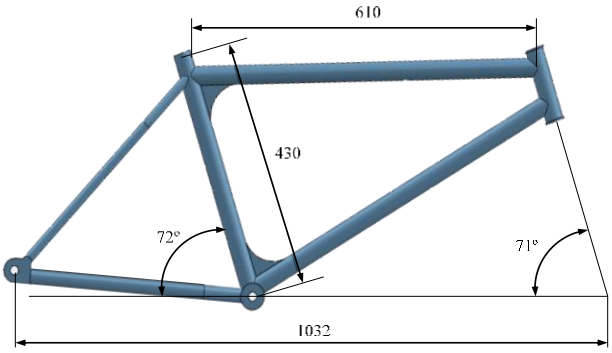


Figure 1. Designed bicycle frame and its physical dimensions (units in mm)

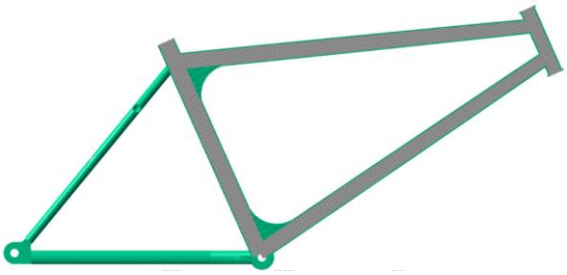


Figure 2. CF frame (green) and PU foam infill (gray, dotted) hybrid structure

Table 1. Material properties of CF and PU Foam material

Parameters	CF	PU Foam
Young's modulus, E_x(GPa)	230	0.01
Young's modulus, E_y(GPa)	230	0.01
Young's modulus, E_z(GPa)	12	0.01
Shear modulus G_{xy}(GPa)	9	0.003
Shear modulus G_{yz}(GPa)	9	0.003
Shear modulus G_{xz}(GPa)	3.6	0.003
Poisson's ratio, υ_{xy}	0.40	0.45
Poisson's ratio, υ_{yz}	0.20	0.32
Poisson's ratio, υ_{xz}	0.20	0.32
Density, ρ (kg/m^3)	1800	60

Finite Element Analysis (FEA) was performed to investigate the dynamic characteristics of both modeling scenarios. The analyses were carried out using the Modal Analysis Module of ANSYS Workbench, a widely utilized commercial FEA software package. The 3D solid geometry created after

modeling was discretized into three-dimensional (tetrahedral) finite elements with an appropriate resolution for FEA. Careful attention was paid to the selection of a suitable mesh density to maintain analysis accuracy and optimize computational time. The finite element model consisted of 43,524 nodes and 21,687 SOLID187 elements, providing a sufficiently refined mesh for accurately capturing the structural response (Figure 3).

Free-free boundary conditions were adopted to determine the structure's natural dynamic behavior, independent of its attachment points (saddle, handlebars, wheels). This approach provides the genuine structural vibration characteristics of the frame, decoupled from the influence of other system components. As a result of the analysis, the first six natural frequencies and their corresponding mode shapes, which characterize the dynamic response of the frame, were calculated for both scenarios.

Figure 3. Bicycle Frame Mesh Structure

The damping characteristics of each constituent material (CF and PU foam) were evaluated using the Modal Strain Energy (MSE) approach in ANSYS. The strain energy contribution of each material for the selected mode shapes was extracted through a customized APDL script, which automated the element-based energy summation process. Subsequently, the modal damping ratios were computed using the standard MSE formulation, incorporating the material-specific strain energy distributions obtained from the finite element model. This procedure enabled a quantitative assessment of the individual material contributions to the overall modal damping behavior of the structure.

RESULTS AND DISCUSSIONS

The analysis results clearly demonstrate the effect of polyurethane foam reinforcement on the dynamic behavior of the bicycle frame. The natural frequency values of mechanical structures are directly related to the structure's mass and stiffness properties (Eq. 1). Even the smallest change in mass and stiffness directly alters the natural frequencies, consequently affecting the dynamic characteristics of the structure.

$$\omega = \sqrt{\frac{k}{m}} \tag{1}$$

In Equation 1, ω, k, and m represent the natural frequency (rad/s), stiffness (N/m), and mass (kg), respectively. It is clear that an increase in mass or a decrease in stiffness has a reducing effect on the natural frequency values.

Table 2. Natural frequencies of the bicycle frame with and without PU foam reinforcement

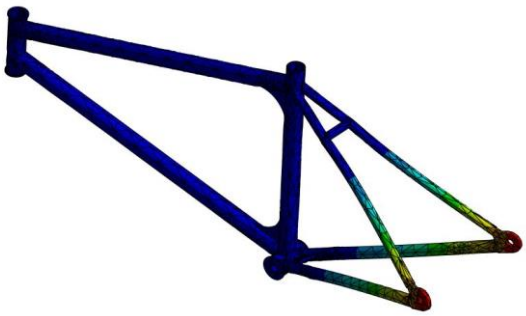
Mode	Natural Frequencies (Hz)		
	CF Frame	CF Frame with PU Foam	Difference (%)
1	83.612	84.032	0.50%
2	94.087	96.32	2.37%

3	237.91	259.76	9.18%
4	314.47	324.21	3.10%
5	371.95	398.14	7.04%
6	406.97	416.46	2.33%

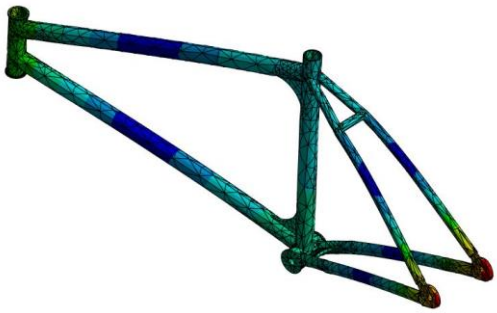
The change in natural frequencies for the carbon fiber bicycle frame before and after polyurethane foam reinforcement is clearly presented in **Hata! Başvuru kaynağı bulunamadı.**. The comparative analysis of the natural frequencies between the pure Carbon Fiber (CF) frame and the CF/PU Foam hybrid frame reveals a consistent upward shift across all first six modes. Despite the introduction of additional mass from the PU foam (≈ 6.5% mass increase), the natural frequencies increased by a range of 0.50% to 9.18%. From a structural dynamics perspective, the natural frequency is governed by the relationship given in Eq. 1. Typically, adding non-structural mass to a system reduces its natural frequency. However, the observed increase in frequencies indicates that the stiffness augmentation (k) provided by the foam core significantly outweighs the inertial penalty (m) of the added material. The foam core likely acts to prevent local buckling or cross-sectional distortion, thereby increasing the effective structural rigidity of the frame members.

The fundamental mode shows a negligible increase of 0.50% ($83.61\ Hz \rightarrow 84.03\ Hz$). This suggests that for the first mode (likely a global bending mode), the foam core is located near the neutral axis or regions of low strain, contributing minimal additional stiffness relative to the added mass. A substantial increase is observed in Mode 3 (9.18%) and Mode 5 (7.04%). This nonlinear jump suggests that these specific mode shapes involve complex deformations—such as torsion or thin-wall breathing—where the internal support of the foam core is most effective. In these modes, the foam effectively couples the carbon fiber walls, preventing relative motion and significantly enhancing the cross-sectional moment of inertia.

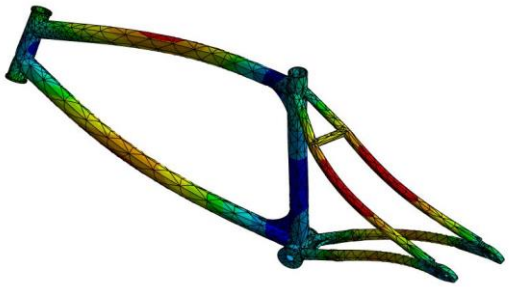
The vibration mode shapes corresponding to each calculated natural frequency value for free vibrations were also analyzed. The obtained mode shapes include both bending and torsional vibrations, and the analyzed mode shapes are given sequentially in Figure 4.



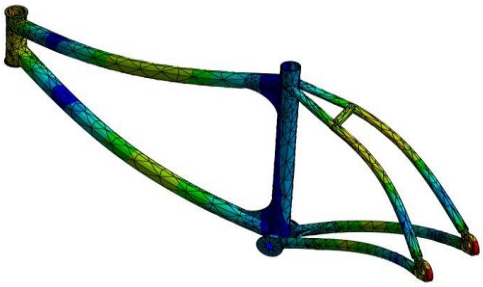
Mode 1



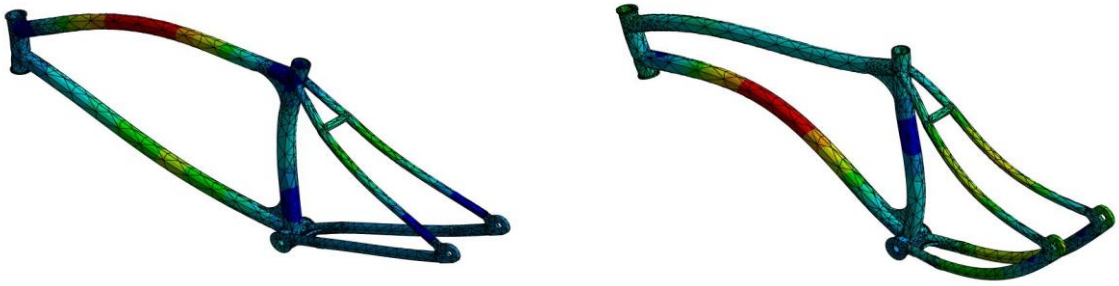
Mode 2



Mode 3



Mode 4



Mode 5 Mode 6

Figure 4. Vibration mode shapes of the bicycle frame

The primary excitation frequency for racing bicycles originates from the cadence (approximately 1.5–2.5 Hz). The obtained natural frequency values (83 Hz and above) are far removed from these excitation frequencies, confirming that the risk of resonance is extremely low. Furthermore, the observed increase in natural frequencies with the inclusion of PU foam further widens the gap between the operational excitation and the structural modes, thereby enhancing the dynamic stability of the frame.

The Modal Strain Energy (MSE) method is a widely adopted approximation in Finite Element Analysis (FEA) for estimating the modal damping ratios of composite or hybrid structures. It relies on the principle that the global damping of a system is the weighted average of the damping capacities of its constituent materials, weighted by the elastic strain energy stored in each material.

For a given vibration mode r, the system's equivalent loss factor, η_{sys}^{r}, is calculated as (Bisagni & Catapano, 2013):

$$\eta_{sys}^{r} = \frac{\sum_{i=1}^{n} \eta_i U_i^r}{U_{total}^r} \tag{2}$$

Where i is the index representing the distinct material regions or element groups within the model. η_i is the material loss factor) i-th component. U_i^r is the elastic strain energy stored specifically within the i-th material component during the deformation of mode r. U_{total}^r is the summation of strain energies stored in all components of the system for that specific mode. The damping ratio (ξ) is defined as half of the system loss factor.

$$\xi = \frac{\eta_{sys}}{2} \tag{3}$$

In this study frequency-independent material loss factors were assumed for all modes, with values set at $\eta_{CF} = 0.005$ (Li et al., 2017) for CF and $\eta_{PU\ Foam} = 0.50$ (Liang et al., 2020) for PU foam. Therefore, damping ratios for all modes for CF is 0.0025 and for PU foam is 0.25. The strain energies obtained from ANSYS for the hybrid structure is given in Table 3. The computed damping ratios of the hybrid structure are presented in Table 4.

Table 3. Strain energies of the CF and PU foam obtained from ANSYS

MODE	Strain Energy (J)	Material
1	1.39E+05	CF
1	1.68E+02	PU Foam
2	1.80E+05	CF
2	3.05E+03	PU Foam
3	1.29E+06	CF
3	4.73E+04	PU Foam
4	2.04E+06	CF
4	3.69E+04	PU Foam

5	3.01E+06	CF
5	1.21E+05	PU Foam
6	3.37E+06	CF
6	5.65E+04	PU Foam

While the reference CF structure exhibits a constant natural damping ratio of $\zeta = 0.25\%$ across all modes, the integration of PU foam resulted in damping ratios ranging from 0.28% to 1.21% for the first six modes. Although the loss factor of the PU foam ($\eta = 0.5$) is two orders of magnitude (100 times) higher than that of the carbon fiber, the global damping ratios of the hybrid system do not approach the intrinsic damping level of the foam (25%). This phenomenon is primarily attributed to the high modulus of elasticity of the CF. Due to the high stiffness of the carbon fiber, the vast majority of the strain energy (typically >95%) is stored within the low-damping carbon layers. The PU foam, being a compliant (low-stiffness) material, stores a relatively small fraction of the total strain energy, thereby limiting its contribution to the global damping ratio.

Table 4. Calculated damping ratios

Mode	Damping Ratio (ξ)
1	0.28%
2	0.66%
3	1.13%
4	0.69%
5	1.21%
6	0.66%

The results indicate a strong dependency on mode shapes, with significant variations in damping efficiency (e.g., Mode 1: 0.28% vs. Mode 5: 1.21%). The result of 0.28%, which is marginally higher than the reference value, suggests that this specific mode shape is dominated by the carbon fiber's deformation. The foam layer likely undergoes minimal strain (insufficient shear deformation) in this mode. The substantial increase in damping ratios for the 3rd (1.13%) and 5th (1.21%) modes indicates that the foam layer plays a more active role in these mode shapes. It is inferred that these modes induce significant shear deformation within the viscoelastic foam layer, allowing the material to dissipate energy more efficiently.

CONCLUSION AND DISCUSSION

This study investigated the dynamic effect of applying polyurethane foam reinforcement to a carbon fiber racing bicycle frame using SolidWorks and ANSYS Workbench. The results of the modal analysis, performed under free-free boundary conditions, can be summarized as follows:

- The introduction of the PU foam core resulted in a consistent increase in natural frequencies across all analyzed modes, ranging from 0.50% for the first mode to 9.18% for the third mode. This upward shift indicates that the geometric stiffening provided by the core—which prevents local cross-sectional distortions—outweighs the inertial penalty of the added mass (0.062 kg). Consequently, the hybrid frame maintains a superior stiffness-to-mass ratio compared to the pure carbon frame, effectively widening the gap between operational excitation frequencies and structural resonances.
- Application of the Modal Strain Energy (MSE) method revealed that the global damping ratio is governed by the distribution of strain energy between the stiff carbon frame and the PU foam core. Although the foam possesses a high loss factor ($\eta = 0.5$), the global damping did not reach the theoretical limit of the core material due to the high stiffness of the carbon fiber, which stores the majority of the strain energy. However, for mode shapes inducing significant shear strain within the core (e.g., Mode 5), the foam's strain energy contribution increased significantly (1.21×10^5), resulting in a nearly 4.8-fold increase in the damping ratio compared to the reference frame.

- The study confirms that the hybrid configuration offers a highly efficient trade-off. With a minimal weight increase of approximately 6.5%, the structure achieves significant gains in both static stability (buckling resistance implied by frequency increase) and energy dissipation capability. The results suggest that for optimal vibration control, the placement of the viscoelastic material should be strategically targeted at regions experiencing maximum shear deformation during critical vibration modes.

This work quantitatively demonstrates the effect of lightweight reinforcement materials on frame dynamics. For future studies, the final effect of the foam infill on riding comfort could be investigated by experimentally determining the damping coefficient of the foam core.

REFERENCES

Akhyar, Husaini, Iskandar, H., & Ahmad, F. (2019). Structural simulations of bicycle frame behaviour under various load conditions. *Materials Science Forum*, *961 MSF*. https://doi.org/10.4028/www.scientific.net/MSF.961.137

Bisagni, C., & Catapano, E. (2013, April 8). Strain Energy Method to Model Composite Structures Damping. *54th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference*. https://doi.org/10.2514/6.2013-1760

Bulej, V., Kuric, I., Sága, M., Vaško, M., Ságová, Z., Bartoš, M., & Legutko, S. (2022). Analysis of Symmetrical/Asymmetrical Loading Influence of the Full-Suspension Downhill Bicycle's Frame on the Crack Failure Formation at a Critical Point during Different Driving Scenarios and Design Improvement. *Symmetry*, *14*(2). https://doi.org/10.3390/sym14020255

Covill, D., Allard, P., Drouet, J. M., & Emerson, N. (2016). An Assessment of Bicycle Frame Behaviour under Various Load Conditions Using Numerical Simulations. *Procedia Engineering*, *147*. https://doi.org/10.1016/j.proeng.2016.06.269

Crequy, S., Chiementin, X., & Kouroussis, G. (2016, November). Operational modal analysis during cycling. *5ième Colloque "Analyse Vibratoire Expérimentale"*.

Deshpande, A. , & Gaikwad, A. B. (2016). Design and Optimization of Bicycle Frame for the Cyclist's Comfort. *International Journal on Recent and Innovation Trends in Computing and Communication*, *4*(5), 220–224.

Huňady, R., & Beliško, M. (2015). Structural Design and Impact Test of a Suspension Mountain Bicycle Frame by Using FEM Analysis. *American Journal of Mechanical Engineering*, *3*(6).

İnce, K., & Gül, O. (2023). Bicycle Frame Design And Structural Analysis. *International Conference on Applied Engineering and Natural Sciences*, *1*(1). https://doi.org/10.59287/icaens.1081

Kumar Mishra, K., & Chaturvedi, V. (2021). Stress Analysis of Bicycle Frame Using Ansys. *International Research Journal of Engineering and Technology*, *May*.

Lauda, D. P., & Donadon, M. V. (2011). Carbon Fiber Bicycle Frame Analysis Using Finite Element Modeling. *21st Brazilian Congress of Mechanical Engineering*.

Li, H., Niu, Y., Mu, C., & Wen, B. (2017). Identification of Loss Factor of Fiber-Reinforced Composite Based on Complex Modulus Method. *Shock and Vibration*, *2017*(1), 6395739. https://doi.org/https://doi.org/10.1155/2017/6395739

Liang, L., Huang, W., Lyu, P., Ma, M., Meng, F., & Sang, Y. (2020). Impacts of PU Foam Stand-Off Layer on the Vibration Damping Performance of Stand-Off Free Layer Damping Cantilever Beams. *Shock and Vibration*, *2020*(1), 8871562. https://doi.org/https://doi.org/10.1155/2020/8871562

Mahadev, Gowda, N., D, P., & B K, V. (2022). Modelling and structural analysis of bicycle frame using FEA for different materials. *Journal of Mines, Metals and Fuels*. https://doi.org/10.18311/jmmf/2021/30110

Mahanthesh, M. R., Prashanth, R. K., & Kirankumar, N. A. (2018). Numerical Analysis for a Bicycle Frame made of Mild Steel and Composite. *IJRTI*, *4*(3), 40–46.

Panchal, D. , & Sunil, L. (2022). Finite element analysis of the classic bicycle frame. *Compliance Engineering Journal*, *13*(1), 151–156.

Sani, M. S. M., Nazri, N. A., Zahari, S. N., Abdullah, N. A. Z., & Priyandoko, G. (2016). Dynamic Study of Bicycle Frame Structure. *IOP Conference Series: Materials Science and Engineering*, *160*(1). https://doi.org/10.1088/1757-899X/160/1/012009

Satrijo, D., Kurdi, O., & Wijaya, S. (2022). Static Linear Stress Analysis of Road Bike Frame Design Using Finite Element Method. *Proceedings of the Conference on Broad Exposure to Science and Technology 2021 (BEST 2021), 210*. https://doi.org/10.2991/aer.k.220131.065

Suthahar, P., Arunkumar, R., Rajeshwaran, M., Asaithambi, T., & Parthasarathy, S. (2023). Design and analysis of bicycle frame by using metal matrix composites. *Materials Today: Proceedings*. https://doi.org/10.1016/j.matpr.2023.05.355

CRMP-2-DRIVEN RADIO-PROTECTION THROUGH SEROTONERGIC ACTIVATION

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Abstract

The exposure to elevated doses of γ-radiation has been remaining a critical concern both in space exploration and in clinical oncology, where radioactive agents and X-rays are used as therapeutic tools. This situation underscores the urgent need for developing novel and biologically effective radio-protective agents. Numerous experimental studies have demonstrated that various environmental stressors influence serotonergic system activity, suggesting its key role in adaptive and defensive mechanisms. Considering these data, we pinpointed on the potential of enhancing serotonergic signaling as a means of increasing resistance to γ-irradiation. Our experiments revealed that intramuscular administration of collapsin-response mediator protein 2 (CRMP-2), a protein functionally associated with the serotonergic system, significantly promoted protection of rat peripheral tissue nuclei against the damaging and mutagenic effects of high-dose γ-radiation. These data indicate that CRMP-2 upregulation may serve as an effective biological radioprotector via modulation of serotonergic pathways.

Keywords: γ-radiation, nuclear pathologies, serotonergic system, collapsin-response mediator protein 2, radioprotection

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ÖZET

Bu araştırmanın amacı, 36-72 ay aralığında çocuğu bulunan babaların baba katılım düzeylerini incelemek ve baba katılımının çeşitli demografik değişkenlere göre farklılaşıp farklılaşmadığını belirlemektir. Araştırma nicel yöntemle ve ilişkisel tarama modelinde yürütülmüştür. Çalışma grubu uygun örnekleme yöntemiyle seçilen toplam 228 katılımcıdan oluşmaktadır. Veriler, Kişisel Bilgi Formu ve Baba Katılım Ölçeği (BAKÖ) aracılığıyla toplanmıştır. Verilerin analizinde bağımsız örneklemler t-testi ve tek yönlü varyans analizi (ANOVA) kullanılmış, anlamlı farklılıkların kaynağını belirlemek için LSD çoklu karşılaştırma testi uygulanmıştır. Etki büyüklükleri için eta kare (η^2) ve Cohen's d değerleri rapor edilmiştir. Bulgular, baba katılımının çocuğun cinsiyetine göre anlamlı biçimde farklılaşmadığını; buna karşın çocuğun yaşı ve kardeş sayısına göre BAKÖ toplam puanı ve alt boyutlarda anlamlı farklılıklar bulunduğunu göstermiştir. Babaya ilişkin değişkenler açısından, öğrenim düzeyi ve algılanan gelir düzeyinin baba katılımıyla ilişkili olduğu, çalışma durumunun özellikle temel bakım ve toplam puanda anlamlı farklılık yarattığı, çalışma zamanının ise toplam puan ve tüm alt boyutlarda anlamlı farklılık oluşturduğu belirlenmiştir. Aile tipine göre anlamlı bir farklılık saptanmamıştır. Ayrıca babalığa hazır olduğunu belirten babaların keyfi meşguliyet, ilgi ve yakınlık ve toplam puanlarının daha yüksek olduğu, temel bakım boyutunda ise farkın anlamlı olmadığı görülmüştür. Sonuç olarak, babaların çocuk bakımına katılımının bireysel ve sosyoekonomik değişkenlerden etkilendiği belirlenmiştir. Bu bulgular, babalık rollerinin desteklenmesine yönelik programların geliştirilmesi açısından önem taşımaktadır.

Anahtar Kelimeler: Baba katılımı, Çocuk bakımı, Erken çocukluk

ABSTRACT

The aim of this study is to examine father involvement levels among fathers who have children aged 36-72 months and to determine whether father involvement differs according to various demographic variables. The study was conducted using a quantitative method and a correlational survey design. The study group consisted of a total of 228 participants selected through convenience sampling. Data were

collected using a Demographic Information Form and the Father Involvement Scale. Independent-samples t-tests and one-way analysis of variance (ANOVA) were used for data analysis, and the LSD post-hoc test was applied to identify the source of significant differences. Effect sizes were reported using eta squared (η^2) and Cohen's d values. The findings indicated that father involvement did not differ significantly by the child's gender; however, significant differences were found in the total FIS score and subscale scores according to the child's age and number of siblings. In terms of paternal variables, fathers' educational level and perceived income level were associated with father involvement; employment status produced significant differences particularly in the basic care subscale and the total score; and working schedule led to significant differences in the total score and all subscales. No significant differences were found by family type. In addition, fathers who reported being ready for fatherhood had higher scores in leisure engagement, affection/interest, and the total score, whereas the difference was not significant in the basic care dimension. Overall, it was determined that fathers' involvement in childcare is influenced by individual and socioeconomic variables. These findings are important for developing programs aimed at supporting fathering roles.

Keywords: Father involvement, Child care, Early childhood.

GİRİŞ

Erken çocukluk dönemi, bireyin bilişsel, duygusal ve sosyal gelişiminin temellerinin atıldığı kritik bir gelişim evresidir. Bu dönemde çocuğun bakım ve eğitiminden sorumlu olan ebeveynlerin, özellikle babaların çocuklarıyla kurdukları etkileşim, çocukların gelişimsel çıktıları üzerinde belirleyici bir rol oynamaktadır. Geleneksel olarak annelere atfedilen çocuk bakım ve yetiştirme sorumluluklarının günümüzde babalar tarafından da daha fazla üstlenilmeye başlanması, baba katılımının çocuk gelişimi açısından ele alınmasını gerekli kılmıştır. Araştırmalar, babaların çocuk gelişimine annelerden farklı ve özgün katkılar sunduğunu; özellikle erken çocukluk döneminde babaların oyun, etkileşim ve öğrenme süreçlerindeki rollerinin çocuk gelişimini desteklediğini ortaya koymaktadır (Palm & Fagan, 2008). Baba katılımının, çocukların bilişsel, sosyal ilişkiler, davranışsal uyum ve psikolojik iyi oluşları üzerinde olumlu etkileri olduğu bildirilmektedir. Özellikle olumlu ve destekleyici baba katılımının, çocukların içselleştirme ve dışsallaştırma davranış sorunlarını azalttığı vurgulanmaktadır (Yoon vd., 2021).

Baba katılımı, babanın çocukla birlikte geçirdiği zaman, çocuğun günlük bakımına katılımı ve çocukla kurduğu duygusal yakınlık gibi çok boyutlu bir yapıyı kapsamaktadır (Lamb, 2012). Son yıllarda yapılan araştırmalar, babaların çocuklarının gelişim süreçlerine aktif katılımının, çocukların akademik başarıları, sosyal becerileri, duygusal düzenleme kapasiteleri ve davranışsal uyumları üzerinde anlamlı ve olumlu etkiler yarattığını ortaya koymaktadır (Rollè vd., 2019; Yoon vd., 2021). Özellikle erken çocukluk döneminde yüksek düzeyde baba katılımının, çocukların sosyal-duygusal gelişimini desteklediği ve duygusal düzenleme becerilerinin gelişimine katkı sağladığı gösterilmiştir (Puglisi vd., 2024). Ayrıca baba katılımının, çocukların davranışsal ve bilişsel gelişimleri üzerinde uzun süreli koruyucu etkilerinin bulunduğuna ilişkin güçlü bulgular ortaya konmuştur (Sarkadi vd., 2008). Puglisi ve arkadaşları (2024), babaların çocuklarıyla kurdukları etkileşimlerin, özellikle erken çocukluk döneminde çocukların duygu düzenleme becerilerinin gelişiminde önemli bir rol oynadığını vurgulamaktadır. Babaların çocuklarıyla gerçekleştirdikleri bu etkileşimler, çocukların çevrelerini aktif biçimde keşfetmelerini ve öğrenme süreçlerine katılımlarını teşvik etmekte; bu durum da çocukların akademik becerilerinin ve okul başarısının artmasına katkı sağlamaktadır (Grossmann et al., 2002). Baba katılımı, aynı zamanda Bronfenbrenner'in kuramı çerçevesinde ele alınmakta; çocuk gelişimini anlamak için hem yakın çevresel etmenlerin (örneğin baba katılımı) hem de uzak bağlamsal etmenlerin (örneğin sosyoekonomik düzey, kültürel yapı ve okul ortamı) birlikte değerlendirilmesi gerektiği vurgulanmaktadır. Bununla birlikte, baba katılımının düzeyi ve niteliği tek başına ele alınabilecek bir yapı olmayıp, çeşitli demografik ve sosyoekonomik değişkenlerden etkilenmektedir. Alınyazında, babanın yaşı, öğrenim durumu, çalışma koşulları, gelir düzeyi ve aile yapısının baba katılımı üzerinde belirleyici olduğu; bunun yanı sıra çocuğa ilişkin özelliklerin, özellikle yaş, kardeş sayısı ve doğum

sırası gibi faktörlerin de baba katılımını şekillendirdiği vurgulanmaktadır (Garcia vd., 2022; Lamb, 2012). Bazı araştırmalar ise baba katılımı ile çocuk gelişim çıktıları arasındaki ilişkinin, aile içi ilişkiler ve anne refahı gibi değişkenler aracılığıyla dolaylı olarak etkilendiğini ileri sürmektedir (Garcia vd., 2022).

Türkiye'de yürütülen güncel çalışmalar da baba katılımının kültürel ve bağlamsal özellikler doğrultusunda farklılaşabildiğini göstermektedir. Türkiye örnekleminde gerçekleştirilen araştırmalarda, baba katılımının babalık rolü algısı ile ilişkili olduğu ve çocukların sosyal davranışları üzerinde dolaylı etkiler gösterebildiği yönünde sonuçlara ulaşılmıştır (Karadeniz & Kaya, 2025; Semiz & Ören, 2024). Ayrıca Türkiye'de erken çocukluk döneminde baba katılımına yönelik lisansüstü tezler ve araştırmaların sayısında artış olduğu, bu alana yönelik akademik ilginin giderek güçlendiği belirtilmektedir (Arslan, 2022). Bu bağlamda, baba katılımını etkileyen değişkenlerin bütüncül bir yaklaşımla incelenmesi hem kuramsal hem de uygulamaya yönelik çalışmalar açısından önem taşımaktadır. Bu araştırmada, 3–6 yaş aralığında çocuğu bulunan babaların çocuklarıyla olan katılım düzeyleri, Baba Katılım Ölçeği (BAKÖ) aracılığıyla incelenmiş; baba katılımının çocuğa ve babaya ilişkin çeşitli demografik değişkenlere göre farklılaşıp farklılaşmadığı ortaya konulmaya çalışılmıştır. Elde edilen bulguların, baba katılımına ilişkin alanyazına katkı sağlaması ve erken çocukluk dönemine yönelik aile temelli destek ve müdahale programlarının geliştirilmesine ışık tutması beklenmektedir.

Bu araştırmanın amacı, 3–6 yaş aralığında çocuğu bulunan babaların çocuklarıyla olan katılım düzeylerini incelemek ve baba katılımının çeşitli demografik değişkenlere göre farklılaşıp farklılaşmadığını belirlemektir. Bu doğrultuda, Baba Katılım Ölçeği (BAKÖ) toplam puanı ve alt boyut puanlarının; çocuğun cinsiyeti, yaşı, kardeş sayısı ve doğum sırası ile babanın yaşı, öğrenim durumu, çalışma durumu, çalışma zamanı, algılanan gelir düzeyi ve aile tipi gibi değişkenlere göre anlamlı bir farklılık gösterip göstermediği araştırmanın alt problemleri kapsamında ele alınmıştır.

YÖNTEM

Araştırma Deseni

Bu araştırma, nicel araştırma yöntemlerinden ilişkisel tarama modeli ile yürütülmüştür. Araştırmada, çocuklara ilişkin çeşitli demografik değişkenlerin BAKÖ (ve alt boyutları) üzerindeki etkileri incelenmiştir.

Evren ve Örneklem

Araştırmanın evrenini, ilgili araştırma döneminde belirlenen ölçütleri karşılayan 3–6 yaş aralığındaki çocuklar oluşturmaktadır. Araştırmanın örneklemi ise bu evrenden uygun örnekleme yöntemiyle seçilen ve araştırmaya katılmayı kabul eden toplam 228 babadan oluşmaktadır. Örneklem büyüklüğünün istatistiksel açıdan yeterliliğini belirlemek amacıyla G*Power 3.1 yazılımı kullanılarak gerçekleştirilmiştir. Yapılan analizde anlamlılık düzeyi ($\alpha = 0,05$), orta düzey etki büyüklüğü ve %80 istatistiksel güç ($1–\beta = 0,80$) dikkate alınmıştır. Bu doğrultuda hesaplanan minimum örneklem büyüklüğünün üzerinde bir sayıya ulaşıldığı belirlenmiştir.

Tablo 1. Çalışma grubundaki çocuklara ilişkin demografik özellikler (n = 228)

Değişken	Kategori	n	%
Cinsiyet	Kız	106	46,5
	Erkek	122	53,5
Çocuğun Yaşı	36–48 aylık	72	31,6
	49–60 aylık	54	23,7
	61–72 aylık	102	44,7

Doğum Sırası	İlk	105	46,1
	İkinci	72	31,6
	Üçüncü	30	13,2
	Dördüncü ve sonrası	21	9,1
Kardeş Sayısı	Bir kardeş	115	50,4
	İki kardeş	66	28,9
	Üç kardeş	29	12,8
	Dört ve üstü	18	7,9

Tablo 1 incelendiğinde, çalışma grubundaki çocukların %53,5'inin erkek, %46,5'inin kız olduğu görülmektedir. Çocukların yaş dağılımı incelendiğinde, en yüksek oranın %44,7 ile 61–72 aylık çocuklardan oluştuğu, bunu %31,6 ile 36–48 aylık ve %23,7 ile 49–60 aylık çocukların izlediği belirlenmiştir. Doğum sırasına göre çocukların %46,1'inin ilk çocuk olduğu, %31,6'sının ikinci çocuk olduğu görülürken, üç ve daha fazla çocuk sırasına sahip olanların oranı %22,4'tür. Kardeş sayısına ilişkin bulgular, çocukların yarısından fazlasının (%50,4) bir kardeşe sahip olduğunu, dört ve üzeri kardeşe sahip çocukların oranının ise düşük (%7,9) olduğunu göstermektedir.

Tablo 2. Babaya ve aileye ilişkin demografik özellikler (n = 228)

Değişken	Kategori	n	%
Babanın Yaşı	18–25	29	12,7
	26–35	24	10,5
	36–45	88	38,6
	45 yaş ve üstü	87	38,2
Babanın Öğrenim Durumu	İlkokul	29	12,7
	Ortaokul	24	10,5
	Lise	88	38,6
	Lisans ve üstü	87	38,2
Algılanan Gelir Düzeyi	Düşük	12	5,3
	Orta	129	56,6
	İyi	73	32,0
	Çok iyi	14	6,1
Çalışma Durumu	Çalışıyor	187	82,0

	Çalışmıyor	41	18,0
Çalışma Zamanı	Tam zamanlı	153	67,1
	Evde	43	18,9
	Yarı zamanlı	20	8,8
	Vardiyalı	12	5,2
Aile Tipi	Çekirdek	178	78,1
	Geniş	41	18,0
	Tek ebeveyn	9	3,9

Tablo 2'ye göre babaların büyük bir bölümünün 36–45 yaş (%38,6) ve 45 yaş ve üzeri (%38,2) gruplarında yer aldığı görülmektedir. Babanın öğrenim durumuna ilişkin bulgular, katılımcıların %77,2'sinin lise ve üzeri eğitim düzeyine sahip olduğunu ortaya koymaktadır. Algılanan gelir düzeyi açısından babaların çoğunluğunun kendilerini orta (%56,6) ve iyi (%32,0) gelir düzeyinde değerlendirdiği belirlenmiştir. Babaların önemli bir kısmının (%82,0) aktif olarak çalıştığı, çalışma zamanına göre ise çoğunluğun (%67,1) tam zamanlı olarak istihdam edildiği görülmektedir. Aile yapısına ilişkin bulgular, katılımcıların büyük çoğunluğunun (%78,1) çekirdek aile yapısına sahip olduğunu; tek ebeveynli ailelerin ise örneklemde sınırlı bir orana (%3,9) sahip olduğunu göstermektedir.

Veri Toplama Aracı

Kişisel Bilgi Formu

Araştırmada katılımcılara ve çocuklarına ilişkin demografik bilgileri toplamak amacıyla araştırmacı tarafından geliştirilen Kişisel Bilgi Formu kullanılmıştır. Form, araştırmanın amaçları doğrultusunda, baba ve çocukla ilgili temel demografik değişkenleri belirlemeye yönelik olarak hazırlanmıştır. Kişisel Bilgi Formu'nda, çocuğun cinsiyeti, çocuğun yaşı, kardeş sayısı, doğum sırası, aile tipi, babanın yaşı, babanın eğitim durumu, babanın çalışma zamanı, babanın gelir düzeyi ve babalığa hazır olma durumu gibi değişkenlere ilişkin sorular yer almaktadır.

Baba Katılım Ölçeği (BAKÖ)

Baba Katılım Ölçeği (BAKÖ), Sımsıkı ve Şendil (2014) tarafından 3–6 yaş aralığında çocuğu bulunan babaların çocuklarıyla birlikte gerçekleştirdikleri etkinliklere katılım düzeylerini ve bu etkinliklerin sıklığını belirlemek amacıyla geliştirilmiş olup, toplam 37 maddeden ve üç alt boyuttan oluşmaktadır. Ölçeğin Keyfi Meşguliyet alt boyutu, babanın çocukla birlikte gerçekleştirdiği serbest zaman etkinlikleri ve oyunları kapsayan 17 maddeden; İlgi ve Yakınlık alt boyutu, babanın çocuğa karşı duyarlılığı, ilgi göstermesi ve sözel ya da fiziksel sevgi ifadelerini içeren 12 maddeden; Temel Bakım alt boyutu ise çocuğun günlük ihtiyaçlarının karşılanması ve fiziksel bakımına ilişkin 8 maddeden oluşmaktadır. Ölçek maddeleri davranış ifadeleri şeklinde düzenlenmiş olup, "Her zaman böyledir" (5 puan) ile "Hiçbir zaman böyle değildir" (1 puan) arasında derecelendirilen beşli Likert tipi bir yapıdadır. Ölçekten her bir alt boyut için ayrı puanlar elde edilebildiği gibi, toplam baba katılım düzeyini gösteren toplam puan da hesaplanabilmektedir. Ölçeğin güvenirliğine ilişkin Cronbach alfa iç tutarlılık katsayıları Keyfi Meşguliyet alt boyutu için .89, İlgi ve Yakınlık alt boyutu için .85, Temel Bakım alt boyutu için .83 ve ölçeğin toplamı için .92 olarak rapor edilmiştir.

Bu araştırmada elde edilen veriler doğrultusunda güvenirlik analizi sonuçları Tablo 3 de verilmiştir.

Tablo 3. Baba Katılım Ölçeği (BAKÖ) toplam ve alt boyutlarının güvenirlik analiz sonuçları

Ölçekler	Cronbach alfa	Madde sayısı
BAKÖ	.961	37
Keyfi Meşguliyet	.929	17
İlgi ve Yakınlık	.880	12
Temel Bakım	.850	8

Veri Analizi

Verilerin analizinde SPSS 26.0 paket programı kullanılmıştır. Analizlere başlamadan önce verilerin normal dağılım varsayımını karşılayıp karşılamadığı incelenmiş; bu kapsamda çarpıklık (skewness) ve basıklık (kurtosis) değerleri değerlendirilmiştir. Yapılan inceleme sonucunda, ilgili değişkenlere ait çarpıklık ve basıklık değerlerinin –2 ile +2 aralığında olduğu belirlenmiş ve bu değerlerin normal dağılım varsayımını sağladığı kabul edilmiştir (George & Mallery, 2010). Analiz sürecinde iki gruplu değişkenlerin karşılaştırılmasında Bağımsız Örneklemler t-Testi, ikiden fazla gruba sahip değişkenlerin karşılaştırılmasında ise Tek Yönlü Varyans Analizi (ANOVA) uygulanmıştır. ANOVA sonucunda istatistiksel olarak anlamlı fark bulunan değişkenlerde, farkın hangi gruplar arasında olduğunu belirlemek amacıyla LSD çoklu karşılaştırma testi kullanılmıştır. Ayrıca, gruplar arasındaki farkların etki büyüklüğünü belirlemek amacıyla eta kare (η^2) değeri hesaplanmıştır. Eta kare değerleri, Cohen'in (1988) önerdiği ölçütler doğrultusunda yorumlanmış; 0,01 küçük, 0,06 orta ve 0,14 büyük etki büyüklüğü olarak kabul edilmiştir. Araştırmada istatistiksel anlamlılık düzeyi $p < 0,05$ olarak kabul edilmiştir.

BULGULAR

Bu bölümde, araştırma kapsamında elde edilen verilerin istatistiksel analizlerine ilişkin bulgulara yer verilmiştir. Baba Katılım Ölçeği (BAKÖ) ve alt boyut puanlarının çeşitli demografik değişkenlere göre farklılaşıp farklılaşmadığını belirlemek amacıyla bağımsız örneklemler t-testi ve tek yönlü varyans analizi (ANOVA) uygulanmıştır. İkiden fazla gruba sahip değişkenlerde, anlamlı farklılıkların hangi gruplar arasında olduğunu belirlemek amacıyla LSD çoklu karşılaştırma testi kullanılmıştır. Analiz sonuçları tablolar hâlinde aşağıda sunulmuştur.

Tablo 4. Baba Katılım Ölçeği (BAKÖ) puanlarının çocuğun cinsiyetine göre karşılaştırılması

Ölçek	Grup	n	$\bar{X}$	ss	t	p
BAKÖ Toplam	Kız	106	87,02	30,43	-0,205	0,200
	Erkek	122	87,81	27,90		
Keyfi Meşguliyet	Kız	106	40,77	15,26	-0,208	0,075
	Erkek	122	41,17	13,61		
İlgi ve Yakınlık	Kız	106	27,68	9,92	0,361	0,571
	Erkek	122	27,22	9,20		
Temel Bakım	Kız	106	17,50	6,46	-0,954	0,787

	Erkek	122	18,32	6,48

Tablo 4'e ilişkin bulgular, Baba Katılım Ölçeği toplam puanı ile alt boyut puanlarının çocuğun cinsiyetine göre anlamlı bir farklılık göstermediğini ortaya koymaktadır (p > 0,05).

Tablo 5. Çocuk yaş değişkenine göre Baba Katılım Ölçeği (BAKÖ) ve alt boyut puanlarına ilişkin tek yönlü varyans analizi (ANOVA) sonuçları

Ölçek / Alt Boyut	Varyans Kaynağı	KT	sd	KO	F	p	η²	Anlamlı Fark (LSD)
BAKÖ Toplam	Gruplar arası	8 588,705	2	4 294,353	5,283	.006*	0,04	1–2
	Gruplar içi	182 891,553	225	812,851				
Keyfi Meşguliyet	Gruplar arası	1 756,957	2	878,478	4,382	.014*	0,03	1–2, 1–3
	Gruplar içi	45 104,004	225	200,462				
İlgi ve Yakınlık	Gruplar arası	783,219	2	391,610	4,449	.013*	0,07	1–2, 1–3
	Gruplar içi	19 804,794	225	88,021				
Temel Bakım	Gruplar arası	631,460	2	315,730	8,015	.001*	0,03	1–2, 2–3
	Gruplar içi	8 863,680	225	39,394				

* p < 0,05(1 = 36–48 ay, 2 = 49–60 ay, 3 = 61–72 ay)

Tablo 5 incelendiğinde, çocuk yaşı değişkenine göre Baba Katılım Ölçeği toplam puanı ve tüm alt boyut puanları arasında istatistiksel olarak anlamlı farklılıklar bulunduğu görülmektedir (p < 0,05). LSD çoklu karşılaştırma testi sonuçları, BAKÖ toplam puanında anlamlı farkın 36–48 ay ile 49–59 ay grupları arasında ortaya çıktığını ve bu farkın 49–59 ay grubundaki çocuklar lehine olduğunu göstermektedir. Benzer biçimde, Keyfi Meşguliyet ve İlgi ve Yakınlık alt boyutlarında anlamlı farklılıkların ağırlıklı olarak 36–48 ay grubu ile 49–59 ay ve 60–72 ay grupları arasında olduğu belirlenmiştir. Temel Bakım alt boyutunda ise anlamlı farkların 36–48 ay ile 49–59 ay ve 49–59 ay ile 60–72 ay grupları arasında olduğu görülmektedir. Etki büyüklüğü değerleri incelendiğinde, İlgi ve Yakınlık alt boyutu için etki büyüklüğünün orta düzeyde (η² = 0,07), BAKÖ toplam puanı ile diğer alt boyutlar için ise küçük düzeyde (η² = 0,03–0,04) olduğu belirlenmiştir. Bu bulgular, çocuk yaşının baba katılımı üzerinde istatistiksel olarak anlamlı ancak sınırlı bir etkiye sahip olduğunu göstermektedir.

Tablo 6. Kardeş sayısına göre Baba Katılım Ölçeği (BAKÖ) ve alt boyut puanlarına ilişkin tek yönlü varyans analizi (ANOVA) sonuçları

Ölçek / Alt Boyut	Varyans Kaynağı	KT	sd	KO	F	p	η²	Anlamlı Fark (LSD)
BAKÖ Toplam	Gruplar arası	18 002,766	3	6 000,922	7,749	< .001*	0,09	1–4, 2–4
	Gruplar içi	173 477,493	224	774,453				
Keyfi Meşguliyet	Gruplar arası	4 442,447	3	1 480,816	7,820	< .001*	0,09	1–3, 1–4, 2–4, 3–4
	Gruplar içi	42 418,514	224	189,368				

İlgi ve Yakınlık	Gruplar arası	1 580,437	3	526,812	6,208	< .001*	0,06	1–4, 2–4
	Gruplar içi	19 007,576	224	84,855				
Temel Bakım	Gruplar arası	808,143	3	269,381	6,946	< .001*	0,06	1–4, 2–4
	Gruplar içi	8 686,997	224	38,781				

* p < 0,05 (1 = Bir kardeş, 2 = İki kardeş, 3 = Üç kardeş, 4 = Dört ve üzeri)

Tablo 6 incelendiğinde, kardeş sayısı değişkenine göre Baba Katılım Ölçeği (BAKÖ) toplam puanı ve tüm alt boyutlarda istatistiksel olarak anlamlı farklılıklar bulunduğu görülmektedir (p < 0,05). LSD çoklu karşılaştırma testi sonuçları, bu farklılıkların özellikle dört ve üzeri kardeşe sahip çocuklar ile daha az kardeşe sahip çocuklar arasındaki karşılaştırmalardan kaynaklandığını göstermektedir. Buna göre, dört ve üzeri kardeşe sahip çocukların BAKÖ toplam puanı ile Keyfi Meşguliyet, İlgi ve Yakınlık ve Temel Bakım alt boyut puanlarının, bir ve iki kardeşe sahip çocuklara kıyasla anlamlı düzeyde daha yüksek olduğu belirlenmiştir. Etki büyüklüğü değerleri incelendiğinde, BAKÖ toplam puanı ile Keyfi Meşguliyet ve İlgi ve Yakınlık alt boyutlarında orta düzeye yakın ($\eta^2 \approx 0,09$), Temel Bakım alt boyutunda ise orta düzeyde ($\eta^2 = 0,06$) etki bulunduğu görülmektedir.

Tablo 7. Baba yaşına göre Baba Katılım Ölçeği (BAKÖ) ve alt boyut puanlarına ilişkin tek yönlü varyans analizi (ANOVA) sonuçları

Ölçek / Alt Boyut	Varyans Kaynağı	KT	sd	KO	F	p	η^2	Anlamlı Fark (LSD)
Keyfi Meşguliyet	Gruplar arası	1 343,366	3	447,789	2,145	.095	0,03	–
	Gruplar içi	46 772,261	224	208,805				
İlgi ve Yakınlık	Gruplar arası	561,142	3	187,047	2,875	.037*	0,04	2–3, 3–4
	Gruplar içi	14 574,660	224	65,065				
Temel Bakım	Gruplar arası	309,654	3	103,218	1,190	.314	0,02	–
	Gruplar içi	19 428,065	224	86,732				
BAKÖ Toplam	Gruplar arası	4 718,368	3	1 572,789	1,892	.132	0,02	–
	Gruplar içi	186 162,141	224	831,081				

Tablo 7 incelendiğinde, baba yaşı değişkenine göre yalnızca İlgi ve Yakınlık alt boyutunda istatistiksel olarak anlamlı bir farklılık bulunduğu görülmektedir ($F = 2,875$; $p < 0,05$). Keyfi Meşguliyet, Temel Bakım ve BAKÖ toplam puanı açısından baba yaşına göre anlamlı bir farklılık saptanmamıştır ($p > 0,05$). LSD çoklu karşılaştırma testi sonuçları, İlgi ve Yakınlık alt boyutundaki anlamlı farkın 36–55 yaş grubundaki babalar ile 26–35 yaş grubundaki babalar arasında ortaya çıktığını ve bu farkın 36–55 yaş grubundaki babalar lehine olduğunu göstermektedir. Etki büyüklüğü değerinin düşük düzeyde ($\eta^2 = 0,04$) olması, baba yaşının baba katılımının bu boyutu üzerindeki etkisinin istatistiksel olarak anlamlı ancak sınırlı olduğunu göstermektedir.

Tablo 8. Babaların öğrenim düzeylerine göre Baba Katılım Ölçeği (BAKÖ) ve alt boyut puanlarına ilişkin tek yönlü varyans analizi (ANOVA) sonuçları

Ölçek / Alt Boyut	Varyans Kaynağı	KT	sd	KO	F	p	η^2	Anlamlı Fark (LSD)
BAKÖ Toplam	Gruplar arası	29 537,291	3	9 845,764	13,619	< .001*	0,15	4–1
	Gruplar içi	161 942,967	224	722,960				
Keyfi Meşguliyet	Gruplar arası	6 806,409	3	2 268,803	12,688	< .001*	0,19	4–1
	Gruplar içi	40 054,551	224	178,815				
İlgi ve Yakınlık	Gruplar arası	2 351,065	3	783,688	9,626	< .001*	0,11	4–1, 4–3
	Gruplar içi	18 236,948	224	81,415				
Temel Bakım	Gruplar arası	1 665,565	3	555,188	15,884	< .001*	0,07	4–1, 4–2, 4–3
	Gruplar içi	7 829,575	224	34,953				

* p < 0,05 (1 = İlkokul, 2 = Ortaokul, 3 = Lise, 4 = Lisans ve üstü)

Tablo 8 incelendiğinde, babaların öğrenim düzeylerine göre Baba Katılım Ölçeği toplam puanı ve tüm alt boyut puanları arasında istatistiksel olarak anlamlı farklılıklar bulunduğu görülmektedir (p < 0,05). LSD çoklu karşılaştırma testi sonuçlarına göre, BAKÖ toplam puanında anlamlı farkın lisans ve üstü öğrenim düzeyine sahip babalar ile ilkokul mezunu babalar arasında olduğu belirlenmiştir. Benzer şekilde, Keyfi Meşguliyet alt boyutunda lisans ve üstü öğrenim düzeyine sahip babaların puanları ilkokul mezunu babalara göre; İlgi ve Yakınlık alt boyutunda lisans ve üstü öğrenim düzeyine sahip babaların puanları ilkokul ve lise mezunu babalara göre; Temel Bakım alt boyutunda ise lisans ve üstü öğrenim düzeyine sahip babaların puanları ilkokul, ortaokul ve lise mezunu babalara göre anlamlı düzeyde farklılaşmaktadır. Etki büyüklüğü değerleri incelendiğinde, öğrenim düzeyinin BAKÖ toplam puanı üzerinde orta düzeyde (η^2 = 0,15), Keyfi Meşguliyet alt boyutunda yüksek düzeyde (η^2 = 0,19), İlgi ve Yakınlık alt boyutunda orta düzeyde (η^2 = 0,11) ve Temel Bakım alt boyutunda orta düzeyde (η^2 = 0,07) etkiye sahip olduğu görülmektedir. Bulgular genel olarak değerlendirildiğinde, babanın öğrenim düzeyi arttıkça BAKÖ toplam puanı ve alt boyut puanlarının arttığı görülmektedir.

Tablo 9. Babanın gelir düzeyine göre Baba Katılım Ölçeği (BAKÖ) ve alt boyut puanlarına ilişkin tek yönlü varyans analizi (ANOVA) sonuçları

Ölçek / Alt Boyut	Varyans Kaynağı	KT	sd	KO	F	p	η^2	Anlamlı Fark (LSD)
BAKÖ Toplam	Gruplar arası	11 372,760	3	3 790,920	4,715	.003*	0,06	2–3
	Gruplar içi	180 107,498	224	804,051				
Keyfi Meşguliyet	Gruplar arası	3 206,640	3	1 068,880	5,485	.001*	0,07	2–3
	Gruplar içi	43 654,320	224	194,885				
İlgi ve Yakınlık	Gruplar arası	675,333	3	225,111	2,532	.058	0,03	–
	Gruplar içi	19 912,680	224	88,896				
Temel Bakım	Gruplar arası	654,326	3	218,109	5,526	.001*	0,05	2–3
	Gruplar içi	8 840,814	224	39,468				

* p < 0,05 (1 = Düşük, 2 = Orta, 3 = İyi, 4 = Çok iyi)

Tablo 9 incelendiğinde, babanın gelir düzeyine göre Baba Katılım Ölçeği toplam puanı ile Keyfi Meşguliyet ve Temel Bakım alt boyutlarında istatistiksel olarak anlamlı farklılıklar bulunduğunu

göstermektedir. ($p < 0,05$). İlgi ve Yakınlık alt boyutunda ise gelir düzeyine göre anlamlı bir farklılık saptanmamıştır ($p > 0,05$). LSD çoklu karşılaştırma testi sonuçları, BAKÖ toplam puanı ile Keyfi Meşguliyet ve Temel Bakım alt boyutlarında anlamlı farkın orta gelir düzeyi ile iyi gelir düzeyi arasındaki karşılaştırmalardan kaynaklandığını göstermektedir. Buna göre, iyi gelir düzeyine sahip babaların BAKÖ toplam puanı ile Keyfi Meşguliyet ve Temel Bakım alt boyutlarındaki ortalama puanlarının, orta gelir düzeyine sahip babalara kıyasla daha yüksek olduğu belirlenmiştir. Etki büyüklüğü değerleri incelendiğinde, Keyfi Meşguliyet alt boyutu ($\eta^2 = 0,07$) ve BAKÖ toplam puanı ($\eta^2 = 0,06$) için orta düzeyde, Temel Bakım alt boyutu ($\eta^2 = 0,05$) için ise düşük–orta düzeyde bir etki olduğu görülmektedir.

Tablo 10. Babanın çalışma durumuna göre Baba Katılım Ölçeği (BAKÖ) ve alt boyut puanlarının bağımsız örneklemler t-testi sonuçları

Ölçek / Alt Boyut	Grup	n	$\bar{X}$	SS	t	p
Keyfi Meşguliyet	Çalışıyor	187	55,77	14,81	-1,220	.224
	Çalışmıyor	41	58,83	13,26		
İlgi ve Yakınlık	Çalışıyor	187	52,40	8,52	-0,879	.380
	Çalışmıyor	41	53,63	6,30		
Temel Bakım	Çalışıyor	187	25,64	9,06	-3,771	< .001*
	Çalışmıyor	41	31,54	9,11		
BAKÖ Toplam	Çalışıyor	187	133,81	29,55	-2,053	.041*
	Çalışmıyor	41	144,00	25,00		

* $p < 0,05$

Tablo 10 incelendiğinde, babanın çalışma durumuna göre Baba Katılım Ölçeği toplam puanı ile Temel Bakım alt boyutunda istatistiksel olarak anlamlı farklılıklar bulunduğu görülmektedir ($p < 0,05$). Buna göre, çalışmayan babaların Temel Bakım alt boyutu puanları ile BAKÖ toplam puanlarının, çalışan babalara kıyasla anlamlı düzeyde daha yüksek olduğu belirlenmiştir. Keyfi Meşguliyet ve İlgi ve Yakınlık alt boyutlarında ise babanın çalışma durumuna göre istatistiksel olarak anlamlı bir fark saptanmamıştır ($p > 0,05$). Bu bulgular, babanın çalışma durumunun özellikle çocuğun temel bakımına yönelik katılımı üzerinde etkili olduğunu, buna karşın diğer boyutlarında belirleyici bir değişken olmadığını göstermektedir.

Tablo 11. Çalışma zamanına göre Baba Katılım Ölçeği (BAKÖ) ve alt boyut puanlarına ilişkin tek yönlü varyans analizi (ANOVA) sonuçları

Ölçek / Alt Boyut	Varyans Kaynağı	KT	sd	KO	F	p	η^2	Anlamlı Fark (LSD)
BAKÖ Toplam	Gruplar arası	12 481,598	3	4 160,533	5,207	.002*	0,07	1–2
	Gruplar içi	178 998,661	224	799,101				

Keyfi Meşguliyet	Gruplar arası	3 252,213	3	1 084,071	5,568	.001*	0,04	1–2
	Gruplar içi	43 608,747	224	194,682				
İlgi ve Yakınlık	Gruplar arası	966,137	3	322,046	3,676	.013*	0,11	1–2
	Gruplar içi	19 621,876	224	87,598				
Temel Bakım	Gruplar arası	587,826	3	195,942	4,928	.002*	0,04	1–2
	Gruplar içi	8 907,314	224	39,765				

* $p < 0,05$ (1 = Tam zamanlı, 2 = Evde, 3 = Yarı zamanlı, 4 = Vardiyalı)

Tablo 11 incelendiğinde, çalışma zamanı değişkenine göre Baba Katılım Ölçeği (BAKÖ) toplam puanı ve tüm alt boyutlarda istatistiksel olarak anlamlı farklılıklar bulunduğu görülmektedir ($p < 0,05$). LSD çoklu karşılaştırma testi sonuçları, bu farklılıkların tam zamanlı çalışan babalar ile evde çalışan babalar arasındaki karşılaştırmalardan kaynaklandığını göstermektedir. Buna göre, tam zamanlı çalışan babaların BAKÖ toplam puanı ile Keyfi Meşguliyet, İlgi ve Yakınlık ve Temel Bakım alt boyut puanlarının, evde çalışan babalara kıyasla anlamlı düzeyde daha yüksek olduğu belirlenmiştir. Yarı zamanlı ve vardiyalı çalışan babalar ile diğer gruplar arasında ise istatistiksel olarak anlamlı bir fark saptanmamıştır. Etki büyüklüğü değerleri incelendiğinde, İlgi ve Yakınlık alt boyutu için etki büyüklüğünün orta düzeyde ($\eta^2 = 0,11$), BAKÖ toplam puanı için orta düzeye yakın ($\eta^2 = 0,07$), Keyfi Meşguliyet ve Temel Bakım alt boyutları için ise düşük düzeyde ($\eta^2 = 0,04$) olduğu görülmektedir.

Tablo 12. Aile tipine göre Baba Katılım Ölçeği (BAKÖ) ve alt boyut puanlarına ilişkin tek yönlü varyans analizi (ANOVA) sonuçları

Ölçek / Alt Boyut	Varyans Kaynağı	KT	sd	KO	F	p	η^2
BAKÖ Toplam	Gruplar arası	1 368,342	2	684,171	0,810	.446	0,01
	Gruplar içi	190 111,917	225	844,942			
Keyfi Meşguliyet	Gruplar arası	490,706	2	245,353	1,191	.306	0,00
	Gruplar içi	46 370,254	225	206,090			
İlgi ve Yakınlık	Gruplar arası	49,894	2	24,947	0,273	.761	0,01
	Gruplar içi	20 538,119	225	91,281			
Temel Bakım	Gruplar arası	69,166	2	34,583	0,826	.439	0,01
	Gruplar içi	9 425,974	225	41,893			

Tablo 12 incelendiğinde, aile tipi değişkenine göre Baba Katılım Ölçeği toplam puanı ve tüm alt boyutlar açısından istatistiksel olarak anlamlı bir farklılık bulunmadığı görülmektedir ($p > 0,05$). Buna göre, çekirdek aile, geniş aile ve tek ebeveynli aile yapılarında yer alan çocukların BAKÖ ve alt boyut puanlarının benzer düzeylerde olduğu söylenebilir. Etki büyüklüğü değerlerinin tüm boyutlar için çok düşük düzeyde ($\eta^2 \leq 0,01$) olması, aile tipinin baba katılımı üzerinde istatistiksel açıdan anlamlı bir etkisinin olmadığını göstermektedir.

Tablo 13. Baba Katılım Ölçeği puanlarının babalığa hazır olma durumuna göre karşılaştırılması

Boyut	Grup	n	X̄	SS	t	sd	p	Cohen's d
Keyfi Meşguliyet	Hazırdım	209	56,98	14,34	2,29	226	,023*	0,55
	Hazır Değildim	19	49,05	15,32				
İlgi ve Yakınlık	Hazırdım	209	53,04	7,92	2,61	226	,010*	0,67
	Hazır Değildim	19	48,00	9,56				
Temel Bakım	Hazırdım	209	27,01	9,32	1,69	226	,093	0,41
	Hazır Değildim	19	23,26	8,89				
BAKÖ Toplam	Hazırdım	209	137,03	28,55	2,43	226	,016*	0,59
	Hazır Değildim	19	120,32	30,25				

*p < 0,05

Tablo 13'e ilişkin bulgular, Yapılan bağımsız örneklemler t-testi sonuçlarına göre, babalığa hazır olduğunu belirten katılımcıların Keyfi Meşguliyet, İlgi ve Yakınlık alt boyutları ve toplam puan ortalamaları, hazır olmadığını belirten katılımcılara kıyasla anlamlı düzeyde daha yüksektir (p < ,05). Temel Bakım boyutu açısından ise gruplar arasında istatistiksel olarak anlamlı bir fark saptanmamıştır (p > ,05). Elde edilen etki büyüklükleri, anlamlı bulunan farkların orta düzeyde etkiye sahip olduğunu göstermektedir.

TARTIŞMA, SONUÇ ve ÖNERİLER

Bu bölümde araştırma kapsamında elde edilen bulgular, baba katılımı alan yazını ve kuramsal yaklaşımlar doğrultusunda tartışılmıştır. Bulguların yorumlanmasında, baba katılımının çok boyutlu yapısı (Keyfi Meşguliyet, İlgi ve Yakınlık, Temel Bakım) temel alınarak, çocuk, baba ve aileye ilişkin değişkenler değerlendirilmiştir. Ayrıca sonuçlar özetlenmiş ve gelecekte yapılacak araştırmalar ile uygulamalara ilişkin öneriler sunulmuştur.

Baba Katılım Ölçeği (BAKÖ) toplam puanı ile Keyfi Meşguliyet, İlgi ve Yakınlık ve Temel Bakım alt boyutlarının çocuğun cinsiyetine göre anlamlı biçimde farklılaşmadığı belirlenmiştir. Bu bulgu, babaların çocuk bakımına ve çocukla etkileşime yönelik katılım düzeylerinin kız ve erkek çocuklar açısından benzer davranışlar sergilediğini göstermektedir. Alan yazında baba katılımını erken çocukluk döneminde ele alan araştırmalar, babaların çocuklarıyla kurdukları ilişkinin niteliğinin çocuğun biyolojik cinsiyetinden ziyade ebeveynlik tutumları, aile içi rol paylaşımı ve etkileşim kalitesiyle ilişkili olduğunu ortaya koymaktadır (Lamb, 2012; Cabrera vd., 2014). Özellikle oyun, duygusal yakınlık ve temel bakım boyutlarında cinsiyete dayalı bir farklılaşmanın görülmemesi, baba katılımının daha bütüncül ve eşitlikçi bir ebeveynlik yaklaşımı çerçevesinde şekillendiğini düşündürmektedir. Bu yönüyle elde edilen bulgular, baba–çocuk etkileşiminin cinsiyet temelli kalıplardan bağımsız olarak ele alınması gerektiğini vurgulayan araştırmalarla örtüşmektedir.

Çocuk yaşı değişkenine göre Baba Katılım Ölçeği (BAKÖ) toplam puanı ve tüm alt boyutlarda anlamlı farklılıklar bulunması, baba katılımının çocuğun gelişimsel özellikleriyle birlikte değişebilen bir yapı sergilediğini göstermektedir. Özellikle 49–60 ay grubundaki çocuklar lehine ortaya çıkan bu farklılıkların, erken çocukluk döneminde ebeveyn–çocuk etkileşiminin gelişimsel gereksinimlere paralel olarak yeniden yapılandığına işaret ettiği söylenebilir. Alan yazında erken çocukluk döneminde ebeveyn katılımının çocuğun yaşına bağlı olarak biçim değiştirdiği vurgulanmaktadır. Daha küçük yaşlarda (36–48 ay), çocukların temel bakım ve fiziksel ihtiyaçlarının ön planda olduğu; bu bakım rollerinin ise çoğunlukla anne tarafından üstlenildiği bildirilmektedir. Bu durum, babaların bu dönemde bakım süreçlerine daha sınırlı düzeyde katılım göstermelerine neden olabilmektedir (Lamb, 2012). Buna karşılık, çocukların yaşlarının ilerlemesiyle birlikte bakım gereksinimlerinin niteliği değişmekte;

babaların katılımı daha çok etkileşim, oyun ve rehberlik temelli rollere kaymaktadır. Keyfi Meşguliyet ve İlgi ve Yakınlık alt boyutlarında daha ileri yaş gruplarında anlamlı biçimde daha yüksek puanların elde edilmesi, çocukların bilişsel, dilsel ve sosyal etkileşim becerilerinin gelişmesiyle açıklanabilir. Araştırmalar, çocukların yaşı ilerledikçe babalarla kurdukları etkileşimin daha karşılıklı, sözel ve oyun temelli hâle geldiğini; bunun da baba katılımını artırdığını göstermektedir (Parke, 2004). Bu yaş döneminde çocukların babalarla oyun oynama, sohbet etme ve ortak etkinliklere katılma kapasitesinin artması, baba–çocuk ilişkisinin niteliğini güçlendiren bir unsur olarak değerlendirilmektedir. Temel Bakım alt boyutunda da yaşa bağlı anlamlı farklılıkların bulunması, baba katılımının yalnızca oyun ve duygusal yakınlıkla sınırlı olmadığını göstermektedir. Özellikle 49–60 ay döneminde çocukların tuvalet, giyinme ve beslenme gibi öz bakım becerilerinde daha aktif hâle gelmeleri, babaların bu süreçlere katılımını kolaylaştırabilmektedir. Pleck (2010), çocukların bakım süreçlerinde daha bağımsız hâle gelmesinin, babaların bakım sorumluluğunu üstlenmesini destekleyen bir etken olduğunu belirtmektedir.

Kardeş sayısına göre Baba Katılım Ölçeği (BAKÖ) toplam puanı ve tüm alt boyutlarda istatistiksel olarak anlamlı farklılıklar bulunduğunu göstermektedir. Özellikle dört ve üzeri kardeşe sahip çocuklar lehine ortaya çıkan bu farklılıklar, baba katılımının aile yapısı ve çocuk sayısıyla ilişkili olarak değişebilen bir özellik olduğunu ortaya koymaktadır. Etki büyüklüklerinin orta düzeyde olması, kardeş sayısının baba katılımı üzerinde yalnızca istatistiksel değil, aynı zamanda pratik açıdan da anlamlı bir etkisi bulunduğuna işaret etmektedir. Bu bulgunun nedenlerinden biri, çok çocuklu ailelerde bakım ve sorumluluk yükünün kaçınılmaz biçimde artmasıdır. Dört ve üzeri çocuğun bulunduğu ailelerde babaların, çocukların günlük bakım, düzen ve ihtiyaçlarının karşılanmasında daha aktif roller üstlenmek zorunda kaldıkları düşünülebilir. Bu durum, baba katılımının özellikle Temel Bakım alt boyutunda daha yüksek puanlarla ortaya çıkmasını açıklayabilir. Nitekim baba katılımını bağlamsal bir süreç olarak ele alan araştırmalar, çocuk sayısının artmasının babaları daha işlevsel ve sorumluluk temelli roller üstlenmeye yöneltebildiğini göstermektedir (Cabrera vd., 2014). Keyfi Meşguliyet ve İlgi ve Yakınlık alt boyutlarında dört ve üzeri kardeşe sahip çocuklar lehine görülen anlamlı farklılıklar ise, baba–çocuk etkileşiminin çok çocuklu ailelerde daha kolektif ve paylaşılan etkinlikler üzerinden şekillenmesiyle açıklanabilir. Çok çocuklu ailelerde babaların çocuklarıyla bireysel etkileşim yerine grup temelli oyunlar, ortak etkinlikler ve paylaşılan zaman dilimleri aracılığıyla ilişki kurmaları, bu alt boyutlardaki puanların yükselmesine katkı sağlayabilir. Bu durum, baba katılımının biçim değiştirebildiğini ve çocuk sayısına bağlı olarak daha kapsayıcı bir yapıya dönüşebildiğini düşündürmektedir (Lamb, 2012). Pleck (2010), baba katılımının yalnızca çocukla geçirilen bireysel zaman üzerinden değil, aile sistemine katkı ve bakım sorumluluğunu üstlenme üzerinden de değerlendirilmesi gerektiğini vurgulamaktadır. İlgi ve Yakınlık alt boyutunda etki büyüklüğünün orta düzeyde olması, çok çocuklu ailelerde baba–çocuk ilişkisinin yalnızca görev temelli değil, duygusal boyutu da içeren bir yapı sergileyebildiğini göstermektedir. Bu durum, babaların çocuklar arasındaki ilişkileri düzenleme, çocuklara eşit ilgi göstermeye çalışma ve aile içi dengeyi koruma çabalarıyla ilişkili olabilir.

Baba yaşı değişkenine göre Baba Katılım Ölçeği (BAKÖ) toplam puanı ile Keyfi Meşguliyet ve Temel Bakım alt boyutlarında anlamlı bir farklılık bulunmazken, yalnızca İlgi ve Yakınlık alt boyutunda orta yaş grubundaki babalar lehine istatistiksel olarak anlamlı bir farkın ortaya çıktığı görülmektedir. Etki büyüklüğünün küçük düzeyde olması, baba yaşının baba katılımının genel düzeyinden ziyade, daha çok baba–çocuk ilişkisinin duygusal boyutu ile ilişkili olduğunu düşündürmektedir. Türkiye örnekleminde yürütülen çalışmalar, babalık rolünün yaş ve yaşam deneyimiyle birlikte niteliksel olarak değişebildiğini göstermektedir. Kağıtçıbaşı (2010), aile içi ilişkileri kültürel bağlamda ele aldığı çalışmalarında, ebeveynlerin yaş ve yaşam evresi ilerledikçe çocukla kurdukları ilişkide daha duyarlı, sabırlı ve ilişki odaklı bir yaklaşım benimsediklerini belirtmektedir. Bu durum, mevcut çalışmada orta yaş grubundaki babaların İlgi ve Yakınlık alt boyutunda daha yüksek puanlara sahip olmasını açıklayan önemli bir çerçeve sunmaktadır. Türkiye'de okul öncesi dönemde baba katılımını inceleyen nicel araştırmalar da, baba yaşının özellikle duygusal yakınlık ve iletişim boyutunda sınırlı fakat anlamlı bir etkisinin olabileceğini ortaya koymaktadır. Yalçın ve Koçak (2018) tarafından yapılan bir çalışmada, baba yaşının temel bakım ve oyun etkinliklerine katılım üzerinde belirleyici olmadığı; buna karşılık baba–çocuk iletişimi ve duygusal etkileşim boyutlarında yaşa bağlı farklılıkların gözlenebildiği rapor edilmiştir. Bu

bulgu, mevcut çalışmada yalnızca İlgi ve Yakınlık alt boyutunda anlamlı fark bulunmasıyla örtüşmektedir. Keyfi Meşguliyet ve Temel Bakım alt boyutlarında baba yaşına göre anlamlı bir farklılık saptanmamış olması, Türkiye bağlamında babaların bu tür katılım davranışlarının yaş değişkeninden çok çalışma koşulları, zaman erişilebilirliği ve aile içi rol paylaşımı gibi yapısal faktörlerle ilişkili olabileceğini düşündürmektedir. Nitekim Sunar ve Fişek (2005), Türkiye'de aile içi rol dağılımını ele aldıkları çalışmalarında, babaların bakım ve oyun etkinliklerine katılımının yaşa göre değil, günlük yaşam düzeni ve sorumluluk paylaşımına göre şekillendiğini vurgulamaktadır. Etki büyüklüğünün küçük düzeyde olması, baba yaşının baba katılımı üzerinde tek başına güçlü bir belirleyici olmadığını, yaşın daha çok ebeveynlik deneyimi ve duygusal olgunlukla ilişkili olarak belirli boyutlarda etkili olabildiğini göstermektedir. Bu bağlamda, mevcut bulgular Türkiye'de aile yapısı ve babalık rollerinin dönüşümünü ele alan çalışmalarla uyumlu bir görünüm sergilemektedir.

Babaların öğrenim düzeylerine göre Baba Katılım Ölçeği (BAKÖ) toplam puanı ve tüm alt boyutlarda istatistiksel olarak anlamlı farklılıklar bulunduğunu göstermektedir. Özellikle lisans ve üstü öğrenim düzeyine sahip babaların, ilkokul, ortaokul ve lise mezunu babalara kıyasla daha yüksek baba katılımı sergiledikleri görülmektedir. Etki büyüklüklerinin BAKÖ toplam puanı ve alt boyutlarda orta ile yüksek düzey arasında değişmesi, öğrenim düzeyinin baba katılımı üzerinde hem istatistiksel hem de pratik açıdan güçlü bir belirleyici olduğunu ortaya koymaktadır. Bu bulgunun olası nedenlerinden biri, öğrenim düzeyi arttıkça babaların çocuk gelişimi, ebeveynlik rolleri ve bakım sorumluluklarına ilişkin farkındalıklarının artmasıdır. Türkiye'de aile ve ebeveynlik üzerine yapılan çalışmalar, eğitim düzeyi yüksek ebeveynlerin çocuklarının gelişimsel gereksinimlerine daha duyarlı olduklarını ve ebeveynlik rollerini daha bilinçli biçimde üstlendiklerini göstermektedir. Kağıtçıbaşı (2010), eğitim düzeyinin artmasıyla birlikte ebeveyn–çocuk ilişkilerinde daha demokratik, destekleyici ve etkileşim temelli bir yaklaşımın benimsendiğini vurgulamaktadır. Keyfi Meşguliyet alt boyutunda öğrenim düzeyine bağlı olarak ortaya çıkan yüksek etki büyüklüğü, eğitim düzeyi yüksek babaların çocuklarıyla oyun oynama, birlikte zaman geçirme ve ortak etkinliklere katılma konusunda daha aktif olduklarını düşündürmektedir. Yapılan çalışmalar, eğitim düzeyi yüksek babaların çocuklarıyla daha fazla sözel etkileşim kurduklarını ve çocuk merkezli oyunlara daha fazla yer verdiklerini ortaya koymaktadır (Yalçın & Koçak, 2018). Bu durum, söz konusu alt boyutta belirgin farklılıkların ortaya çıkmasını açıklamaktadır. İlgi ve Yakınlık alt boyutunda lisans ve üstü öğrenim düzeyine sahip babaların hem ilkokul hem de lise mezunu babalara kıyasla daha yüksek puanlara sahip olması, baba–çocuk ilişkisinin duygusal niteliğinin eğitimle ilişkili olabileceğini göstermektedir. Eğitim düzeyi arttıkça babaların çocukların duygusal ihtiyaçlarını tanıma, empati kurma ve etkili iletişim becerileri geliştirme olasılıklarının yükseldiği belirtilmektedir. Türkiye'de ebeveynlik tutumlarını inceleyen araştırmalar, eğitim düzeyi yüksek babaların daha sıcak ve destekleyici ebeveynlik davranışları sergilediklerini ortaya koymaktadır (Sunar & Fişek, 2005). Temel Bakım alt boyutunda da öğrenim düzeyine göre anlamlı farklılıkların bulunması, eğitim düzeyi yüksek babaların bakım sorumluluklarını daha fazla üstlendiklerini göstermektedir. Bu bulgu, Türkiye'de geleneksel olarak anneye atfedilen bakım rollerinin, eğitim düzeyi arttıkça daha eşitlikçi biçimde paylaşılabildiğine işaret etmektedir. Eğitim düzeyi yüksek babaların çocukların beslenme, giyinme ve günlük bakım süreçlerine daha aktif katılım göstermeleri, baba katılımının yalnızca etkileşim değil, bakım boyutunda da güçlendiğini ortaya koymaktadır.

Babanın gelir düzeyine göre Baba Katılım Ölçeği (BAKÖ) toplam puanı ile Keyfi Meşguliyet ve Temel Bakım alt boyutlarında istatistiksel olarak anlamlı farklılıklar bulunduğunu, buna karşın İlgi ve Yakınlık alt boyutunda gelir düzeyine bağlı anlamlı bir farklılaşma olmadığını göstermektedir. Bu sonuçlar, babanın ekonomik koşullarının baba katılımının bazı boyutlarını etkilerken, duygusal yakınlık gibi ilişki temelli boyutlar üzerinde daha sınırlı bir role sahip olduğunu düşündürmektedir. BAKÖ toplam puanı ile Keyfi Meşguliyet ve Temel Bakım alt boyutlarında anlamlı farkın özellikle orta gelir düzeyi ile iyi gelir düzeyi arasındaki karşılaştırmalardan kaynaklanması, baba katılımının ekonomik kaynaklara erişimle ilişkili olabileceğine işaret etmektedir. Gelir düzeyinin yükselmesi, babaların çocuklarıyla birlikte zaman geçirme, oyun oynama ve günlük bakım süreçlerine katılma olanaklarını artırabilmektedir. Zaman kullanımı ve iş–aile dengesi literatürü, ekonomik koşullar iyileştikçe ebeveynlerin çocuklarına ayırabildikleri zamanın hem nicelik hem de nitelik açısından arttığını ortaya

koymaktadır (Hofferth & Lee, 2015). Keyfi Meşguliyet alt boyutunda gelir düzeyine bağlı olarak ortaya çıkan orta düzeydeki etki büyüklüğü, gelir düzeyi yüksek babaların çocuklarıyla serbest zaman etkinliklerine katılımının daha yüksek olabileceğini göstermektedir. Ekonomik olanakların artması, babaların çocuklarıyla oyun, gezme ve ortak etkinlikler gerçekleştirmesini kolaylaştırmakta; bu durum baba katılımının etkileşim temelli boyutlarını güçlendirebilmektedir. Buna karşılık, orta gelir düzeyindeki babaların ekonomik kaygılar ve iş yükü nedeniyle çocukla geçirilen serbest zamanın daha sınırlı olabileceği değerlendirilmektedir. Temel Bakım alt boyutunda gelir düzeyine bağlı olarak ortaya çıkan küçük–orta düzeydeki etki, babanın ekonomik koşullarının bakım sorumluluklarının paylaşımı üzerinde de etkili olabileceğini göstermektedir. Gelir düzeyi yükseldikçe babaların çocukların günlük bakım ihtiyaçlarına katılımının artması, bakım süreçlerinin daha planlı ve destekleyici biçimde yürütülmesiyle ilişkili olabilir. Bununla birlikte etki büyüklüğünün sınırlı olması, temel bakım davranışlarının yalnızca ekonomik koşullarla değil, aile içi rol paylaşımı ve ebeveynlik anlayışı gibi faktörlerle birlikte değerlendirilmesi gerektiğini göstermektedir. İlgi ve Yakınlık alt boyutunda gelir düzeyine göre anlamlı bir farklılık bulunmaması, baba–çocuk arasındaki duygusal ilişkinin ekonomik koşullardan görece bağımsız bir yapı sergilediğine işaret etmektedir. Bu bulgu, ebeveyn–çocuk ilişkisinin duygusal boyutunun maddi kaynaklardan ziyade ebeveynin duyarlılığı, iletişim biçimi ve aile içi etkileşim örüntüleriyle ilişkili olduğunu vurgulayan çalışmalarla uyumludur (Conger & Donnellan, 2007). Bu bağlamda, baba katılımının duygusal yönünün ekonomik düzeyden bağımsız olarak sürdürülebildiği söylenebilir. Etki büyüklükleri birlikte değerlendirildiğinde, babanın gelir düzeyinin baba katılımı üzerinde istatistiksel olarak anlamlı ancak sınırlı bir etkisinin olduğu görülmektedir. Bu durum, baba katılımının ekonomik koşullardan etkilendiğini; ancak bu etkinin tek başına belirleyici olmadığını ve baba katılımının çok boyutlu bir yapı sergilediğini ortaya koymaktadır.

Babanın çalışma durumuna göre Baba Katılım Ölçeği (BAKÖ) toplam puanı ile Temel Bakım alt boyutunda istatistiksel olarak anlamlı farklılıklar bulunduğunu; buna karşılık Keyfi Meşguliyet ve İlgi ve Yakınlık alt boyutlarında anlamlı bir farklılaşma olmadığını göstermektedir. Çalışmayan babaların Temel Bakım ve BAKÖ toplam puanlarının çalışan babalara kıyasla daha yüksek olması, baba katılımının özellikle zaman erişilebilirliği ve günlük bakım sorumlulukları bağlamında şekillendiğini düşündürmektedir. Bu bulgunun olası nedenlerinden biri, çalışmayan babaların çocukların günlük bakım süreçlerinde fiilen daha fazla bulunabilmeleridir. Çalışma yaşamının dışında olmak ya da aktif istihdamda yer almamak, babaların çocukların beslenme, giyinme, uyku ve hijyen gibi temel bakım ihtiyaçlarına doğrudan katılımını kolaylaştırmaktadır. Zaman kullanımı ve bakım emeği literatürü, ebeveynlerin çocuk bakımına ayırabildikleri zamanın, istihdam durumuna bağlı olarak anlamlı biçimde farklılaştığını ortaya koymaktadır (Craig & Mullan, 2011). Bu bağlamda, çalışmayan babaların temel bakım alt boyutunda daha yüksek puanlara sahip olması beklenen bir sonuç olarak değerlendirilebilir.

BAKÖ toplam puanında da çalışmayan babalar lehine anlamlı bir fark bulunması, temel bakım davranışlarının baba katılımının genel düzeyini yükselten önemli bir bileşen olduğunu göstermektedir. Temel bakım etkinlikleri, baba katılımının sürekliliğini ve görünürlüğünü artıran davranışlar arasında yer almakta; bu etkinliklere düzenli katılım, toplam katılım puanlarını da doğrudan etkilemektedir. Bu durum, baba katılımının niceliksel olarak büyük ölçüde günlük bakım sorumlulukları üzerinden şekillenebildiğini göstermektedir. Buna karşılık, Keyfi Meşguliyet ve İlgi ve Yakınlık alt boyutlarında babanın çalışma durumuna göre anlamlı bir farklılık bulunmaması, bu katılım biçimlerinin istihdam durumundan görece bağımsız bir yapıya sahip olabileceğini düşündürmektedir. Serbest zaman etkinlikleri ve duygusal yakınlık, çoğu zaman babaların iş dışında kalan sınırlı zaman dilimlerinde de sürdürebildikleri etkileşim biçimleri olarak değerlendirilmektedir. İş–aile etkileşimi literatürü, babaların yoğun çalışma koşullarına rağmen çocuklarıyla duygusal bağ kurma ve kısa süreli etkileşimleri sürdürme eğiliminde olabildiklerini ortaya koymaktadır (Nomaguchi & Milkie, 2020). Temel bakım alt boyutunda ortaya çıkan anlamlı farkın, diğer alt boyutlarda görülmemesi, baba katılımının boyutlara göre farklı belirleyicilere sahip olduğunu göstermektedir. Bu bulgu, baba katılımının tek boyutlu bir yapı olmadığını; bakım, oyun ve duygusal yakınlık gibi farklı alanların farklı yapısal ve bağlamsal koşullardan etkilendiğini ortaya koymaktadır. Etki büyüklüklerinin BAKÖ toplam ve Temel Bakım alt boyutlarında anlamlı olması, istihdam durumunun özellikle bakım emeği açısından dikkate değer bir değişken olduğunu göstermektedir.

Babanın çalışma zamanına göre Baba Katılım Ölçeği (BAKÖ) toplam puanı ile tüm alt boyutlarda istatistiksel olarak anlamlı farklılıklar bulunduğunu göstermektedir. Bu farklılıkların özellikle tam zamanlı çalışan babalar ile evde çalışan babalar arasındaki karşılaştırmalardan kaynaklanması, baba katılımının yalnızca zaman miktarıyla değil, zamanın nasıl yapılandırıldığı ve sınırlandırıldığı ile yakından ilişkili olduğunu düşündürmektedir. Etki büyüklüklerinin özellikle İlgi ve Yakınlık alt boyutunda orta düzeyde olması, çalışma zamanının baba–çocuk etkileşiminin duygusal boyutu üzerinde dikkate değer bir etkisi bulunduğunu ortaya koymaktadır. Tam zamanlı çalışan babaların BAKÖ toplam ve tüm alt boyutlarda evde çalışan babalara kıyasla daha yüksek puanlara sahip olması, ilk bakışta zaman erişilebilirliği beklentisiyle çelişkili görünse de, bu durum iş–aile sınırları kuramı çerçevesinde anlam kazanmaktadır. İş ve aile rollerinin mekânsal ve zamansal olarak net biçimde ayrıldığı durumlarda, ebeveynlerin aile zamanını daha planlı, odaklı ve nitelikli biçimde kullanabildikleri belirtilmektedir. Tam zamanlı çalışan babaların iş ve aile rollerini daha belirgin sınırlarla ayırabilmeleri, çocuklarıyla geçirdikleri zamanı daha bilinçli ve etkileşim temelli hâle getirebilmiş olabilir (Clark, 2000). Evde çalışan babaların daha düşük katılım puanlarına sahip olması ise, çalışma ve aile rollerinin aynı mekânda iç içe geçmesiyle ilişkili olabilir. Evden çalışma biçimi, zaman erişilebilirliğini artırmakla birlikte, iş ve aile rollerinin sürekli kesişmesine ve rol çatışmasına yol açabilmektedir. Bu durum, babaların çocuklarıyla geçirdikleri zamanın sürekliliğini ve niteliğini olumsuz etkileyebilmektedir. İş–aile sınırlarının belirsizleştiği durumlarda ebeveynlerin çocukla kurdukları etkileşimin daha bölünmüş ve düzensiz hâle gelebildiği rapor edilmektedir (Allen vd., 2014). İlgi ve Yakınlık alt boyutunda etki büyüklüğünün diğer alt boyutlara kıyasla daha yüksek olması, çalışma zamanının baba–çocuk ilişkisinin duygusal niteliği üzerinde daha belirgin bir rol oynadığını göstermektedir. Tam zamanlı çalışan babaların, iş dışındaki zaman dilimlerini çocuklarıyla duygusal bağ kurmaya ayırmaları; evde çalışan babaların ise iş taleplerinin sürekliliği nedeniyle bu tür etkileşimleri erteleyebilmeleri olasıdır. Bu durum, baba katılımının yalnızca fiziksel olarak birlikte bulunmaya değil, duygusal erişilebilirliğe de bağlı olduğunu ortaya koymaktadır. Yarı zamanlı ve vardiyalı çalışan babalar ile diğer gruplar arasında anlamlı farklılık bulunmaması, bu çalışma biçimlerinin baba katılımı açısından daha heterojen deneyimler içerebileceğini düşündürmektedir. Bu gruplarda çalışma saatlerinin düzensizliği ya da değişkenliği, baba katılımını artırıcı ya da azaltıcı yönde tek tip bir etki yaratmamış olabilir.

Aile tipi değişkenine göre Baba Katılım Ölçeği (BAKÖ) toplam puanı ile Keyfi Meşguliyet, İlgi ve Yakınlık ve Temel Bakım alt boyutlarında istatistiksel olarak anlamlı bir farklılık bulunmadığını göstermektedir. Çekirdek aile, geniş aile ve tek ebeveynli aile yapılarında yer alan babaların katılım düzeylerinin benzer örüntüler sergilemesi, baba katılımının aile tipinden ziyade aile içi işlevsellik ve rol paylaşımıyla ilişkili olabileceğini düşündürmektedir. Etki büyüklüklerinin tüm boyutlarda çok küçük düzeyde olması, aile tipinin baba katılımı üzerinde hem istatistiksel hem de pratik açıdan sınırlı bir etkisinin bulunduğunu ortaya koymaktadır. Bu bulgunun olası açıklamalarından biri, günümüz aile yapılarında aile tipleri arasındaki sınırların giderek geçirgen hâle gelmesidir. Özellikle çekirdek ve geniş aile yapılarında, babaların çocuk bakımına ve çocukla etkileşime katılım düzeyleri, aile tipinden bağımsız olarak benzer biçimlerde şekillenebilmektedir. Aile sistemleri yaklaşımı, ebeveynlik davranışlarının ailedeki birey sayısından çok, rollerin nasıl dağıtıldığı ve aile üyeleri arasındaki etkileşimin niteliği tarafından belirlendiğini vurgulamaktadır (Minuchin, 1985). Türkiye bağlamında aile yapısındaki dönüşümü ele alan çalışmalar, geniş ailelerde yaşayan babaların çocuk bakımına daha az katılım gösterdiğine ilişkin geleneksel varsayımların güncelliğini büyük ölçüde yitirdiğini ortaya koymaktadır. Sunar ve Fişek (2005), Türkiye'de aile yapısının giderek daha esnek ve işlevsel bir hâl aldığını; babalık rollerinin aile tipinden bağımsız olarak yeniden tanımlandığını belirtmektedir. Bu durum, mevcut çalışmada aile tipine göre baba katılımında anlamlı bir farklılık bulunmamasını açıklayan önemli bir bağlam sunmaktadır. Tek ebeveynli aile yapılarında da baba katılımının diğer aile tiplerine benzer düzeylerde olması, baba rolünün yalnızca hane yapısıyla sınırlı bir olgu olmadığını göstermektedir. Babalığın fiziksel olarak aynı evde bulunmaktan ziyade, çocukla kurulan ilişki, sorumluluk alma ve bakım süreçlerine katılım üzerinden tanımlandığı görülmektedir. Bu yaklaşım, baba katılımını "varlık"tan çok "işlev" temelinde ele alan çağdaş ebeveynlik literatürüyle örtüşmektedir (Marsiglio, Amato, Day, & Lamb, 2000). Aile tipine göre anlamlı bir farklılık bulunmaması, baba katılımının aile içindeki destek mekanizmaları, eş ilişkisi ve bireysel ebeveynlik tutumları gibi değişkenlerle daha yakından ilişkili olabileceğini düşündürmektedir. Bu bağlamda, aile tipinin yapısal

bir değişken olarak baba katılımını açıklamada sınırlı kaldığı, aile işlevselliğinin daha belirleyici bir rol oynadığı söylenebilir.

Araştırmada babalığa hazır olma algısına göre Baba Katılım Ölçeği toplam puanı ile Keyfi Meşguliyet ve İlgi ve Yakınlık alt boyutlarında anlamlı farklılıklar bulunmuş; babalığa hazır olduğunu belirten babaların çocuklarıyla daha fazla etkileşim kurdukları ve daha yüksek düzeyde duygusal yakınlık sergiledikleri belirlenmiştir. Temel Bakım alt boyutunda ise anlamlı bir farklılık saptanmamıştır. Bu bulgular, babalığa hazır olma algısının baba katılımının özellikle etkileşim ve duygusal boyutlarıyla ilişkili olduğunu göstermektedir. Babalığa hazır olma algısı, ebeveynlik öz-yeterliği ve babalık rolünü benimseme süreçleriyle ilişkilidir. Kendini bu role hazır hisseden babaların, çocuklarıyla etkileşim kurmaya ve duygusal bağ geliştirmeye daha istekli oldukları belirtilmektedir (Bandura, 1997). Alanyazında yer alan benzer çalışmalarda babalık rolünü bilinçli biçimde üstlenen babaların çocuklarıyla daha nitelikli zaman geçirdiklerini ortaya koymaktadır (Biber, 2016; İvrendi & Işıkoğlu, 2010; Jones & Prinz, 2005; Semiz & Ören, 2024). Temel bakım davranışlarının ise daha çok zaman, çalışma koşulları ve aile içi iş bölümü gibi yapısal etmenlerle ilişkili olduğu düşünülmektedir.

Sonuç olarak araştırmada, BAKÖ toplam puanı ile Keyfi Meşguliyet, İlgi ve Yakınlık ve Temel Bakım alt boyutlarının çeşitli demografik ve bağlamsal değişkenlere göre farklılaşıp farklılaşmadığı incelenmiştir. Elde edilen bulgular doğrultusunda, baba katılımının tek bir değişkenle açıklanamayacak ölçüde çok boyutlu ve bağlama duyarlı bir yapı sergilediği sonucuna ulaşılmıştır. Ayrıca BAKÖ toplam puanı ve alt boyutlarının çocuğun cinsiyetine göre anlamlı biçimde farklılaşmadığı çocuk yaşı değişkenine göre BAKÖ toplam puanı ve alt boyutlarda anlamlı farklılıklar bulunduğu, kardeş sayısı değişkenine göre BAKÖ toplam puanı ve alt boyutlarda anlamlı farklılıklar bulunduğu, baba yaşı değişkenine göre baba katılımının genel düzeyinde belirgin bir farklılık bulunmadığı, ancak duygusal yakınlık boyutunda farklılaşma görülebildiği, baba öğrenim düzeyi değişkenine göre BAKÖ toplam puanı ve alt boyutlarda anlamlı farklılıklar bulunduğu, babanın gelir düzeyi değişkenine göre baba katılımının bazı boyutlarında anlamlı farklılaşmalar görüldüğü, babanın çalışma durumuna göre baba katılımının özellikle temel bakım boyutunda farklılaştığı, babanın çalışma zamanına göre BAKÖ toplam puanı ve alt boyutlarda anlamlı farklılıklar bulunduğu, aile tipi değişkenine göre BAKÖ toplam puanı ve alt boyutlarda anlamlı farklılaşma bulunmadığı, babalığa hazır olma algısına göre BAKÖ toplam puanı ve alt boyutlarda anlamlı farklılıklar bulunduğu, sonucuna ulaşılmıştır.

Bu araştırmada elde edilen bulgular doğrultusunda aşağıda bazı öneriler sunulmuştur.

- Baba katılımını daha kapsamlı ve derinlemesine açıklayabilecek yeni araştırmalara ihtiyaç duyulduğu görülmektedir. Bu kapsamda, baba katılımının yalnızca demografik değişkenler üzerinden değil, bireysel, ilişkisel ve bağlamsal boyutları birlikte ele alan bütüncül yaklaşımlarla incelenmesi önerilmektedir.
- Bu araştırmada nicel veriler üzerinden ulaşılan sonuçların derinleştirilmesi amacıyla, ilerleyen çalışmalarda nitel araştırma yöntemlerine yer verilmesi önerilmektedir. Özellikle babaların babalığa hazır olma algılarını, bakım sorumluluklarını ve çocukla kurdukları ilişkiyi nasıl anlamlandırdıklarını ortaya koyacak görüşme ve gözlem çalışmalarının, nicel bulgulara anlam kazandıracağı düşünülmektedir.
- Baba katılımının gelişimsel bir süreç olduğu dikkate alındığında, gelecek çalışmalarda boylamsal araştırma desenlerinin kullanılması önerilmektedir. Bu tür çalışmalar, baba katılımının çocuk yaşı ilerledikçe nasıl değiştiğini ve farklı gelişim dönemlerinde hangi boyutlarının öne çıktığını ortaya koymaya katkı sağlayabilir.
- Aile tipi değişkeninde anlamlı farklılık bulunmaması, aile yapısından ziyade aile içi işlevselliğin daha belirleyici olabileceğini düşündürdüğünden, gelecek araştırmalarda eş ilişkisi, ebeveynler arası iş birliği, rol paylaşımı ve algılanan sosyal destek gibi değişkenlerin modele dâhil edilmesi önerilmektedir.
- Çalışma zamanı ve evden çalışma biçiminin baba katılımıyla ilişkili bulunması, ilerleyen araştırmalarda farklı çalışma modellerinin baba–çocuk etkileşimi üzerindeki etkilerinin daha ayrıntılı biçimde incelenmesini gerekli kılmaktadır. Özellikle iş ve aile yaşamı arasındaki sınırların nasıl kurulduğuna ve bu sınırların baba–çocuk etkileşimini nasıl şekillendirdiğine

odaklanan çalışmaların, baba katılımını açıklamada önemli katkılar sunabileceği düşünülmektedir.

- Son olarak, farklı kültürel ve sosyoekonomik bağlamlarda yürütülecek karşılaştırmalı çalışmaların, baba katılımının bağlamsal özelliklerini ortaya koyarak alan yazına katkı sağlayacağı düşünülmektedir.

KAYNAKLAR

Allen, T. D., Cho, E., & Meier, L. L. (2014). Work–family boundary dynamics: A person–environment fit perspective. *Journal of Applied Psychology, 99*(1), 99–121. https://doi.org/10.1037/a0036235

Arslan, R. (2022). Erken çocukluk döneminde baba katılımı konusunda yapılan lisansüstü tezlerin çeşitli değişkenler açısından incelenmesi. *Uluslararası Erken Çocukluk Eğitimi Çalışmaları Dergisi*, *7*(2), 1–12.

Bandura, A. (1997). Self-efficacy: The exercise of control. W. H. Freeman.

Biber, K. (2016). Perceptions of father involvement among Turkish fathers. *Journal of Education and Training Studies, 4*(1), 1–9.

Cabrera, N. J., Fitzgerald, H. E., Bradley, R. H., & Roggman, L. (2014). The Ecology of Father-Child Relationships: An Expanded Model. *Journal of Family Theory & Review, 6*(4), 336–354.https://doi.org/10.1111/jftr.12054

Cabrera, N. J., Volling, B. L., & Barr, R. (2018). Fathers are parents, too! *Child Development Perspectives, 12*(3), 152–157.https://doi.org/10.1111/cdep.12275

Clark, S. C. (2000). Work/family border theory: A new theory of work/family balance. *Human Relations, 53*(6), 747–770. https://doi.org/10.1177/0018726700536001

Cohen, J. (1988). Statistical power analysis for the behavioral sciences (2nd ed.). Lawrence Erlbaum Associates.

Conger, R. D., & Donnellan, M. B. (2007). An interactionist perspective on the socioeconomic context of human development. *Annual Review of Psychology, 58*, 175–199. https://doi.org/10.1146/annurev.psych.58.110405.085551

Craig, L., & Mullan, K. (2011). How mothers and fathers share childcare: A cross-national time-use comparison. *American Sociological Review, 76*(6), 834–861. https://doi.org/10.1177/0003122411427673

Garcia, O. F., Serra, E., Garcia, F., Martínez, I., & Cruise, E. (2022). Parenting styles and short- and long-term socialization outcomes: A study among parents and children. *Frontiers in Psychology*, 13, 926234. https://doi.org/10.3389/fpsyg.2022.926234

George, D., & Mallery, P. (2010). SPSS for Windows step by step: A simple guide and reference (10th ed.). Pearson.

Greenhaus, J. H., & Allen, T. D. (2011). Work–family balance. In *APA handbook of industrial and organizational psychology* (pp. 165–183). APA.

Grossmann, K. E., Grossmann, K., Fremmer-Bombik, E., Kindler, H., Scheuerer-Englisch, H., & Zimmermann, P. (2002). The uniqueness of the child–father attachment relationship: Fathers' sensitive and challenging play as a pivotal variable in a 16-year longitudinal study. *Social Development, 11*(3), 301–337. https://doi.org/10.1111/1467-9507.00202

Hofferth, S. L., & Lee, Y. (2015). Family structure and time use. *Journal of Family Issues, 36*(3), 333–356. https://doi.org/10.1177/0192513X13478317

İvrendi, A., & Işıkoğlu, N. (2010). A Turkish view on fathers' involvement in children's play. *Early Childhood Education Journal, 37*(6), 519–526. https://doi.org/10.1007/s10643-010-0380-4

Jeynes, W. H. (2015). Father involvement and children's academic achievement: A meta-analysis. *Urban Education, 50*(6), 708-743.

Jones, T. L., & Prinz, R. J. (2005). Potential roles of parental self-efficacy in parent and child adjustment: A review. *Clinical Psychology Review, 25*(3), 341–363. https://doi.org/10.1016/j.cpr.2004.12.004

Kağıtçıbaşı, Ç. (2010). Benlik, aile ve insan gelişimi: Kültürel psikoloji. Koç Üniversitesi Yayınları.

Karadeniz, G., & Kaya, B. N. (2025). Babalık rolü algısı ile babanın katılımı arasındaki ilişkilerin baba-çocuk oyununa yansımaları. *Akdeniz Kadın Çalışmaları ve Toplumsal Cinsiyet Dergisi*, 8(1), 71–95. https://doi.org/10.33708/ktc.1509129

Lamb, M. E. (2010). *The role of the father in child development* (5th ed.). Wiley.

Marsiglio, W., Amato, P., Day, R. D., & Lamb, M. E. (2000). Scholarship on fatherhood in the 1990s and beyond. *Journal of Marriage and Family, 62*(4), 1173–1191. https://doi.org/10.1111/j.1741-3737.2000.01173.x

Minuchin, S. (1985). Families and family therapy. Harvard University Press.

Nomaguchi, K. M., & Milkie, M. A. (2020). Parenthood and well-being: A decade in review. *Journal of Marriage and Family, 82*(1), 198–223. https://doi.org/10.1111/jomf.12646

Palm, G., & Fagan, J. (2008). Father involvement in early childhood programs: Review of the literature. *Early Child Development and Care, 178*(7–8), 745–759. https://doi.org/10.1080/03004430802352137

Parke, R. D. (2004). Development in the family. *Annual Review of Psychology, 55*, 365–399. https://doi.org/10.1146/annurev.psych.55.090902.141528

Pleck, J. H. (2010). Paternal involvement. *Marriage & Family Review, 46*(3), 182–204.

Puglisi, N., Rattaz, V., Favez, N., & Tissot, H. (2024). Father involvement and emotion regulation during early childhood: A systematic review. *BMC Psychology, 12*, Article 675. https://doi.org/10.1186/s40359-024-02182-x

Rollè, L., Gullotta, G., Trombetta, T., Curti, L., Gerino, E……. (2019). Father involvement and children's psychological adjustment: A systematic review. *Frontiers in Psychology*, 10, 2405. https://doi.org/10.3389/fpsyg.2019.02405

Sarkadi, A., Kristiansson, R., Oberklaid, F., & Bremberg, S. (2008). Fathers' involvement and children's developmental outcomes: A systematic review of longitudinal studies. *Acta Paediatrica*, 97(2), 153–158. https://doi.org/10.1111/j.1651-2227.2007.00572.x

Semiz, S., & Ören, M. (2024). Okul öncesi dönemde baba kişiliği, babalık rolü algısı ve sosyal davranışlar: Baba katılımının aracı rolü. *Anadolu Üniversitesi Eğitim Fakültesi Dergisi*, *8*(1), 244–275. https://doi.org/10.34056/aujef.1315331

Sımsıkı, H., & Şendil, G. (2014). Baba Katılım Ölçeği'nin (BAKÖ) geliştirilmesi. *Elektronik Sosyal Bilimler Dergisi*, 13(49), 104–123.

Sunar, D., & Fişek, G. (2005). Contemporary Turkish families. In J. L. Roopnarine & U. Gielen (Eds.), Families in global perspective (pp. 169–183). Allyn & Bacon.

Yalçın, H., & Koçak, N. (2018). Okul öncesi dönemde baba katılımını etkileyen değişkenlerin incelenmesi. *Türkiye Sosyal Araştırmalar Dergisi, 22*(2), 395–410.

Yoon, S., Bellamy, J. L., Kim, W., & Yoon, D. (2021). Father involvement and behavior problems among young children: The role of paternal warmth. *Journal of Family Psychology*, 35(2), 197–207.

MEKANİK BİR ADIM, İNSANÎ BİR DOKUNUŞ: ROBOTLARIN ÖZEL EĞİTİMDEKİ YOLCULUĞU

A MECHANICAL STEP, A HUMAN TOUCH: THE JOURNEY OF ROBOTS IN SPECIAL EDUCATION

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ÖZET

Son yıllarda hızla gelişen robotik sistemler, özel eğitim alanında öğretim süreçlerini dönüştürerek öğrenme deneyimlerini zenginleştiren yenilikçi araçlar olarak öne çıkmaktadır. Bu teknolojiler, özel gereksinimli bireylerin öğrenme motivasyonlarını artırmak, sosyal etkileşimlerini güçlendirmek ve bağımsız yaşam becerilerini desteklemek açısından önemli bir rol üstlenmektedir. Bununla birlikte, teknik altyapı eksiklikleri, finansal sınırlılıklar, etik ve güvenlik kaygıları ile teknolojiye yönelik olumsuz tutumlar, robotik öğretim uygulamalarının özel eğitim ortamlarında etkili ve sürdürülebilir bir şekilde kullanılmasını zorlaştırmaktadır. Dolayısıyla, bu araştırma, robotik teknolojilerin özel eğitim ortamlarında kullanımına yönelik mevcut uygulamaları inceleyerek süreçte karşılaşılan sınırlılıkları ortaya koymayı amaçlamaktadır. Ayrıca, bu araştırmanın bir diğer amacı, robotik teknolojilerin özel eğitimde kullanılmasına ilişkin etik ilkeleri derinlemesine incelemektir. Bu araştırma, nitel araştırma yaklaşımına dayalı olarak tasarlanmış betimsel bir alan yazın incelemesi niteliğindedir. Araştırmada, özel eğitimde robotik teknolojilerin kullanımını konu alan ulusal ve uluslararası çalışmalar incelenmiştir. Alandaki güncel eğilimleri belirleyebilmek amacıyla 2015-2025 yılları arasında yayımlanan çalışmalar IEEE Xplore, ERIC, Scopus ve Web of Science veri tabanlarında taranmıştır. Elde edilen çalışmalar, nitel veri çözümleme yaklaşımlarından içerik analizi yöntemi kullanılarak değerlendirilmiştir. Araştırma bulguları, robotik teknolojilerin özel eğitimde özellikle otizm spektrum bozukluğu, zihinsel yetersizlik ve bedensel yetersizlik grubundaki bireylerle yürütülen öğretim süreçlerinde yoğun olarak kullanıldığını göstermektedir. Alan yazında yer alan çalışmalar, robotik teknolojilerin öğrencilerin dikkatini daha uzun süre sürdürebilmesine olanak tanıdığını, öğrenmeye yönelik içsel güdülerini desteklediğini ve sosyal etkileşim becerilerinin gelişiminde önemli katkılar sunduğunu göstermektedir. Ayrıca, robotik uygulamaların bireyselleştirilmiş öğretimi destekleyerek öğrenme sürecini daha etkileşimli ve verimli hâle getirdiği belirlenmiştir. Bununla birlikte, elde edilen bulgular robotik sistemlerin kullanımında yaşanan teknik aksaklıkların, öğretim sürecini destekleyecek uzman desteğinin sınırlı olmasının ve araç-gereç erişimindeki yetersizliklerin öğretim sürecinin sürekliliğini ve kalitesini olumsuz etkilediğini göstermektedir. Ayrıca, robotik uygulamaların eğitim süreçlerine dâhil edilmesinde veri koruma standartlarının belirsizliği, öğrencilerin kişisel bilgilerinin

güvence altına alınmasındaki güçlükler ve etik onam mekanizmalarının yeterince yapılandırılmamış olması, bu teknolojilerin kullanımını etik açıdan tartışmalı hâle getiren temel etmenler arasında değerlendirilmektedir. Bu doğrultuda, özel eğitimde robotik teknolojilerin etkili bir şekilde kullanılabilmesi için öğretmenlerin teknolojik yeterliklerini geliştirmeye yönelik hizmet içi eğitim programlarının hazırlanması, altyapı ve donanım yatırımlarının güçlendirilmesi ve erişilebilirliği artıran düşük maliyetli yerli çözümlerin desteklenmesi gerekmektedir. Ayrıca, robotik teknolojilerin özel eğitimde kullanımına yönelik etik riskleri en aza indirmek için veri gizliliği politikalarının güçlendirilmesi, öğrenci mahremiyetini koruyan açık protokollerin oluşturulması ve insan-robot etkileşiminde ortaya çıkabilecek etik sorunlara yönelik rehberlerin hazırlanması gerekmektedir.

Anahtar Kelimeler: Robotik Teknolojiler, Özel Eğitim, Etik, İnsan-Robot Etkileşimi.

ABSTRACT

In recent years, rapidly developing robotic systems have emerged as innovative tools that transform teaching processes in special education, enriching learning experiences. These technologies play a significant role in increasing the learning motivation of individuals with special needs, strengthening their social interactions, and supporting their independent living skills. However, technical infrastructure deficiencies, financial constraints, ethical and safety concerns, and negative attitudes toward technology make it difficult to use robotic teaching applications effectively and sustainably in special education settings. Therefore, this research aims to examine current applications of robotic technologies in special education settings and identify the limitations encountered in the process. Furthermore, another objective of this research is to thoroughly examine the ethical principles related to the use of robotic technologies in special education. This research is a descriptive literature review based on a qualitative research approach. The study examined national and international studies on the use of robotic technologies in special education. In order to identify current trends in the field, studies published between 2015 and 2025 were searched in the IEEE Xplore, ERIC, Scopus, and Web of Science databases. The studies obtained were evaluated using the content analysis method from qualitative data analysis approaches. The research findings show that robotic technologies are intensively used in special education, particularly in teaching processes conducted with individuals with autism spectrum disorder, intellectual disability, and physical disability. Studies in the field show that robotic technologies enable students to sustain their attention for longer periods, support their intrinsic motivation to learn, and make significant contributions to the development of their social interaction skills. Furthermore, it has been determined that robotic applications support individualized teaching, making the learning process more interactive and efficient. However, the findings show that technical glitches in the use of robotic systems, limited expert support to assist in the teaching process, and insufficient access to tools and equipment negatively affect the continuity and quality of the teaching process. Furthermore, the uncertainty of data protection standards, difficulties in securing students' personal information, and insufficiently structured ethical consent mechanisms in the inclusion of robotic applications in educational processes are considered key factors that make the use of these technologies ethically controversial. In this regard, in order for robotic technologies to be used effectively in special education, it is necessary to prepare in-service training programs aimed at developing teachers' technological competencies, strengthen infrastructure and hardware investments, and support low-cost local solutions that increase accessibility. Furthermore, to minimize the ethical risks associated with the use of robotic technologies in special education, it is necessary to strengthen data privacy policies, establish open protocols that protect student privacy, and prepare guidelines addressing ethical issues that may arise in human-robot interaction.

Keywords: Robotic Technologies, Special Education, Ethics, Human-Robot Interaction.

METAVERSE TEKNOLOJİSİNİN ÖZEL EĞİTİMDEKİ DÖNÜŞTÜRÜCÜ ROLÜNÜN İNCELENMESİ

EXAMINING THE TRANSFORMATIVE ROLE OF METAVERSE TECHNOLOGY IN SPECIAL EDUCATION

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ÖZET

Metaverse, sanal, artırılmış ve karma gerçeklik teknolojilerini bir araya getirerek oluşturulan çok katmanlı bir sanal evrendir. Bu evrende kullanıcılar, üç boyutlu, etkileşimli ve kalıcı dijital ortamlarda temsili avatarlar aracılığıyla çeşitli deneyimler yaşayabilmektedir. Mevcut araştırma, metaverse teknolojisinin özel eğitimdeki rolünü incelemeyi amaçlamaktadır. Bu araştırma, nitel araştırma yaklaşımıyla yürütülen betimsel bir alan yazın incelemesi niteliğindedir. Çalışmada, metaverse teknolojisinin özel eğitimdeki kullanımına ilişkin ulusal ve uluslararası düzeyde yayımlanan araştırmalar analiz edilmiştir. İlgili yayınlara ulaşmak amacıyla 2015–2025 yılları arasında yayımlanan çalışmalar Google Scholar, ERIC, Scopus ve Web of Science veri tabanlarında taranmıştır. Elde edilen araştırmalar, içerik analizi yöntemi kullanılarak çözümlenmiştir. Araştırmadan elde edilen bulgular, metaverse teknolojisinin özel eğitim alanına sağladığı olumlu etkileri detaylı bir şekilde ortaya koymaktadır. Metaverse, öğrencilerin bireysel ihtiyaçlarına uygun olarak özelleştirilmiş öğrenme deneyimleri sunmaktadır. Bu kişiselleştirilmiş yaklaşım, özel gereksinimli bireylerin öğrenme süreçlerini daha etkili ve verimli hâle getirmektedir. Ayrıca, metaverse, öğrencilere görsel olarak zengin eğitim materyalleri sunarak, öğrenme sürecini daha çekici ve etkili hale getirmektedir. Bunun yanı sıra, metaverse teknolojisi, öğrencilere güvenli ve etkileşimli sanal ortamlarda iş birliğine dayalı öğrenme deneyimleri sunarak sosyal becerilerini geliştirmelerine olanak sağlamaktadır. Öte yandan, metaverse teknolojisi, güvenli sanal simülasyonlar yoluyla öğrencilerin çeşitli senaryoları deneyimlemesine imkân tanıyarak onların gerçek dünyadaki durumlara daha iyi hazırlanmalarına yardımcı olmaktadır. Son olarak, metaverse tabanlı oyunlaştırılmış öğrenme deneyimleri, öğrencilerin derse olan ilgisini artırarak motivasyon ve katılım düzeylerini yükseltmektedir. İncelenen araştırmalar, metaverse teknolojisinin özel eğitim alanına uyarlanması sürecinde çeşitli zorluklarla karşılaşıldığını ortaya koymaktadır. Bazı öğrenciler, teknolojik altyapının yetersizliği ve gerekli cihazlara ulaşmadaki güçlükler nedeniyle bu teknolojiden beklenen düzeyde yararlanamamaktadır. Bununla birlikte, metaverse tabanlı öğrenme ortamlarında kişisel verilerin kötüye kullanılması, öğrenci mahremiyetini ihlal ederek etik sorumlulukların yerine getirilmemesine yol açmaktadır. Ayrıca, alan yazında yer alan araştırmalar, metaverse'in aşırı kullanımının öğrencilerde teknolojiye bağımlılık geliştirme riskini artırabileceğini ortaya koymaktadır. Bu durum, öğrencilerin dijital ortama aşırı odaklanarak gerçek yaşam deneyimlerinden uzaklaşmalarına neden olabilmektedir. Öte yandan, metaverse teknolojisinin kurulumu ve sürdürülebilir bakımı genellikle yüksek maliyet gerektirmektedir. Dolayısıyla, metaverse teknolojisinin yüksek maliyeti özellikle sınırlı bütçesi olan eğitim kurumları açısından önemli bir engel teşkil etmektedir. Bu araştırmada, metaverse teknolojisinin özel eğitimdeki etkisini güçlendirmeye yönelik çeşitli öneriler sunulmaktadır. Öncelikle, metaverse uygulamalarının tüm öğrenciler için erişilebilir olmasını sağlamak amacıyla, cihaz ve internet erişimindeki eksikliklerin giderilmesine

yönelik çalışmalar yapılmalıdır. Öğrencilerin kişisel verilerinin güvenliğini sağlamak amacıyla, metaverse ortamlarında uygulanacak gizlilik ve güvenlik politikalarının geliştirilmesi gerekmektedir. Bu politikaların teknolojik gelişmeler doğrultusunda düzenli aralıklarla güncellenmesi de büyük önem taşımaktadır. Son olarak, eğitimcilerin metaverse teknolojilerini etkili bir şekilde kullanabilmeleri için gerekli bilgi ve becerileri kazanmalarına yönelik hizmet içi eğitim programlarının düzenlenmesi önerilmektedir.

Anahtar Kelimeler: Metaverse, Yapay Zeka, Özel Eğitim, Özel Gereksinimli Bireyler.

ABSTRACT

The metaverse is a multi-layered virtual universe created by combining virtual, augmented, and mixed reality technologies. In this universe, users can experience various interactions through representative avatars in three-dimensional, interactive, and persistent digital environments. The current research aims to examine the role of metaverse technology in special education. This research is a descriptive literature review conducted using a qualitative research approach. The study analyzes national and international research published on the use of metaverse technology in special education. To access relevant publications, studies published between 2015 and 2025 were searched in the Google Scholar, ERIC, Scopus, and Web of Science databases. The obtained studies were analyzed using the content analysis method. The findings from the research reveal in detail the positive effects of metaverse technology on the field of special education. The metaverse offers learning experiences customized to the individual needs of students. This personalized approach makes the learning processes of individuals with special needs more effective and efficient. Furthermore, the metaverse makes the learning process more engaging and effective by providing students with visually rich educational materials. In addition, metaverse technology enables students to develop their social skills by offering collaborative learning experiences in safe and interactive virtual environments. On the other hand, metaverse technology helps students better prepare for real-world situations by allowing them to experience various scenarios through secure virtual simulations. Finally, metaverse-based gamified learning experiences increase students' interest in the course, raising their motivation and participation levels. The studies reviewed reveal that various challenges are encountered in the process of adapting metaverse technology to the field of special education. Some students are unable to benefit from this technology to the expected extent due to inadequate technological infrastructure and difficulties in accessing the necessary devices. Furthermore, the misuse of personal data in metaverse-based learning environments violates student privacy and leads to a failure to fulfill ethical responsibilities. Furthermore, studies in the field literature reveal that excessive use of the metaverse may increase the risk of developing technology addiction in students. This situation may cause students to become overly focused on the digital environment and distance themselves from real-life experiences. On the other hand, the setup and sustainable maintenance of metaverse technology generally require high costs. Therefore, the high cost of metaverse technology poses a significant obstacle, especially for educational institutions with limited budgets. This study presents various recommendations aimed at enhancing the impact of metaverse technology in special education. First, efforts should be made to address deficiencies in device and internet access to ensure that metaverse applications are accessible to all students. To ensure the security of students' personal data, privacy and security policies to be implemented in metaverse environments must be developed. It is also crucial that these policies are regularly updated in line with technological developments. Finally, it is recommended that in-service training programs be organized to enable educators to acquire the necessary knowledge and skills to effectively use metaverse technologies.

Keywords: Metaverse, Artificial Intelligence, Special Education, Individuals with Special Needs.

CDS YARIMKEÇİRİCİLƏRİNDƏ MİS DİFFUZİYANIN VE FOTOSTİMULYASİYANIN KONTAKT VE FOTOELEKTRİK XASSƏLƏRƏ TƏSİRİNİN TƏDQİQİ

STUDY OF THE EFFECT OF COPPER DIFFUSION AND PHOTOSTIMULATION ON CONTACT AND PHOTOELECTRIC PROPERTIES IN CDS SEMICONDUCTORS

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Özət

Bu işdə Cu–CdS kontaktlarında mis diffuziyasının ve fotostimülyasının yarımkeçiricinin elektrik ve fotoelektrik xassələrinə təsiri araştırılmıştır. Misin elektron qohumluğunun CdS-dən az olması baxmayaraq, işıqlandırma və termik emal nəticəsində mis atomlarının CdS altlığının diffuziyası müşahidə edilmiş ve səthəyaxın oblastda kompensasiya olunmuş qatların yaranmasına səbəb olmuşdur. Aparılan spektral ölçü cihazı göstərmişdir ki, Cu diffuziyası CdS-də qadağan olunmuş zonada (≈1,8 eV) enerjik səviyyələr yaradır və bu da udma Cu–CdS–Cu simmetrik strukturlarında işıqlandırmadan əvvəl və sonra qeyd olunan volt-amper xarakteristikaları fotohəssaslığın mühafizəsini göstərmişdir. Bunun səbəbi işığın təsiri ilə mis ionlarının (xüsusilə Cu^+) işıqlanan səthə doğru daha çok diffuziya etməsi ve rekombinasiya mərkəzlərinin yaranmasıdır. Əlavə olaraq, ışığın eyni zamanda tətbiq olunan elektrik sahəsi ilə birlikdə struktura daha güclü təsir etdiyi müəyyən edilmişdir

Açar sözlər: Fotostimülyasiya, diffuzuya, termik emal, aşqar temperatur.

Phd. Akbarova Nurida Yashar

Abstract

In this study, the effects of copper diffusion and photostimulation in Cu–CdS contacts on the electrical and photoelectrical properties of the semiconductor were investigated. Although the electron affinity of copper is lower than that of CdS, illumination and thermal treatment cause copper atoms to diffuse into the CdS substrate, leading to the formation of compensated layers in the near-surface region.

Spectral measurements showed that Cu diffusion creates energetic levels within the forbidden band of CdS (≈1.8 eV), which results in additional absorption. In Cu–CdS–Cu symmetric structures, the voltage–current characteristics recorded before and after illumination demonstrated changes in photosensitivity. The reason for this is the enhanced diffusion of copper ions (particularly Cu^+) toward the illuminated surface under light exposure and the formation of recombination centers.

Furthermore, it was determined that the simultaneous application of illumination and an external electric field produces an even stronger effect on the structure.

Keywords: Photostimulation, diffusion,thermal treatment,doping temperature.

Əslində mislə n-tip CdS arasındakı kontakt düzənləndirici olmamalıdır, çünki misin elektron qohumluğu (Fm=4,4 eV) CdS-in elektron qohumluğundan (FCdS=4,5 eV) azdır. Lakin xarici təsirlər hesabına Cds-ə çəkilmiş mis təbəqələrinin altlığın digər tərəfinə (CdS tərəfə) nüfuz etməsi nəticəsində kompensə olunmuş oblast əmələ gələ bilər ki, bu da Cu-CdS strukturunun elektrik, fotoelektrik və digər xassələrinə təsir edə bilər.

Əvvəlcə CdS-ə diffuziya etmiş mis aşqarının energetik səviyyələrinin göstəricilərinə baxaq.

Tozşəkilli CdS-in səthinə 9000C-də Cu(NO3)2 məhlulundan çökdürülmüş qatdan misin CdS-ə diffuziya etməsi, qadağan olunmuş zonada valent zonanın yuxarısında 1,8 eV məsafədə energetik səviyyə yaradır.

Nisbətən aşqar temperaturlarda (400-5000C) CdS monokristalının diffuzion aşqarlanması /5/ işində yerinə yetirilmişdir. Bu təcrübələrdə n-tip müstəvi paralel nümunələrin T=3000K-də xüsusi müqaviməti (-109om□sm qalınlığı 0,06÷0,08 sm) üzərinə vakuumda mis oturdulmuşdur. Sonra nümunəni aşqarlanmaq üçün onu üsücü komponent olan kükürdün buxarlanmasının qarşısını almaqdan ötəri içərisində əlavə olaraq CdS tozu olan kvars ampulanın içərisinə yerləşdirmişlər. Ampula □6□10-3□a vakuumadək sorulmuşdur. Termik emal 400-5000C-də nümunənin bütün həcminin eyni qaydada aşqarlanması lazım olan müddətdə aparılmışdır.

Termik emalın təsirini nəzərə almaq məqsədilə mislə aşqarlanmaq üçün qoyulmuş CdS nümunəsi ilə yanaşı eyni zamanda analoъi şəraitdə (yalnız mis aşqarı olmadan) ayrıca bir ampulada kontrol nümunələr termik emal olunmuşdur.

Diffuzion aşqarlanmadan sonra nümunələrin hər iki işçi səthindən zədələnmiş qatlar aradan götürülmüş və optik ölçmələr aparmaq üçün bu səthlər cilalanmışlar. Hər iki nümunənin qalınlığı 2 mkm-dən artıq olmamışdır.

Şəkil 2-də 4000C-də mislə aşqarlanmış CdS nümunəsi ilə kontrol nümunə arasında udulma əmsallarının fərqinin spektril paylanması göstərilmişdir. Göründüyü kimi misin CdS-ə diffuzion daxil edilməsi h□□1,3eV enerjilərdə əlavə udmanın meydana çıxmasına səbəb olur ki, bu da yükdaşıyıcıların valent zonadan dərin mis enerji səviyyəsinə keçməsi ilə izah olunur.

Indi isə Cu-CdS-Cu simmetrik strukturuna işıqlanmanın təsirinin nəticələrinə baxaq. Belə strukturlar n-tip müstəvi paralel CdS-in (d=0,5mm T=300 K-olduqda) iki qarşı səthinə nazik yarımşəffaf mis qatının (qalınlığı 50 nm) vakuumda uçurdulması ilə aranmışdır. Bu qayda ilə alınmış Cu-CdS-Cu strukturunda ilkin olaraq qaranlıqda aə işıqda (işıqlanmanın intensivliyi p=25mvt/sm2) volt-amper xaraktersitikaları və fotohəssaslığı spektrləri öyrənilmişdir. Sonra bu strukturlar bir tərəfləri qaranlıq saxlanılmaqla digər tərəfi ağ işığın işıqlandırılmışdı

Şəkil 2. Mislə diffuzion aşqarlanmış CdS- nümunəsi ilə kontrol nümunəsinin udma əmsalları

fərqinin (□□=□1□2) spektral paylanması.

Şəkil 3. birtərəfli işıqlanmadan qabaq (1) və sonra (2) Cu-CdS-Cu

strukturunun (pCdS□109□□sm) qaranlıq (a) və işıq (b)

volt amper xarakteristikaları.

Bütün bu ölçülər otaq temperaturdan aparılmışdır. Işığın intensivliyi p=25mvt/sm2 işıqlanma müddəti isə 1 saat olmudur. Bundan sonra ölçmələr təkrar olunmuşdur. Qeyd etmək lazımdır ki, istər işığın təsiri ilə volt-amper xarakteristikası çıxarılarkən, istərsə də struktur 1 saat müddətində işıqlanmaya məruz qaldıqda həmişə eyni bir C səthi işıqlandırırlar. Digər səth isə həmişə qaranlıqda saxlanılır (T-səthi).

3-şəklində 1saatlıq işıqlanmadan qabaq (1-əyriləri) və işıqlanmadan sonra (2 əyriləri) Cu-CdS-Cu strukturunun qaranlıq (a) və işıq (b) volt amper əyriləri göstərilmişdir.

Göründüyü kimi, 1 saatlıq işıqlanmadan sonrakı fotohəssaslıq işıqlanmaya qədərki fotohəssaslıqdan azdır. Qısaqapanma cərəyanının sıxlığı və açıq dövrdə gərginliyin (p=380mvt/sm2 olduqda) işıqlanmadan qabaq Iqq=0,3mA/sm2; Uad=0,07v işıqlanmadan sonra isə Iqq=0,1 mA/sm2, Uad=0,08v olmuşdur. Bu dəyişikliklər n-tip CdS-ə onda akseptor xassələr yarada bilən misin fotostimulyasiya yolu ilə daxil olması ilə izah olunur ki, bu da altlığın səthəyaxın oblastında kompensə olunmuş səthlərin yaranmasına gətirib çıxarır.

Analoji efektlər yüksəkomlu n-tip CdS əsasında yaradılmış Cu-CdS-Cu simmetrik strukturunda da müşahidə olunmuşdur (p=109□□sm).

Əgər fərz etsək ki, işığın təsiri ilə Cu-CdS-Cu xarakteristikalarının dəyişməsi effekti mis aşqarlarının ionlaşması və (Cu0) neytral mis atomlarından və ya (Cu-) mis ionlarından daha çox mütəhərrik olan (Cu+) müsbət yüklü mis ionlarının işıqlandırılan səth tərəfindən CdS-ə daha çox daxil olması ilə əlaqələndirilməlidir. Bunu yoxlamaq üçün yüksəkomlu CdS əsasında yaradılmış Cu-CdS-Cu strukturunun 1 saatlıq bir səthdən işıqlanmış prosesi ilə eyni vaxtda C-elektrodundan T-elektroduna doğru yönəlmiş sabit U=200v-luq elektrik tətbiq olunmuşdur.

4- şəklində işığa və sabit elektrik sahəsinin təsirinə ( ) məruz qalmasından qabaq (I) və sonra (II) işıqlanma altında Cu-CdS-Cu strukturunun volt amper xarakteristikası göstərilmişdir. Bu zaman xarakteristikada yalnız 1 saatlıq işıqlanmaya məruz qalan struktura nisbətən daha güclü düzlənmə müşahidə olunur.

Şəkil 4. Eyni zamanda elektrik sahəsi tətbiq olunduğu hal üçün( ) işıqlanmadan qabaq (1) və işıqlanmadan sonra (2) Cu-CdS-Cu strukturunun işıq voltamper xarakteristikası.

Strukturunun volt amper xarakteristikasının işığın və elektrik sahəsinin eyni vaxtda təsiri ilə belə dəyişməsi onu göstərir ki, işığın təsiri ilə ionlaşmış (〖Cu〗 ^+) mis atomları müsbət potensiallı işıqlandırılan elektrod tərəfdən CdS-in içərilərinə daxil olur. Mənfi elektrod (həm qaranlıq) tərəfdə mis ionları elektrik sahəsinin tormozlayıcı təsiriə məruz qalırlar. Elektrofotostimuliyasiya nəticəsində CdS kontakt oblastlarının bu cür qeyri bərabər aşqarlanması (CdS-də müsbət eletrod tərəfdə misin konsenta rsiyası mənfi elektrod tərəfindəkindən çoxdur) bu hissələrdə xüsusi elektrik müqavimətinin fərqinə

səbəb olur. Bu iəs CdS-in aşqar əks səthlərinə yükdaşıyıcılar üçün müxtəlif olan energetik çəpərlər yaradır. Dönməz fotostimulyasiya dəyişiklikləri həm də Cu-CdS-Cu strukturlarının fotohəssaslığı spektrilərinə özünü göstərir.

Nəticə

1.Tədqiqat nəticələri göstərir ki, misin CdS yarımkeçiricisinə diffuziyası və fotostimulyasiya prosesi Cu–CdS kontaktlarının elektrik və fotoelektrik xassələrinə nəzərəçarpacaq dərəcədə təsir göstərir. Misin elektron qohumluğunun CdS-dən az olmasına baxmayaraq, xarici təsirlər – termik emal və işıqlandırma – nəticəsində mis atomlarının CdS altlığına nüfuz etməsi müşahidə edilir və bu proses səthəyaxın oblastda kompensasiya olunmuş zonaların yaranmasına səbəb olur.

2.Aşqar temperaturunda aparılmış diffuziya təcrübələri göstərir ki, mis CdS-də qadağan olunmuş zonanın içərisində, valent zona səviyyəsindən təqribən 1,8 eV yuxarıda əlavə energetik səviyyə yaradır. Bu energetik səviyyənin mövcudluğu udulma spektrində $h\nu > 1,3$ eV diapazonunda əlavə udulmanın əmələ gəlməsi ilə təsdiqlənir.

3.Cu–CdS–Cu simmetrik strukturunun foto- və elektrofotostimulyasiya şəraitində öyrənilməsi göstərir ki, bir səthdən uzunmüddətli işıqlandırma fotohəssaslığın azalmasına, qısaqapanma cərəyanının və açıq dövr gərginliyinin dəyişməsinə səbəb olur. Bu dəyişikliklər mis atomlarının (xüsusilə ionlaşmış Cu^+ ionlarının) işıq təsiri ilə CdS-ə daha intensiv daxil olması və kontakt sahəsində qeyri-bərabər aşqarlanmaya gətirib çıxarması ilə izah edilir.

4.İşıqlanma ilə eyni zamanda elektrik sahəsinin tətbiqi mis ionlarının CdS daxilində miqrasiyasını daha da gücləndirir və volt-amper xarakteristikasında daha səciyyəvi düzənlənmə yaradır. Bu isə göstərir ki, elektromiqrasiyanın və fotostimulyasiyanın birgə təsiri nəticəsində mis ionlarının strukturdaxili paylanması asimmetrik olur və kontakt oblastlarında müxtəlif energetik baryerlərin formalaşmasına səbəb olur.

5.Aparılan bütün ölçmələrdən belə nəticəyə gəlmək olar ki, Cu–CdS strukturlarında mis diffuziyası və fotostimulyasiya uzunmüddətli, qismən dönməz dəyişikliklər yaradır və bu dəyişikliklər materialın elektrik, fotoelektrik və kontakt xassələrinin idarə olunmasında mühüm rol oynayır. Bu effektlərin öyrənilməsi Cu–CdS əsaslı fotodetektorların, günəş elementlərinin və sensor qurğuların optimallaşdırılması üçün əhəmiyyətlidir.

Ədəbiyyat

1. Киреев П.С.«Физика полупроводников»- Москва.Высшая школа, 1969

2. Смит Р. «Полупроводники» М. Мир. 1982.

3. Стафеев В.И., Кракушан Е.И. «Магнитадоиды» М.Наука. 1975.

4. «Електроны в полупроводниках» т. 2 «Полупроводниковые преобразователи» под. ред. Поъели Х. Вилнюс, Моксилас. 1980.

5.Фистул Т.Ю. «Введение в физику полупроводников» Москва.Высшая школа. 1975

PARALLEL CURRİCULUM MODEL: A METHODOLOGİCAL COMPARATİVE ANALYSİS BASED ON THREE DOCTORAL THESES

KOŞUT ÖĞRENME PROGRAMI: ÜÇ TEZE DAYALI KARŞILAŞTIRMALI BİR YÖNTEMSEL ANALİZ

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ABSTRACT

The aim of this study is to conduct a content-based and methodological analysis of three graduate theses that examine the effects of the Parallel Curriculum Model (PCM) on gifted and talented students. Parallel learning is shaped within the frameworks of cognitive flexibility, constructivism, cognitive load, and multimedia learning theories. Three doctoral dissertations carried out in Türkiye were methodologically analyzed in terms of research design, study group, data collection instruments, data analysis methods, instructional implementation, and methodological strengths and limitations.

The theses investigated the impact of PCM-based differentiated instruction in English, Mathematics, and Turkish courses on students' learning outcomes such as creativity, academic achievement, self-efficacy, and critical thinking. Overall findings indicate that the interdisciplinary and multifaceted structure of the PCM significantly contributes to the cognitive and metacognitive development of gifted learners. However, methodological limitations—such as small sample sizes and limited reliability in qualitative analyses—restrict the generalizability of the results.

The methodological analysis revealed that all three studies share common tendencies, including single-center implementation and small sample groups. In conclusion, the PCM appears to be an effective instructional model for gifted and talented students across different subject areas.

Keywords: Parallel Curriculum Model, Methodological Analysis, Gifted Students, Highly Able Learners

ÖZET

Bu çalışmanın amacı, Koşut Eğitim Programı'nın üstün zekalı ve özel yetenekli öğrenciler üzerindeki etkilerini inceleyen üç lisansüstü tezi, içerik temelli ve yöntemsel olarak analiz etmektir. Koşut öğrenme; bilişsel esneklik, yapılandırmacılık, bilişsel yük ve çoklu ortam öğrenme kuramları kapsamında şekillenen bir öğrenme yaklaşımıdır. Türkiye'de yapılmış olan üç doktora tezi; araştırma deseni, çalışma grubu, veri toplama araçları, veri analiz yöntemleri, uygulama süreci, yöntemsel güçlü ve zayıf yönleri doğrultusunda yöntemsel olarak incelenmiştir. Çalışmada incelenen tezler; İngilizce, Matematik ve Türkçe derslerinde koşut öğrenme yaklaşımıyla farklılaştırılmış öğretimin, öğrencilerin, yaratıcılık, akademik başarı, öz yeterlik ve eleştirel düşünme gibi öğrenme çıktıları üzerindeki etkileri araştırmaktadır. Bulgular genel olarak koşut öğrenmenin disiplinler arası ve çok yönlü bir yapıya sahip olmasının özel yetenekli öğrencilerin hem bilişsel hem üstbilişsel gelişim süreçlerine oldukça anlamlı katkılar sağladığını göstermektedir. Bunun yanı sıra örneklemin sınırlı olması, nitel analiz güvenirliğinin zayıf olması gibi yöntemsel eksikliklerin bulguların genellenebilirliğini sınırladığı görülmektedir. Yöntemsel analiz, üç tezin nitel ağırlıklı veya deneysel yöntemlerinin güçlü ve zayıf yönlerini açığa çıkarmıştır. Üç tezin yöntemsel analizi sonucunda, ortak eğilimin tek merkezli uygulama ve küçük örneklem grubu olduğu belirlenmiştir. Sonuç olarak koşut öğrenmenin, farklı disiplinlerde özel yetenekli öğrencilere yönelik etkili bir model olduğu görülmektedir.

Anahtar Kelimeler: Koşut Eğitim Programı, Yöntemsel Analiz, Özel Yetenekli Öğrenciler, Üstün Zekalı Öğrenciler

GİRİŞ

Son yıllarda üstün zekalı ve özel yetenekli öğrencilere yönelik öğretimde üst düzey düşünme becerileri, farklılaştırma, süreç odaklı yaklaşım ve disiplinler arası bütüncül yaklaşım kavramları ön plana çıkmıştır. Koşut Eğitim Programı öğrenciyi merkeze alan, öğrencinin hazır bulunuşluk düzeyleri, yetenekleri üzerinden planlamalar yapan bir modeldir.

Bandura, Bruner, Csikszentmihalyi, Dewey, Dweck, Gardner, Glasser, Piaget, Sternberg, Taba ve Vygotsky gibi önemli eğitim kuramcılarının öğrenme, gelişim ve farklılaştırma yaklaşımlarının bütünleştirilmiş halidir.

Koşut Eğitim Programı, özellikle Mayer'in (2009) Çoklu Ortam Öğrenme Kuramı, Spiro ve arkadaşlarının (1992) Bilişsel Esneklik Kuramı ve yapılandırmacı öğrenme ilkeleriyle yakından ilişkilidir. Koşut öğrenme, öğrenenin bilişsel süreçlere aktif katılımını teşvik ederek bilginin anlamlandırılmasına katkı sağlar. Koşut Eğitim Programı'nın temel ilkeleri arasında; öğrencinin bilişsel-duyuşsal ihtiyaçlarına duyarlı olması, programın esnek olması, becerilerin eğitime yön vermesi, öğretmenin alan uzmanlığına sahip olması ve öğrenme çıktılarının kalıcılığa odaklanması yer almaktadır. Bu doğrultuda program, öğrencilerin sanat, bilim ve teknoloji gibi alanlarda kendi potansiyellerini keşfetmelerini destekleyen ve öğrenciye uygun zorluk düzeyine sahip etkinlikler bütünü olarak tasarlanır. Koşut Eğitim Programı, öğrencileri genel bir program kapsamında yetiştirmek yerine öğrencilerin potansiyeline uygun bilişsel talep düzeyini arttırmak ve öğrenme sürecini dört temel koşut üzerinden yapılandırmayı amaçlamaktadır. Tomlinson ve arkadaşları (2017) tarafından geliştirilen Koşut Eğitim Programı, çekirdek eğitim programı, bağlantılar eğitim programı, uygulama eğitim programı ve kimliğe duyarlılık eğitim programı olmak üzere dört koşuttan oluşmaktadır.

Koşut Eğitim Programı, öğrenme sürecini dört koşut üzerinden yapılandırır:

1. Çekirdek Eğitim Programı Koşutu:

Çekirdek Eğitim Programı Koşutu, öğrencilerin temel ilke, beceriler ve kavramları derinlemesine kavramasını amaçlar. Yaratıcı ve eleştirel düşünmeyi teşvik eder ve öğrenme sürecini sonuç odaklı olacak şekilde yapılandırır.

2. Bağlantılar Eğitim Programı Koşutu:

Öğrencilerin disiplinler arası ilişkiler kurabilmesini sağlamaktadır. Öğrencilerin disiplinler arası bağlamlarda öğrenme transferi yapabilmesini ve farklı bakış açılarını kazanmasını sağlar.

3. Uygulama Eğitim Programı Koşutu:

Öğrencilerin öğrendikleri bilgi ve becerileri bir uzman gibi uygulamalarını hedefler. Problem çözme, süreç, üretim ve profesyonel yaklaşımların deneyimlenmesine odaklanır.

4. Kimliğe Duyarlılık Koşutu:

Öğrencilerin kendilerini belirli bir alanda tanımalarını, ilgi ve eğilimlerini fark etmelerini ve meslek seçimlerini bilinçli bir şekilde yapmalarını sağlar.

Program içerik, giriş etkinlikleri, öğretim stratejileri, öğrenme etkinlikleri, gruplama yöntemleri, kaynak seçimi, ek etkinlikler, ders kapanışı ve Artan Düşünsel Talep yaklaşımını içermektedir. Bu bileşenler öğrencilerin bireysel gelişim hızına göre öğrenme sürecinin düzenlenmesini sağlar. Artan Düşünsel Talep yaklaşımı, bir konuda acemilikten uzmanlığa doğru bir gelişimin olduğu öğretim süreçlerini hedefler. Genel olarak Koşut Eğitim Programı, öğrencilerin eleştirel düşünme, yaratıcılık, bilişsel derinlik, disiplinler arası ilişkilendirme ve kendini tanıma becerilerini kapsayan bütüncül bir yapı sunmaktadır (Kaplan, 2009; Tomlinson & Imbeau, 2023).

Koşut Eğitim Programı, öğrencilerin kendi potansiyelleri doğrultusunda ilerlemelerini, artan düşünsel taleple sürekli olarak gelişmelerini sağlar. Koşut Eğitim Programı, öğrencinin kendi öğrenmesini gerçekleştirmesi, öğretmene planlama kolaylığı sunması, kalıcı öğrenme sağlaması, disiplinler arası bağlantıların güçlendirilmesi ve üstbilişsel düşünmeyi merkeze almasını hedeflemektedir (VanTassel-Baska, 2013).

Koşut Eğitim Programı Türkiye'de özel yetenekli ve üstün zekalı öğrencilere yönelik öğretimde giderek daha fazla dikkate alınmaktadır. Bu bildiride incelenen üç tez, Koşut Eğitim Programı'nın üç farklı ders alanında uygulanabilirliği ve etkililiğini incelemektedir.

Her üç tezde ortak amaç, koşut öğrenmenin öğrencilerin bilişsel ve üstbilişsel düzeylerine etkisini denemek ve değerlendirmektir. Bu bildiri, tezleri araştırma deseni, çalışma grubu, veri toplama araçları, veri analiz yöntemleri, uygulama süreçleri ve yöntemsel güçlü ve zayıf yönleri bakımından karşılaştırmakta ve elde edilen bulguları sunmaktadır.

Araştırma kapsamında incelenen üç doktora tezi, Koşut Eğitim Programı'nın farklı derslerde özel yetenekli ve üstün zekalı öğrenciler üzerindeki etkilerini inceleyerek literatüre önemli katkılar sunmaktadır. Çalışma kapsamında incelenen tezler:

İslekeller-Bozca (2017) tarafından hazırlanmış olan *''Üstün Zekalı Öğrencilerde Türkçe Koşut Eğitim Programının Başarıya, Eleştirel Düşünmeye ve Yaratıcılığa Etkisi''* adlı doktora tezi, Koşut Öğrenme

Programının Türkçe dersinde öğrencilerin eleştirel düşünme, yaratıcılık ve Türkçe dersinde başarı düzeylerini, anlamlı biçimde arttırdığı sonucunu elde etmiştir.

Ergut-Kalkan (2025) tarafından hazırlanmış olan *''Koşut Eğitim Programına Göre Farklılaştırılan Matematik Öğretim Programının Özel Yetenekli Öğrencilerin Matematik Yaratıcılığına, Başarısına ve Özyeterliğine Etkisi''* adlı doktora tezi Koşut Öğrenme Programının matematiksel yaratıcılığı ve özyeterliği güçlendirdiği sonucunu elde etmiştir.

Yılmaz (2025) tarafından hazırlanmış olan *''Koşut Eğitim Programına Göre Farklılaştırılmış İngilizce Öğretim Programının Özel Yetenekli Öğrencilerin Akademik Başarılarına, Yaratıcı Yazmalarına ve Özyeterliklerine Etkisi''* adlı doktora tezi ise Koşut Eğitim Programının dil özyeterliği ve yabancı dilde yaratıcı yazma üzerinde olumlu etkiler yarattığı sonucunu elde etmiştir.

Bu bildiri, incelenen üç doktora tezinin; araştırma deseni, çalışma grubu, veri toplama araçları, veri analiz yöntemleri, uygulama süreçleri ve yöntemsel güçlü ve zayıf yönlerini sistematik olarak karşılaştırmakta ve Koşut Eğitim Programı'nın Türkiye kapsamındaki mevcut durumunu bütüncül bir çerçevede ortaya koymayı amaçlamaktadır.

Problem Durumu

Türkiye'de üstün zekalı ve özel yetenekli öğrencilere yönelik farklılaştırılmış öğretim ve program geliştirme uygulamaları ön plana çıkmakla birlikte, uygulamaya ilişkin araştırmaların yöntemsel niteliğine yönelik incelemeler sınırlıdır. Eğitim araştırmalarında, güçlü bir kuramsal temele sahip olan Koşut Eğitim Programı'nın nasıl kullanıldığı, yöntemsel sınırlılıkları ve güçlü yönleri sistematik olarak yeterince değerlendirilmemiştir. Bu çalışmada incelenmiş olan üç tezin ortak olumlu eğilimleri olmakla birlikte, tek merkezli uygulamalar, küçük örneklemler, nitel analizdeki sınırlılıklar gibi bilimsel gerçekliği etkileyen zayıf yönlerin de olduğu görülmektedir. Bu doğrultuda yöntemsel meta-analiz niteliğinde karşılaştırmalı analiz gerekmektedir. Bu araştırma, Koşut Eğitim Programı alanında, program uzmanlarına, öğretmenlere ve araştırmacılara rehber niteliğinde olacaktır.

Araştırmanın Amacı

Bu araştırmanın amacı, Koşut Eğitim Programı kapsamında hazırlanmış üç doktora tezini araştırma deseni, çalışma grubu, veri toplama araçları, veri analiz yöntemleri, uygulama süreci, yöntemsel güçlü ve zayıf yönleri açısından incelemek ve karşılaştırmaktır. Araştırma kapsamında elde edilen bulgular doğrultusunda Koşut Eğitim Programı'nın Türkiye kapsamındaki niteliğini tartışmak ve yapılacak çalışmalarda rehberlik edecek olması oldukça önemlidir.

Bu bağlamda Koşut Eğitim Programı ile ilgili üç doktora tezinin yöntemsel analizinin yapılması amacıyla aşağıdaki sorulara yanıt aranmıştır.

1) Koşut Eğitim Programı'na dayalı üç doktora tezinde kullanılan araştırma desenleri nelerdir?
2) Koşut Eğitim Programı'na dayalı üç doktora tezinde çalışma grupları nasıl belirlenmiştir?
3) Koşut Eğitim Programı'na dayalı üç doktora tezinde veri toplama araçlarının türleri nelerdir?
4) Koşut Eğitim Programı'na dayalı üç doktora tezinde kullanılan veri analiz yöntemleri nelerdir?
5) İngilizce, Matematik ve Türkçe alanlarındaki Koşut Eğitim Programı uygulamalarının süreç tasarımları nasıldır?

6) Koşut Eğitim Programı'na dayalı üç doktora tezinin yöntemsel açıdan güçlü ve zayıf yönleri nelerdir?

YÖNTEM VE ARAŞTIRMANIN SÜRECİ

Yöntem

Bu araştırma, Koşut Eğitim Programı'na dayalı üç doktora tezini inceleyen nitel araştırma modelinde olup doküman analizi yöntemi kullanılarak incelenmiştir. Doküman analizi, araştırma konusu kapsamında seçilmiş olan materyallerin incelenerek sistematik bir şekilde değerlendirme yapılmasıdır (O'Leary, 2017, s.497). Doküman analizi, nitel araştırmalar sürecinde araştırmanın ayrıntılı bir şekilde incelenmesi için önemlidir. Bu doğrultuda incelenen materyallerin, araştırmanın amacı doğrultusunda ayrıntılardan özelden genele çıkarımlar yapılması doküman analizinin temelini oluşturmaktadır (Creswell, 2018). Bu çalışmanın analizinde aynı zamanda içerik analizi yaklaşımı da yer almaktadır. İçerik analizi, dokümanlarda belirlenecek temaların sistematik bir biçimde oluşturulması ve karşılaştırılması süreçlerini kapsamaktadır (Krippendorff, 2013). Araştırmanın incelenmesinde kullanılan yöntemsel analiz kapsamında tutarlılık, güvenirlik raporlaması, veri çeşitliliği, örneklem yeterliliği, aktarılabilirlik boyutlarında değerlendirme yapılmıştır.

Bu araştırmada, Koşut Eğitim Programı'na dayalı üç doktora tezi araştırma deseni, çalışma grubu, veri toplama araçları, veri analiz yöntemleri, uygulama süreci, yöntemsel güçlü ve zayıf yönleri gibi belirlenmiş kategoriler doğrultusunda incelenmiştir.

Çalışma Grubu

Bu araştırmada çalışma grubunu, İşlekeller-Bozca (2017)'nın *''Üstün Zekalı Öğrencilerde Türkçe Koşut Eğitim Programının Başarıya, Eleştirel Düşünmeye ve Yaratıcılığa Etkisi''*adlı tezi, Ergut- Kalkan (2025)'ın *''Koşut Eğitim Programına Göre Farklılaştırılan Matematik Öğretim Programının Özel Yetenekli Öğrencilerin Matematik Yaratıcılığına, Başarısına ve Özyeterliğine Etkisi''*adlı tezi ve Yılmaz (2025)'ın*''Koşut Eğitim Programına Göre Farklılaştırılmış İngilizce Öğretim Programının Özel Yetenekli Öğrencilerin Akademik Başarılarına, Yaratıcı Yazmalarına ve Özyeterliklerine Etkisi''*adlı tezi oluşturmuştur.

Veri Analizi Süreci

Veri analizi dört aşamada gerçekleştirilmiştir.

1) Okuma: Tezlerin yöntem bölümleri ayrıntılı bir biçimde okunarak incelemeye dahil edilecek kategoriler belirlenmiştir.
2) Yöntemsel Kodlama: Araştırma deseni, çalışma grubu, veri toplama araçları, veri analiz yöntemleri, uygulama süreci, yöntemsel güçlü ve zayıf yönler temaları oluşturulmuştur.
3) Karşılaştırmalı Analiz: Üç tez çapraz karşılaştırmaya tabi tutulmuştur.
4) Sentez ve Yorumlama: Ortak eğilimler, yöntemsel farklılıklar bir arada değerlendirilmiştir (Creswell, 2014).

BULGULAR

Bu çalışma sonucunda, Koşut Eğitim Programı'na dayalı üç doktora tezi yöntemsel analiz ile incelenmiştir. İncelenen tezler, araştırma deseni, çalışma grubu, veri toplama yöntemleri, veri analiz yöntemleri, uygulama süreci, yöntemsel güçlü ve zayıf yönleri açısından incelenerek, karşılaştırmalı bir şekilde sunulmuştur.

Tablo 1. Üç Tezin Araştırma Desenlerine Ait Bulgular

Boyut	Türkçe Koşut Eğitim Programı (İşlekeller Bozca, 2017)	Matematik Koşut Eğitim Programı Tezi (Ergut Kalkan, 2025)	İngilizce Koşut Eğitim Programı (Yılmaz, 2025)
Araştırma Deseni	Kontrol Gruplu Ön Test-Son Test Deney Deseni	Ön Test- Son Test Kontrol Gruplu Desen	Kontrol gruplu ön test- son test deseni

Tablo 1 incelendiğinde, Türkçe Koşut Eğitim Programı çalışmasında kontrol gruplu ön test- son test deney deseni kullanılmıştır. Matematik Koşut Eğitim Programı çalışmasında ön test-son test kontrol gruplu desen kullanılmıştır. İngilizce Koşut Eğitim Programı çalışmasında kontrol gruplu ön test- son test deseni kullanılmıştır. Üç tez çalışmasında kullanılan kontrol gruplu ön test- son test deney deseni güçlü nedensel kanıt sunmaktadır. Koşut Eğitim Programı'nın etkilerini çok boyutlu incelemiştir.

Tablo 2. Üç Tezin Çalışma Grubuna Ait Bulgular

Boyut	Türkçe Koşut Eğitim Programı (İşlekeller Bozca, 2017)	Matematik Koşut Eğitim Programı Tezi (Ergut Kalkan, 2025)	İngilizce Koşut Eğitim Programı (Yılmaz, 2025)
Çalışma Grubu	26 üstün zekalı ve yetenekli 4.sınıf öğrencisi	İzmir ilinde Bilim ve Sanat Merkezi'ne devam eden 6.sınıf 28 öğrenci	Trabzon'da Bilim ve Sanat Merkezi'nde öğrenim gören 24 özel yetenekli 6.sınıf öğrencisi

Tablo 2 incelendiğinde, üç çalışmada da özel yetenekli öğrenci grupları ile çalışıldığı görülmektedir. Örneklem büyüklüğünde farklılıklar bulunmaktadır. İngilizce Koşut Eğitim Programı çalışmasında 24 katılımcı ile örneklemi istatistiksel güç açısından en sınırlı olanıdır. Matematik Koşut Eğitimi Programı çalışması örneklemi istatiksel güç açısından en güçlü olanıdır. Genel olarak tüm çalışmalar tek merkezli olduğu için dış geçerlilik açısından ortak bir sınırlılık oluşturmaktadır.

Tablo 3. Veri Toplama Araçlarına Ait Bulgular

Boyut	Türkçe Koşut Eğitim Programı (İşlekeller Bozca, 2017)	Matematik Koşut Eğitim Programı Tezi (Ergut Kalkan, 2025)	İngilizce Koşut Eğitim Programı (Yılmaz, 2025)
Veri Toplama Araçları	Türkçe Başarı Testi, Cornell Eleştirel Düşünme Becerileri Ölçeği, Yaratıcı Yazma Ölçeği	Matematik Başarı Testi, Matematik Başarı Testi Geliştirilme Süreci, Matematiksel Yaratıcılık Ölçeği, Matematik Öz-Yeterlik Ölçeği	İngilizce Başarı Testi, Yaratıcı Yazma Ölçeği, Yazma Öz-Yeterlik Ölçeği

Tablo 3 incelendiğinde, Türkçe Koşut Eğitim Programı çalışması veri toplama aracı çeşitliliği bakımından en zengin olanıdır. Matematik Koşut Eğitim Programı çalışması yüksek güvenirlik değerleri ile nicel ölçme araçlarına sahiptir. İngilizce Koşut Eğitim Programı çalışmasında kullanılan yaratıcı yazma ölçeği performansa dayalı ürünlere ağırlık verdiği için nitel derinlik sunmaktadır.

Tablo 4. Veri Analiz Yöntemlerine Ait Bulgular

Boyut	Türkçe Koşut Eğitim Programı (İşlekeller Bozca, 2017)	Matematik Koşut Eğitim Programı Tezi (Ergut Kalkan, 2025)	İngilizce Koşut Eğitim Programı (Yılmaz, 2025)
Veri Analizi	Non- parametrik Mann Whitney-U testi, Wilcoxon-Z analizi	Non-parametrik Mann Whitney-U testi, Wilcoxon İşaretli Sıralar Testi	Non-parametrik Mann Whitney U testi, Wilcoxon-Z analizi

Tablo 4 incelendiğinde, üç tezin de aynı veri analizi yöntemlerini kullandığı görülmektedir. Kullanılmış olan non-parametrik testler analizlerin güçlü olmasını desteklemiştir. İngilizce Koşut Eğitim Programı çalışması ürün analizi ile özgün bir ürün değerlendirmesi sunarak diğer tezlere göre daha güçlü bir nitel derinliğe sahiptir.

Tablo 5. Uygulama Süreçlerine Ait Bulgular

Boyut	Türkçe Koşut Eğitim Programı (İşlekeller Bozca, 2017)	Matematik Koşut Eğitim Programı Tezi (Ergut Kalkan, 2025)	İngilizce Koşut Eğitim Programı (Yılmaz, 2025)
Uygulama Süreci	Dört koşutun bütüncül uygulaması, uzun süreli etkinlikler	Disiplinler arası bağlantılar güçlü, etkinlik temelli	Süre kısa, uygulama ayrıntılı ancak yoğun

Tablo 5 incelendiğinde, Türkçe Koşut Eğitim Programı çalışmasının uygulama süreci açısından en sistematik ve kapsamlı yapıda olduğu görülmektedir. Matematik Koşut Eğitim Programı çalışması, disiplinler arası bağları güçlendiren, etkinlik temelli uygulamalarla özgünlük kazanmıştır. İngilizce Koşut Eğitim Programı çalışması, uygulama süreci açısından en yoğun içeriğe sahip olmakla beraber sürenin kısa olması etkiyi sınırlayan bir faktör olabilir.

Tablo 6. Güçlü Yönler ve Zayıf Yönlere Ait Bulgular

Boyut	Türkçe Koşut Eğitim Programı (İşlekeller Bozca, 2017)	Matematik Koşut Eğitim Programı Tezi (Ergut Kalkan, 2025)	İngilizce Koşut Eğitim Programı (Yılmaz, 2025)
Güçlü Yönler	Nitel derinlik, kuramsal çerçeve, ürün çeşitliliği	Ölçme araçlarının güvenirliği yüksek	Yaratıcı yazma ürünleri güçlü
Zayıf Yönler	Kodlayıcı güvenirliği sınırlı	Tek merkez, küçük örneklem	En küçük örneklem, nitel güvenirlik sınırlı

Tablo 6 incelendiğinde, her çalışmanın kendi içinde güçlü yönleri bulunmaktadır. Türkçe Koşut Eğitim Programı çalışmasının güçlü yönleri, kuramsal çerçeve, nitel derinlik ve ürün çeşitliliğidir. Matematik Koşut Eğitim Programı çalışmasının en öne çıkan güçlü yönü ölçme araçlarının güvenirliğinin yüksek olmasıdır. İngilizce Koşut Eğitim Programı çalışmasının öne çıkan güçlü yanı ise yaratıcı yazma ürünlerinin özgünlük açısından nitel derinliğe sağladığı katkıdır. Üç tez çalışmasının ortak zayıf yönleri ise tek merkezli uygulama yapılması, örneklemin küçük olması ve dış geçerliliğin sınırlı olmasıdır.

Genel olarak bulgular değerlendirildiğinde, üç tez çalışmasında Koşut Eğitim Programı Modeli'nin yaratıcı ürünlerin niteliğini yükselttiği, üst düzey düşünme becerilerini geliştirdiği, öğrencilerin akademik başarılarını arttırdığı ve disiplinler arası uyum sağlamaya imkan sağladığı ortaya çıkmaktadır. Yöntemsel olarak en kapsamlı çalışma Türkçe Koşut Eğitim Programı çalışması (İşlekeller Bozca, 2017) olurken, Matematik Koşut Eğitim Programı çalışması (Ergut Kalkan, 2025) analiz gücü bakımından en

güçlü, İngilizce Koşut Eğitim Programı çalışması (Yılmaz, 2025) yaratıcı yazma ve performansa dayalı ürünler açısından en özgün nitelikteki çalışma olmuştur.

SONUÇ VE ÖNERİLER

Bu çalışmada Koşut Eğitim Programı'nın özel yetenekli öğrenciler üzerindeki etkilerini inceleyen üç doktora tezi yöntemsel olarak analiz edilmiştir. Çalışmalar, araştırma deseni, çalışma grubu, veri toplama araçları, veri analiz yöntemleri, uygulama süreci, güçlü ve zayıf yönler bakımından incelenerek karşılaştırılmıştır. Bu bölümde elde edilen sonuçlar, alan yazın ve Koşut Eğitim Programı'nın kuramsal temelleri rehberliğinde bütüncül bir şekilde tartışılmakta ve genel sonuçlar ile uygulamaya yönelik öneriler sunulmaktadır. İslekeller-Bozca (2017) tarafından hazırlanan Türkçe Koşut Eğitim Programı çalışması, dört koşutun bütüncül olarak uygulanmasının öğrencilerin yaratıcılık ve eleştirel düşünme becerilerini önemli düzeyde arttırdığını göstermiştir. Ergut-Kalkan (2025) tarafından hazırlanan Matematik Koşut Eğitim Programı çalışması, üst düzey problem çözme becerileri ve matematiksel yaratıcılığın koşut temelli öğretim sayesinde güçlendiğini ortaya koymaktadır. Yılmaz (2025) tarafından hazırlanan İngilizce Koşut Eğitim Programı çalışması, yaratıcı yazma uygulamaları sayesinde öğrencilerin akıcılık, esneklik ve özgünlük alanlarında anlamlı bir artış olduğunu göstermiştir. Elde edilen bulgular, Koşut Eğitim Programı'nın temelinde yer alan bilişsel esneklik, farklılaştırılmış içerik, artan düşünsel talep ve çok boyutlu düşünme ilkeleriyle uyumludur (Tomlinson, 1999; Kaplan, 2009).

Veri toplama araçları ve uygulama süreçleri açısından üç doktora tezinde farklılıklar olmakla birlikte, öğrenci merkezli, öğrencilerin bireysel farklılıklarına önem veren ve performansa dayalı ürünlerin değerlendirilmesi ortak noktaları olarak yer almaktadır. İncelenen tez çalışmaları bu yönüyle, Koşut Eğitim Programı'nın temel yapı taşları olan çekirdek, bağlantılar, uygulama ve kimlik koşutlarının öğretim programlarında uygulanmasının öğrenme çıktıları üzerindeki olumlu etkisini ortaya koymaktadır. Özellikle Türkçe Koşut Eğitim Programı çalışması (İslekeller-Bozca, 2017) bütüncül bir şekilde tüm koşutları uygulaması açısından literatürde önemli bir örnek oluşturmaktadır. Yılmaz (2025)'ın İngilizce Koşut Eğitim Programı çalışması ise yaratıcı yazma ürünleri sayesinde nitel analizde derinlemesine performans değerlendirmesi yaptığı için literatürde oldukça önemli bir yere sahiptir.

Bununla birlikte, üç tez çalışmasının yöntemsel açıdan ortak sınırlılıkları bulunmaktadır. Çalışmalar, örneklem büyüklükleri ve tek merkezli yürütülmesi açısından sınırlı kalmıştır. Deneysel çalışmalarda küçük örnekleme sahip çalışmalarda deneysel etkinin sonucu görülebilir fakat genellenebilirlik açısından yetersiz kalabilir. Türkçe Koşut Eğitim Programı çalışmasında kodlayıcılar arası güvenirliğin sınırlı olması da geçerlik açısından zayıf bir yön olarak değerlendirilmektedir. Bu sınırlılıklara rağmen üç tez çalışması da koşut eğitim ilkelerini sistematik bir biçimde uygulamıştır. Üç tez çalışması da yöntemsel çeşitlilik ve veri toplama araçlarının güvenirliğini sağladığı için ortak güçlü yönleri bulunmaktadır.

Genel olarak literatürle karşılaştırıldığında elde edilen bulgular, Koşut Eğitim Programı'nın özel yetenekli öğrencilerde yüksek bilişsel performansı desteklediğini ortaya koyan önceki çalışmalarla uyumlu olduğu sonucu elde edilmiştir. Üstün yetenekli öğrencilerin özgün ürün üretme, yaratıcılık ve problem çözme becerilerinde disiplinler arası ve çok boyutlu öğrenme etkinliklerinin oldukça etkili olduğuna yönelik açıklamalar, üç tez çalışmasının bulgularıyla örtüşmektedir. Koşut Eğitim Programı'nın öğrencilerin üst düzey düşünme becerilerini geliştirmesine yönelik bulguların üç tez çalışmasında da tutarlı olması literatüre önemli bir katkı sunmaktadır.

Sonuç olarak, üç tezin tamamında başarı testleri son test uygulamasında anlamlı farklılık göstermiştir. Koşut Eğitim Programı özel yetenekli öğrencilerin akademik başarılarını önemli ölçüde arttırmaktadır. Öğrencilerin üstbilişsel farkındalıkları ve öz yeterliklerini arttırmaktadır. Bu durum özellikle uygulama

koşutu ve kimlik koşutlarının etkililiğini göstermektedir. Yaratıcılık tüm disiplinlerde gelişmiştir. Yaratıcılığın gelişmesi Koşut Eğitim Programı bilişsel esneklik ve yapılandırmacılıkla uyumludur. Uygulama süreçleri öğretimsel etkiyi belirlemede önemli bir paya sahiptir. Dört koşutun bütüncül uygulanması çalışmaların daha güçlü sonuçlar elde etmesini sağlamıştır. Yöntemsel açıdan örneklemin küçük olması ve tek merkezli çalışmaların olması sınırlılık oluşturmaktadır.

Öneriler

1) Öğretmenlere koşut temelli farklılaştırılmış öğretim konusunda hizmet içi eğitimler verilmelidir.
2) Uygulama süreçleri, öğrencilerin üst düzey becerilerini gösterebilecekleri, uzun dönemlere yayılmış proje ve performans çalışmalarıyla desteklenmelidir.
3) Karma yöntemli araştırmalar teşvik edilmelidir.
4) Biyoloji derslerinde Koşut Eğitim Programı'nın dört koşutu sistematik olarak bütünleştirilebilir. Özellikle çevre bilimleri, biyoteknoloji ve ekoloji konularında öğrencilerin özgün çalışmalar üretmesini desteklemek için uygulama ve kimlik koşutu destekli çalışmalar yapılabilir.
5) Bilimsel metin okuma çalışmaları için Biyoloji-İngilizce dersleri arasında disiplinler arası bağlantıların kurulduğu çalışmalar yapılabilir.
6) Özel yetenekli öğrencilerin bilimsel becerilerini desteklemek için bilimsel yazma ve sunum etkinlikleri Koşut Eğitim Programı kapsamında ürün boyutunda entegre edilebilir.

KAYNAKÇA

Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). SAGE Publications.

Creswell, J. W., & Poth, C. N. (2018). *Qualitative inquiry and research design: Choosing among five approaches* (4th ed.). Thousand Oaks: SAGE.

Ergut- Kalkan, G. (2025). *Koşut eğitim programına göre farklılaştırılan matematik öğretim programının özel yetenekli öğrencilerin matematik yaratıcılığına, başarısına ve özyeterliğine etkisi.* Doktora Tezi, İstanbul Üniversitesi- Cerrahpaşa, Lisansüstü Eğitim Enstitüsü, İstanbul.

İşlekeller-Bozca, A. (2017). *Üstün zekalı öğrencilerde Türkçe koşut eğitim programının başarıya, eleştirel düşünmeye ve yaratıcılığa etkisi.* Doktora Tezi, İstanbul Üniversitesi, Eğitim Bilimleri Enstitüsü, İstanbul.

Kaplan, S. N. (2009). *The grid: A model to construct differentiated curriculum for the gifted.* In J. S. Renzulli, E. J. Gubbins, K. S. McMillen, R. D. Erkert ve C.A. Little (Eds.), *Systems and models for developing the gifted and* talented (2nd end., pp. 235-253). Mansfield Center, CT: Creative Learning Press.

Krippendorff, K. (2018). *Content analysis: An introduction to its methodology* (3rd ed.). Sage Publications.

Mayer, R. E. (2009). *Multimedia learning* (2nd ed.). Cambridge University Press.

O'Leary, Z. (2017). *The essential guide to doing your research project.* SAGE.

Spiro, R. J., Feltovich, P. J., Jacobson, M. J., & Coulson, R. L. (1992). Cognitive flexibility, constructivism, and hypertext: Random access instruction for advanced knowledge acquisition in ill-structured domains. In T. Duffy & D. Jonassen (Eds.), *Constructivism and the technology of instruction: A conversation* (pp. 57–76). Lawrence Erlbaum Associates.

Tomlinson, C.A. (1999). *The differentiated classroom: Responding to the needs of all learners,* Association for Supervision and Curriculum Development.

Tomlinson, C. A., Kaplan, S. N., Renzulli, J. S., Purcell, J. H., Leppien, J. H., & Burns, D. E. (2017). *Koşut eğitim programı: Üstün yetenekli öğrenciler için farklılaştırılmış öğretim modeli* (M. A. Çözer & S. Emir, Çev.). Nobel Akademik Yayıncılık.

Tomlinson, C.A. (2023). The parallel curriculum model: A design to develop potential & challenge high-ability learners. In *Systems and models for developing programs for the gifted and talented* (pp. 571-598). New York, NY: Routledge.

VanTassel-Baska, J. (2013). The world of cross-cultural research: Insights for gifted education. *Journal for the Education of the Gifted*, 36(1), 6-18.

Yılmaz, E. (2025). *Koşut eğitim programına göre farklılaştırılmış İngilizce öğretim programının özel yetenekli öğrencilerin akademik başarılarına, yaratıcı yazmalarına ve özyeterliklerine etkisi.* Doktora Tezi, İstanbul Üniversitesi- Cerrahpaşa, Lisansüstü Eğitim Enstitüsü, İstanbul.

WHAT IS DIGITAL WISDOM? PRACTICAL SUGGESTIONS: AN ANALYSIS STUDY

DİJİTAL BİLGELİK NEDİR? UYGULAMAYA DÖNÜK ÖNERİLER: BİR ANALİZ ÇALIŞMASI

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ABSTRACT

Wisdom is the capacity to discern knowledge, acquire intuitive understanding through common sense, and internalize and apply these qualities. Alternatively, it can be defined as intelligence or foresight. It can also be defined as the ability to think and act by drawing on knowledge-based experiences, understandings, common sense, and insight. According to the Turkish Language Association, the word "wisdom" means "knowledgeable, having a command of a subject," but in its original language, according to the Oxford Dictionary, it is emphasized as "possessing knowledge, experience, and the ability to make sound decisions." In recent years, technology has developed at an incredible pace, and its use has increased. Technology, as a factor, cannot replace human thought, reasoning, and problem-solving abilities. However, digital wisdom will help us navigate the technologically complex and advanced virtual world. Digital wisdom can be defined as individuals' ability to use technology wisely in their daily thinking and decision-making processes and to share their findings.

The overall purpose of this research is to analyze the relevant literature on digital wisdom and provide practical recommendations. A case study design was employed within the scope of the research's qualitative research model. In this context, relevant documents were analyzed. These documents included articles, theses, internet resources, and other data sources. Content analysis was used in data analysis.

The analysis of the data obtained on the subject revealed that the literature on digital wisdom in our country lacks sufficient studies. It is particularly noteworthy that more studies have been conducted on the concept of digital literacy, which falls under the scope of digital wisdom. It was determined that the dissertations and articles used the same measurement tool, originally developed in Turkish, and that the studies were insufficient in quantity. Teachers and educators should utilize digital wisdom in teaching and learning practices to explore new pedagogical approaches that will benefit their students in the future. Recommendations are included for the conclusions.

Key Words: Digital Wisdom; Technological Developments; 21st Century Skills

ÖZET

Bilgelik, bilgiyi, ayırt edebilme, sağduyuyla sezgisel anlayış edinebilme kapasitesinin yanı sıra bu nitelikleri içselleştirebilme ve uygulayabilme yeteneğidir. Diğer taraftan akıl veya öngörü olarak da tanımlanabilir. Aynı zamanda bilgi odaklı deneyimler, anlayışlar, sağduyudan ve içgörüden yararlanarak düşünebilme ve hareket edebilme yeteneği olarak ifade edilebilmektedir. *Bilgelik* kelimesi TDK'na göre "Bilgili, konuya hâkim olma durumu" anlamlarına gelmesine rağmen, kelimenin orijinal dilindeki anlamı, Oxford sözlüğüne göre "bilgiye, tecrübeye sahip olma ve iyi karar verebilme" şeklinde ifade edilmektedir. Son yıllarda teknoloji akıl almaz hızda gelişmekte ve kullanımı artmaktadır. Teknoloji bir faktör olarak insan düşüncesinin, muhakeme yapabilme ve problem çözebilme yeteneklerinin yerini alamayacaktır. Ancak *dijital bilgelik,* teknoloji açısından karmaşık ve gelişmiş sanal ortamda olan dünyadaki gezinmelerimize yardımcı olacaktır. Dijital bilgelik; bireylerin günlük yaşantısında düşünebilme ve karar verebilme süreçlerinde teknolojiyi bilgece kullanabilme ve sonuçlarını paylaşabilme şeklinde tanımlanabilir.

Bu araştırmanın genel amacı; dijital bilgelik nedir? ilgili literatür analiz edildikten sonra uygulamaya dönük öneriler belirtmektir. Araştırma nitel araştırma modeli kapsamında durum çalışması deseni kullanılmıştır. Bu kapsamda konuyla ilgili dokümanlar analiz edilmiştir. İlgili dokümanlar makale, tezler, internet kaynakları, vb veri kaynaklarıdır. Verilerin analizinde içerik analizi yöntemi kullanılmıştır.

Konuyla ilgili elde edilen verilerin analizinde sonuç olarak; dijital bilgelik konusunda ülkemizde yeterince çalışmanın literatürümüzde yer almadığı belirlenmiştir. Özellikle dijital bilgelik kavramının kapsamında yer alan, dijital okuryazarlık kavramıyla ilgili çalışmaların daha fazla hazırlanmış olduğu dikkat çekmektedir. Hazırlanmış olan tez ve makale çalışmalarında Türkçe olarak hazırlanmış olan aynı ölçme aracının kullanıldığı belirlenmiş olup çalışmaların nicelik olarak yeterli olmadığı belirlenmiştir. Öğretmenlerin ve eğitimcilerin, gelecekte öğrencilerine fayda sağlayacak yeni pedagojik yaklaşımları keşfetmek için öğretim ve öğrenme uygulamalarıyla ilgili dijital bilgelikten yararlanmalıdır. Sonuçlar yönünde önerilere yer verilmiştir.

Anahtar Kelimeler: Dijital Bilgelik; Teknolojik Gelişmeler; 21.yy Becerileri

GİRİŞ

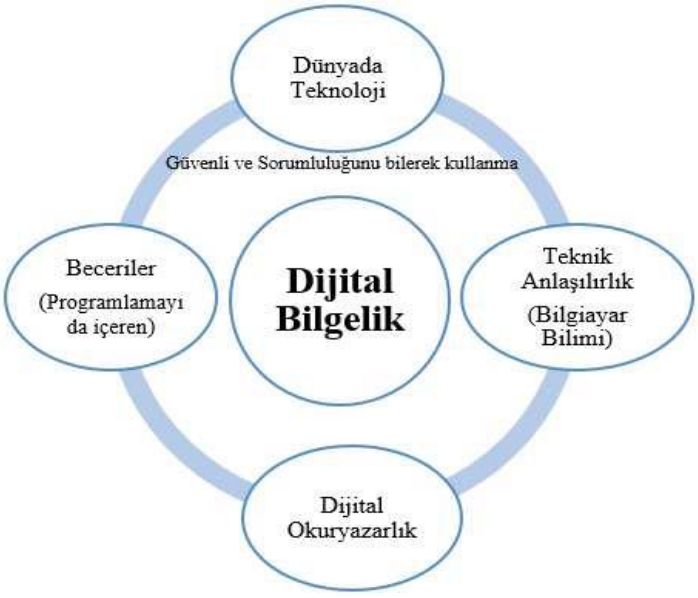
Bilgelik, bilgiyi, ayırt edebilme, sağduyuyla sezgisel anlayış edinebilme kapasitesinin yanı sıra bu nitelikleri içselleştirebilme ve uygulayabilme yeteneğidir. Diğer taraftan akıl veya öngörü olarak da tanımlanabilir. Aynı zamanda bilgi odaklı deneyimler, anlayışlar, sağduyudan ve içgörüden yararlanarak düşünebilme ve hareket edebilme yeteneği olarak ifade edilebilmektedir. *Bilgelik* kelimesi TDK'na göre "Bilgili, konuya hâkim olma durumu" gibi anlamı vurgulamasına karşın, kelimenin orijinalindeki vurgusu, Oxford sözlüğündeki açıklamasına göre "uyun etkili bilgi, tecrübe sahibi olabilmek ve en iyi kararı verebilmektir" şeklinde ifade edilmektedir. Son yıllarda teknoloji akıl almaz hızda gelişmekte ve kullanımı artmaktadır. Teknoloji bir faktör olarak insanın düşünce yeteneğini, muhakeme yapabilme ve problem çözebilme yeteneklerinin yerini alamayacaktır. Ancak *dijital bilgelik,* teknoloji açısından karmaşık ve gelişmiş sanal ortamda olan dünyadaki gezinmelerimize yardımcı olacaktır. Dijital bilgelik; bireylerin günlük yaşantısında düşünebilme ve karar verebilme süreçlerinde teknolojiyi bilgece kullanabilme ve sonuçlarını paylaşabilme şeklinde tanımlanabilir (Türk, 2017).

21. yüzyıla doğru ilerledikçe, Marc Prensky tarafından 2001 yılında yaratılan dijital yerli/dijital göçmen paradigması önemini yitiriyor. Prensky, "dijital bilgelik" olarak adlandırdığı kavramın gelişimine odaklanmamız gerektiğini öne sürmektedir. Dijital teknolojinin kullanımının bizi sadece daha akıllı değil, aynı zamanda gerçekten çok daha bilge yapabileceğini savunan Prensky, bizim daha fazla bilgiye erişimimizi sağlayan ve analitik düşünebilme yeteneklerimizi geliştiren araçların hem bilgeliğin ne olduğunu yeniden şekillendireceğini hem de bize daha bilge olma gücü vereceğini anlatıyor. Bu araçlar, ister karmaşık simülasyonlar veya veritabanları biçiminde, isterse de bilgiyi geldiği anda işlememize

yardımcı olan yerleşik araçlar biçiminde olsun, düşünme gücümüzü artırıyor. Bu gelişmelerden ortaya çıkacak dijital olarak gelişmiş kişi, yani dijital homo sapiens, günümüz insanından iki temel açıdan farklılaşıyor. Bunlar; Dijital gelişimi insan varoluşunun ayrılmaz bir parçası olarak kabul ediyor. Dijital bilgelik, hem doğuştan gelen yetenekleri tamamlamak için dijital gelişmelerin bilinçli kullanımında hem de daha akıllıca karar vermeyi kolaylaştırmak için gelişmelerin kullanımında kendini gösterir. Dijital bilgelik kavramını literatüre kazandıran Prensk'e göre, hayal edilemeyecek kadar karmaşık bir gelecekte, ne kadar akıllı olursa olsun, becerilerini kullanabilme yönünde geliştirilmemiş kişi, en az akıllı gelişmiş insanın bile kullanabileceği bilgelik araçlarına sahip olmayacaktır (Prensky, 2009; Türk, 2017).
Bilgelik, tanımlanması zor evrensel bir kavramdır. Bilgiyi anlamayı ve uygulamayı içerir. Dijital teknolojiler ise, bilgeliğin ve akıllıca karar almanın gelişimini kolaylaştırma kapasitesine sahiptir. Bazıları bilgeliği, bilgiyi yeni durumlara etkili bir şekilde uygulama yeteneği olarak tanımlamıştır (Maimon, 2012). Dijital teknoloji, verilere erişim, daha derin analizler yapma becerisi, planlama ve öncelik sırasına koyabilme becerisi, başkalarına dair içgörüler, alternatif bakış açılarına erişim sağladığı için daha fazla bilgeliğe yol açabilmektedir. Dijital araçlar bilişsel yeteneklerimizi, hafızamızı ve muhakeme yeteneğimizi geliştirerek karmaşık analizler yapmamıza yardımcı olur.
Dijitalleşme aşamasında kültürel süreç, geleneksel toplumlarda var olandan farklı olarak yeni ilgi alanlarının oluşmasında etkili olmaktadır. Van Dijk'a göre dijital kültürün farklı özellikleri vardır ki bunları yedi madde altında sıralayabiliriz. Bunlar;

1. *Önceden programlama ve yaratıcılık*
2. *Parçalanma*
3. *Yeniden birleştirme: Kolaj*
4. *Kullanıcı Üretimi*
5. *Hızlanma*
6. *Görselleştirme*
7. *Nicelleştirme (Dijk, 2018: 294-307).*

Diğer taraftan Şekil 1'de dijital bilgelik kavramının ilişkili olduğu kavramlar vurgulanmaktadır. Şekil 1'de görüldüğü gibi dijital bilgelik kavramı, güvenli ve sorumluluğunu bilerek dünyada teknolojinin kullanılmasını gerektirmektedir. Bu kapsamda programlamayı da içeren becerilerin, bilgisayar biliminin-teknik anlaşılırlığının bilinmesi gerektiği ve kesinlikle dijital okuryazar olmak gerektiği belirtilmektedir. Tüm boyutların farkındalığının ve bilinçliliğinin olması dijital bilgeliğin niteliğini arttırmaktadır kesinlikle.



Şekil: NAACE'ye göre BİT çerçevesi (Aktaran, Türk, 2017:19)

Dijital teknolojinin kullanımı bizi sadece daha akıllı kılmayacak, aynı zamanda gerçekten daha bilge kılmak için kullanılabileceğine inanabiliriz. Dijital bilgelik, hem doğuştan gelen kapasitemizin ötesinde bilişsel güce erişmek için dijital teknolojinin kullanımından kaynaklanan bilgeliği hem de yeteneklerimizi geliştirmek için teknolojinin ihtiyatlı kullanımındaki bilgeliği ifade eden çift yönlü bir kavramdır. Teknoloji sayesinde, geleceğin bilgelik arayanları, devam eden dünya çapındaki tartışmalara, kayıtlı tüm tarihe, şimdiye kadar yazılmış her şeye, çok sayıdaki vaka çalışmaları, toplanmış veri kütüphanelerine ve yıllarca hatta yüzyıllarca süren gerçek deneyime eşdeğer olarak son derece gerçekçi olarak ifade edilmiş tecrübelere eşi benzeri görülmemiş şekilde erişimden faydalanabileceklerdir. Bu kaynakları nasıl ve ne kadar kullandıkları, ihtiyaç duyduklarını bulmak için bunları nasıl filtreledikleri ve teknolojinin onlara nasıl yardımcı olduğu, karar ve yargılarının bilgeliğini belirlemede kesinlikle önemli bir rol oynayacaktır. Teknoloji tek başına sezginin, sağduyunun, problem çözme becerilerinin ve net bir ahlaki yönlendirmenin yerini almayacaktır. Ancak akıl almaz derecede karmaşık bir gelecekte, dijital olarak geliştirilmemiş kişi, ne kadar bilge olursa olsun, dijital olarak geliştirilmiş en az bilge insanın bile erişebileceği bilgelik araçlarına erişemeyecektir. Dahası, beynin artık genel olarak son derece esnek olduğu ve aldığı girdiye sürekli olarak uyum sağladığı düşünüldüğünde, teknolojiyle sık sık etkileşim kuranların beyinlerinin bu etkileşimle yeniden yapılandırılması mümkün. Geleceğin bilgelik arayanlarının beyinleri, organizasyon ve yapı olarak bugünkü beyinlerimizden temelden farklılık gösterecektir. Geleceğin bilgelik arayışında olanlar, zaman ilerledikçe daha karmaşık hale gelen dijital teknolojinin sunduğu bilişsel geliştirmeler olmadan bugünün bilgelik seviyesine ulaşabilecekler, ancak bu bilgelik, karmaşık ve teknolojik olarak gelişmiş bir dünyada yol almak için ne nicelik ne de nitelik olarak yeterli olmayacak (Prensky, 2009; Türk, 2017).
Oxford İngilizce Sözlüğü, bilgeliğin temel bileşeninin yargı olduğunu öne sürerek, "Hayat ve davranışla ilgili konularda doğru yargıda bulunma kapasitesi, araç ve amaç seçiminde sağlam yargıda bulunabilme kapasitesi" (OED (Oxford English Dictionary), 1989) olduğunu ifade etmektedir. Filozof Robert Nozick (1990), bilgeliğin neyin önemli olduğunu bilmekte yattığını öne sürerken; diğer tanımlar ise bilgeliği, Aristoteles'in "pratik bilgelik" olarak adlandırdığı sorun çözme yeteneği olarak görmektedir (Vikipedi, 2009). Bazı tanımlar-hepsi olmasa da-bilgeliğe ahlaki bir bileşen atfeder ve bilgeliği "doğru" veya "sağlıklı" olanı ayırt etme yeteneğinde bulunabilme olarak vurgulamaktadırlar.
Dolayısıyla bilgelik, bağlam dikkate alınmadan kesin olarak tanımlanamaz. Bu tartışmada özellikle faydalı olan ilginç bir bilgelik tanımı, bilgeliğin bir yargıya veya karara varırken ele alınan konuların genişliğinde görülebileceğini öne süren Howard Gardner'dan (2000) gelmektedir. Bu kaynakları bir araya getirerek bilgeliği, karmaşık insan sorunlarına pratik, yaratıcı, bağlamsal olarak uygun ve duygusal olarak tatmin edici çözümler bulma yeteneği olarak tanımlayabiliriz (http://www.innovateonline.info/index.php?view=article&id=705).
Barnet Berry ve arkadaşları, 2011 yılında yayınlanan "***Teaching 2030"*** adlı kitaplarında, yeni ortaya çıkan ve eğitimi değiştirecek durumları 4 başlık altında değerlendirmişlerdir:

1. *Öğrenciler ve öğretmenler için dönüştürülmüş bir öğrenme ekolojisi,*
2. Siber ağlardaki kusursuz gruplar arası ilişkiler (öğrenme ağları),
3. 21. yüzyılın meslekleri, farklılaştırılmış ve kişiselleştirilmiş kariyer yolları,
4. Öğretmen girişimciliği ve geleceğe dönük İnovasyon (ogrenmeyoldasi.weebly.com/kayhan-karl305-blog/dijital-bilgelik-yolculuu)

Mitchel Resnick şöyle diyor: "Bugün okullarda uygulanan müfredatın büyük bir bölümü, kağıt-kalem çağı için tasarlanmıştır. Bu durum iki nedenle değişmeli: Öğrencileri başarılı olmaları için hazırladığımız dijital toplumsal yaşamın dönüşümü ve dijital teknolojilerin öğrencilerimizin öğrenme biçimlerini değiştirmesi... Endüstriyel çağdan bilgi toplumu çağına ve şimdi de yaratıcı toplum çağına geçiş yaşıyoruz." (ogrenmeyoldasi.weebly.com/kayhan-karl305-blog/dijital-bilgelik-yolculuu). Dolayısıyla bu geçiş döneminde kesinlikle her bireyin dijital bilge olabilmesi oldukça önemli.

Bu araştırmanın genel amacı; dijital bilgelik nedir? ilgili literatür analiz edildikten sonra uygulamaya dönük öneriler belirtmektir. Bu kapsamda Türkiye'de hazırlanmış olan çok az sayıdaki (***1 makale, 1 yüksek lisans tezi ve 1 doktora tezi***) çalışmaların analiz edilmesi hedeflenmiş olup konuyla ilgili literatürün değerlendirilmesi yapılmıştır.

YÖNTEM

Bu araştırmanın genel amacı; dijital bilgelik nedir? ilgili literatür analiz edildikten sonra uygulamaya dönük öneriler belirtmektir. Araştırma nitel modelinde hazırlanmıştır. Bu kapsamda durum çalışması deseni içeriğinde doküman analizi yapılmıştır. Çeşitli disiplinleri kapsayan ve birçok terimi bir araya getiren nitel araştırma modelini bir tek cümleye sığdırarak açıklamak hiç kolay değildir. Bu nedenle, kapsayıcı şemsiye kavram olarak yapılandırılmıştır. Nitel araştırma, algı ve olayları analiz etmek için gözlem, görüşme ve doküman analizi gibi nitel veri toplama yöntemlerinin kullanıldığı kapsamlı bir araştırma türüdür (Yıldırım & Şimşek, 2018). İlgili dokümanlar arasında makaleler, tezler, internet kaynakları ve diğer veri kaynakları yer almıştır. Sosyal bilimlerde doküman analizi, tüm araştırmacıların bir araştırma planı olarak ve iyi yapılandırılmış, ayrıntılı bir yöntem olarak kullanabileceği yararlı bir yaklaşımdır (Mogalakwe, 2006). Dokümanlar araştırmacılar için oldukça önemli veri kaynaklarındandır. Verilerin analizinde içerik analizi yönteminin kullanımı tercih edilmiştir. Bu kapsamda konuyla ilgili dokümanlar analiz edilmiştir. İlgili dokümanlar makale, tezler, internet kaynakları vb veri kaynaklarıdır. İçerik analizi nitel bir veri analizi yöntemidir. Yazılı, sözlü veya görsel dokümanları sistematik olarak analiz etmek için nitel veya nicel olarak kullanılabilen bir yöntem olan içerik analizi, 1950'lere ve kitle iletişim araştırmalarına kadar uzanır (White & Marsh, 2006: 22).

BULGULAR VE YORUMLAR

Dijital bilgelik, Marc Prensky tarafından "zamanımızın teknolojisini düşünce ve karar alma süreçlerimize entegre etmek, bunu akıllıca yapmak ve sonuçları paylaşmak" (Prensky, 2012a: 47) anlamında ortaya atılan bir terimdir. Dijital bilgelik, sorulara en akıllıca yanıtları elde etmek için zihnin faaliyetlerini bilgisayarın işlemleriyle birleştirme yeteneğini ifade eder (Shaughnessy, Fulgham & Prensky, 2010:30). İfade edilen noktalar; geleceğin nitelikli insanının modern tarifi niteliğindedir.

İnsan zihni düşünme, örüntüleri görme, kategoriler ve ilişkiler oluşturma ve sezgi yeteneğine sahiptir. Makineler, büyük miktarda veriyi depolama, işleme ve analiz etmekte mükemmeldir. Ayrıca, karmaşık durumlarda risk değerlendirmesi yaparken insan yargısının yanılabilir olması nedeniyle karar alma süreçlerinde de büyük yardımcı olabilirler (Wilkinson-Ryan, 2020). Dijital araçlar, bu iki dünyayı, yani insanlığın dünyasını ve bilgisayarların dünyasını birbirine bağlar. Beklenen sonuç, insan zekâsının gelişmesi ve dijital bilgeliğin kazanılmasıdır. Dijital bilgelik, zihin ve dijital araçların birleşiminden doğar; geliştirilmemiş zihnin sıradan görevleri dış kaynak kullanarak kaybettiği şey, kazanılan bilgelikle fazlasıyla telafi edilecektir. Bilgelik ve özellikle pratikte tercih edilen bilgelik, bireyleri daha güçlü yapan dijital gelişmeler yönünde önemli olduğu anlaşılmalıdır (Prensky, 2012b: 211).

Ulusal literatürde hazırlanmış olan çalışmalar

Türkiye'de ilgili kaynakların taranması sonucunda sadece üç tane çalışmanın hazırlanmış olduğu tespit edilmiştir. Bu çalışmalar aşağıda analiz edilmiştir.

Çalışma-1 Doktora Tez çalışması: Türk, M. (2017). Öğretmen adaylarının dijital bilgeliğe ilişkin yeterlik algılarının incelenmesi. Yayımlanmamış doktora tezi. Eskişehir: Anadolu Üniversitesi.

Çalışmanın bilgisi	Türk, M. (2017). Öğretmen adaylarının dijital bilgeliğe ilişkin yeterlik algılarının incelenmesi. Yayımlanmamış doktora tezi. Eskişehir: Anadolu Üniversitesi.
Amaç	Bu çalışmanın amacı, öğretmenlik mesleği açısından dijital bilgeliğe ilişkin yeterlikleri ve göstergeleri belirlemek ve Türkiye genelindeki öğretmen adaylarının dijital bilgeliğe ilişkin yeterlik algı profillerini tespit etmektir (Türk, 2017).
Yöntem	Keşfedici sıralı karma desenin kullanıldığı araştırmanın nitel aşamasında, farklı alanlardan uzmanların katılımlarıyla gerçekleştirilen yapılandırılmamış görüşmeler ve Delphi turları sonrasında Düşünme ve Karar Verme, Toplumsallık ve Duygusallık olmak üzere dijital bilgeliğe ilişkin 3 farklı yeterlik alanının bulunduğu bir yapı oluşturulmuştur. Üç Delphi turu sonunda uzlaşma sağlanan bu yapıya ilişkin gösterge maddeleri kullanılarak ***"Dijital Bilgelik Yeterlik Algısı Ölçeği"*** geliştirilmiştir. Düşünme ve Karar Verme, Sosyal Duyarlılık ve Paylaşımcılık faktörlerinin bulunduğu bu ölçek kullanılarak gerçekleştirilen nicel aşamada ise, 2017 yılı içerisinde 1474 öğretmen adayından veri toplanmıştır (Türk, 2017).
Sonuçlar	Elde edilen bulgulara göre öğretmen adaylarının kendilerini dijital bilgelik konusunda genel olarak yüksek düzeyde yeterli görmektedir. Ayrıca öğretmen adaylarının dijital bilgelik yeterlik algıları, yaş ve bölüm değişkenlerine göre anlamlı farklılık gösterirken cinsiyet açısından farklılık göstermemektedir. Öğretmen adaylarının dijital bilgelik yeterlik algıları ve teknoloji kullanma yeterlikleri arasında pozitif ve orta düzeyde ilişki bulunurken genel olarak akademik başarı ortalaması ve günlük internet kullanım süresi arasında herhangi bir ilişki bulunmamaktadır. Bununla birlikte öğretmen adaylarının dijital bilgelik yeterlik algılarıyla dijital yerlilik özellikleri arasında pozitif ve orta düzeyde bir ilişki olduğu gözlenmiştir (Türk, 2017).

Çalışma-2 Yüksek Lisans Tez çalışması: Sericik, Z. (2025). Okul yöneticilerinin dijital liderlik düzeyleri ile öğretmenlerin dijital bilgelik yeterlikleri arasındaki ilişki. Yayımlanmamış yüksek lisans tezi. Gaziantep: Gaziantep Üniversitesi.

Çalışmanın bilgisi	Sericik, Z. (2025). Okul yöneticilerinin dijital liderlik düzeyleri ile öğretmenlerin dijital bilgelik yeterlikleri arasındaki ilişki. Yayımlanmamış yüksek lisans tezi. Gaziantep: Gaziantep Üniversitesi.
Amaç	Bu araştırmanın amacı, okul yöneticilerinin dijital liderlik düzeyi ile öğretmenlerin dijital bilgelik yeterlikleri arasındaki ilişkiyi incelemektir (Sericik, 2025).
Yöntem	Araştırmada nicel araştırma yöntemlerinden biri olan ilişkisel tarama modeli kullanılmıştır. Araştırmanın örneklemini 2024-2025 eğitim öğretim yılında Osmaniye iline bağlı Kadirli ilçesinde bulunan ilkokul, ortaokul ve lise kademelerinde görev yapan 598 öğretmen oluşturmaktadır. Araştırmanın örneklemi, öğretmenlerin çalıştıkları okul türüne göre ilkokul, ortaokul ve lise grubu şeklinde tabakalar oluşturularak orantılı tabakalı örnekleme yöntemi ile belirlenmiştir. Araştırma verilerini elde etmek amacıyla araştırmacı tarafından hazırlanan "Kişisel Bilgi Formu", Bilginoğlu ve Yozgat (2023) tarafından Türkçe'ye uyarlanan "Dijital Liderlik Ölçeği" ve Türk (2017) tarafından geliştirilen "***Dijital Bilgelik Yeterlik Algısı Ölçeği***" kullanılmıştır. Araştırmada elde edilen veriler SPSS 25.0 paket programı kullanılarak analiz edilmiştir. Öncelikle veri setlerinde Mahalanobis uzaklığı değerleri incelenecek verilerde uç değerlerin olmadığı tespit edilmiştir. Araştırma sonucunda elde edilen verilerin normallik varsayımını karşılayıp karşılamadığına bakmak için Kolmogorov–Smirnov ve Shapiro–Wilk testleri uygulanmıştır (Sericik, 2025).
Sonuçlar	Yapılan analizler sonucunda okul yöneticilerinin dijital liderliklerine ilişkin öğretmen algılarının yüksek düzeyde olduğu tespit edilmiştir. Araştırma sonuçlarına göre; cinsiyet, yaş ve mesleki kıdem bağımsız değişkenlerine göre oluşturulan öğretmen gruplarının, okul yöneticilerinin dijital liderlik düzeyine ilişkin algıları arasında istatistiksel olarak anlamlı fark olduğu görülmüştür. Ancak okul türü, öğrenim durumu ve aynı okul yöneticisi ile çalışma süresine göre oluşturulan öğretmen gruplarının okul yöneticilerinin dijital liderlik düzeyine ilişkin algıları arasında istatistiksel olarak anlamlı fark olmadığı görülmüştür. Araştırma sonuçlarına göre öğretmenlerin dijital bilgelik yeterliklerinin yüksek düzeyde olduğu belirlenmiştir. Cinsiyet, yaş, mesleki kıdem, okul türü, öğrenim durumu ve aynı okul yöneticisi ile çalışma süresine göre oluşturulan öğretmen gruplarının dijital bilgelik yeterlikleri arasında istatistiksel olarak anlamlı farklılık olmadığı tespit edilmiş. Ayrıca öğretmenlerin görüşlerine göre okul yöneticilerinin dijital liderlik düzeyleri ile öğretmenlerin dijital bilgelik yeterlikleri arasında pozitif yönlü ve orta düzeyde istatistiksel olarak anlamlı bir ilişki bulunmuştur (Sericik, 2025).

Çalışma-3 Makale: Özerbaş, M.A. & Mambetakhunova, D. (2023). Kırgızistan'daki üniversite öğrencilerinin dijital bilgeliğe ilişkin yeterlik algılarının incelenmesi. *Millî Eğitim, 52* (240), 2507-2530.

Çalışmanın bilgisi	Özerbaş, M. A. & Mambetakhunova, D. (2023). Kırgızistan'daki üniversite öğrencilerinin dijital bilgeliğe ilişkin yeterlik algılarının incelenmesi. *Millî Eğitim, 52* (240), 2507-2530.
Amaç	Bu araştırmanın amacı, üniversite öğrencilerinin dijital bilgeliğe ilişkin yeterlik algı düzeylerini belirlemektir (Özerbaş & Mambetakhunova, 2023).
Yöntem	Nicel araştırma modeli kapsamında ilişkisel ve betimsel tarama deseni birlikte kullanılmıştır. Araştırmanın çalışma grubu, 2021-2022 eğitim-öğretim yılında Kırgızistan-Türkiye Manas Üniversitesinin farklı fakültelerinde öğrenim gören 6100 öğrenciden basit tesadüfi örneklem yöntemiyle belirlenen 225 öğrenciden oluşmaktadır. Araştırma ile ilgili veriler kişisel bilgi formu ile Türk (2017) tarafından geliştirilen "***Dijital Bilgelik Yeterlik Algısı Ölçeği***" kullanılarak toplanmıştır. Ölçekte Düşünme ve Karar Verme, Sosyal Duyarlılık, Paylaşımcılık olmak üzere üç ana alt boyutu bulunmakta ve ilk 16 maddesi Düşünme ve Karar Verme, sonraki 11 maddesi (17-27. maddeler) Sosyal Duyarlılık ve son 4 maddesi (28-31. maddeler) Paylaşımcılık faktörünü ölçmektedir. Ölçme aracı toplam 31 maddeden ve 7'li Likert tipinde oluşmaktadır. Araştırmada elde edilen veriler SPSS kullanılarak analiz edilmiştir. Verilerin normal dağılım şartını yerine getirip getirmediğini belirlemek için iki normallik testinden yararlanılmıştır. Verilerin normal dağıldığı belirlendikten sonra; cinsiyet, yaş, sınıf ve günlük dijital teknoloji kullanım süresi değişkenlerine göre ikili değişkenler arasındaki farklılığı belirlemek için parametrik testlerden "bağımsız t-testi", ikiden fazla değişken için "tek yönlü ANOVA" testi ve iki değişken arasındaki ilişkiyi belirlemek için ise Spearman korelasyon katsayısı testi kullanılmıştır. Fakülte ve bölüm değişkenlerine göre ise verilerin normal dağılmadığı belirlenmiş ve non parametrik testlerden "Kruskal-Wallis testi" kullanılmıştır (Özerbaş & Mambetakhunova, 2023).
Sonuçlar	Yapılan testlerin sonuçlarına göre; öğrencilerin dijital bilgelik açısından yeterlik algılarının cinsiyet ve sınıf değişkenlerine göre istatiksel olarak anlamlı bir farklılık göstermediği görülmüştür. Öğrencilerin yaş, fakülte ve bölüm değişkenlerine göre ölçeğin paylaşımcılık boyutunda istatistiksel olarak anlamlı bir farklılaşmanın olduğu saptanmıştır. Günlük dijital teknoloji kullanım süresi ile öğrencilerin dijital bilgeliğe ilişkin yeterlik algıları arasında anlamlı bir ilişki görülmemiştir (Özerbaş & Mambetakhunova, 2023).

Yukarıda belirtildiği gibi, Çalışma-1 ve Çalışma-2 tez çalışmaları ve Çalışma-3 makale çalışmasının dikkat çekici noktaları söz konusudur. Bu kapsamda aşağıda tespit edilen noktalar belirtilebilir;

*Türkiye'de dijital bilgelik konusunda hazırlanmış olan çalışmalar nicel ve karma araştırma modelinde hazırlanmışlardır. Nicel araştırma modelinde betimsel tarama deseni kullanılırken karma araştırma modelinde ise ölçme araçlarının maddelerinin hazırlanmasında nitel araştırma modeli kullanılmıştır.

* Bu çalışmalar 1 tane makale, 1 tane yüksek lisans tezi ve 1 tane doktora tezinden oluşmaktadır. En kapsamlı hazırlanan çalışma doktora tezidir. Karma modelde hazırlanmış olan bir araştırma olup hem nicel hem de nitel boyutu vardır. Özellikle doktora tezinin nicel boyutunda hazırlanmış olan ölçme aracı "***Dijital Bilgelik Yeterlik Algısı Ölçeği***" diğer iki çalışmanın ki makale ve yüksek lisans tezinin temel veri toplama aracını oluşturmaktadır. Çünkü bu çalışmalarda veriler bu ölçme aracıyla toplanmıştır. Dolayısıyla ulusal literatürde ilk çalışmanın Türk (2017) tarafından hazırlanmış olan doktora tez çalışması olduğu belirlenmiştir.

* *Dijital Bilgelik Yeterlik Algısı Ölçeği*; Düşünme ve Karar Verme, Sosyal Duyarlılık ve Paylaşımcılık boyutlarından oluşmaktadır. Bu boyutlar dijital bilgelik kavramıyla ilgili belirtilen tanımlarda yer alan boyutları destekler niteliktedir.

* Çalışmaların katılımcı gruplarını öğretmen adayları, öğretmenler ve üniversite öğrencileri oluşturmaktadır. Bu durum araştırmacıların kolay ulaşabileceği araştırma gruplarının katılımıyla çalışmaların hazırlandığının bir göstergesi olmakla birlikte dijital bilgelik konusu toplumda yaşayan her kesimi ilgilendirdiğinden farklı katılımcı gruplarının çalışmalarda yer verilmesi tercih edilmiştir diyebiliriz. Çalışmalarda oldukça kalabalık çalışma gruplarının katılımının sağlandığı, çalışma evreni kapsamından çalışma örnekleminin seçiminin tercih edildiği belirlenmiştir.

* Çalışmalarda özellikle SPSS programı nicel verilerin analizi amaçlı kullanılmıştır. Bu kapsamda nicel veri analizinde demografik özelliklere göre dijital bilgelik düzeyinin farklılık gösterip göstermediği farklı analiz yöntemleriyle test edilmiştir.

* Çalışmalarda tespit edilen önemli sonuçlar şöyledir; öğretmen adayları dijital bilgelik konusunda kendilerinin yüksek düzeyde yeterli olduğunu düşünmektedirler. Ancak dijital bilgelik yeterlik algıları, yaşa ve bölüme göre anlamlı farklılık gösterirken cinsiyete göre farklılık göstermemektedir. Dijital bilgelik yeterlik algısı ile teknoloji kullanma yeterlikleri ve dijital yerlilik özellikleri arasında pozitif ve orta düzeyde ilişki bulunurken, akademik başarı ortalaması ve günlük internet kullanım süresi arasında herhangi bir ilişki bulunmamıştır (Türk, 2017).

Öğretmenlerin dijital bilgelik yeterlik düzeylerinin yüksek düzeyde olduğu belirlenmiştir. Cinsiyet, yaş, mesleki kıdem, okul türü, öğrenim durumu ve aynı okul yöneticisi ile çalışma süresine göre oluşturulan öğretmen gruplarının dijital bilgelik yeterlikleri arasında istatistiksel olarak anlamlı farklılık olmadığı tespit edilmiş. Ayrıca öğretmenlerin görüşlerine göre okul yöneticilerinin dijital liderlik düzeyleri ile öğretmenlerin dijital bilgelik yeterlikleri arasında pozitif yönlü ve orta düzeyde istatistiksel olarak anlamlı bir ilişki bulunmuştur (Sericik, 2025).

Üniversite öğrencilerinin dijital bilgelik yeterlik algıları cinsiyet, sınıf düzeyi ile günlük dijital teknolojiden yaralanma süresi değişkenine göre anlamlı farklılık göstermediği belirlenmiştir. Öğrencilerin fakülte, bölüm ve yaş değişkenlerine göre dijital bilgelik yeterlik ölçeğinin paylaşımcılık boyutunda istatistiksel olarak anlamlı bir farklılaşmanın olduğu saptanmıştır (Özerbaş & Mambetakhunova, 2023).

SONUÇ VE ÖNERİLER

"Geleneksel" düşünce tarzımız derin bir değişimden geçiyor; öyle ki, zihin ve teknolojinin en iyi kombinasyonunu bulmak yeni bir bilgelik, yani "dijital bilgelik" gerektiriyor. Gençken hayatınızın geri kalanında işinize yarayacak bir sürü bilgiyi ezberlemek veya tüm kariyeriniz boyunca devam edebileceğiniz bir iş veya işveren aramak gibi eski bilgelik türleri, çağdaş dünyamızda artık mantıklı değil. Günümüzde bilgiler çok hızlı bir şekilde güncelliğini yitiriyor. Günümüzde ihtiyaç duyulan beceriler birden fazla disiplin ve kaynaktan gelmek zorunda kalmaktadır (Prenskly, 2012b).

Dijital teknolojilerin yaygın varlığı, bu medyaların kullanımıyla daha akıllı hale gelme ihtiyacını doğurmuştur. Elbette, teknoloji kullanımı tek başına insan düşüncesinin, problem çözme becerilerinin ve sağlam/yerinde yargısının yerini almayacaktır. Dijital bilgelik, teknoloji olarak karmaşık ve bir o kadar da gelişmiş bir dünyada en doğru olanı bulmamıza ve karar vermemize yardımcı olacaktır. Herkesi dijital yönde geliştirmenin bizi daha akıllı ve bilge kılabileceğine inanmadığımızı söylemeye gerek yok. Dijital geliştirmelerimizden bazıları ikilemlere yol açabilir. Dijital teknolojilerin potansiyel faydalarına ve zararlarına gözlerimizi dört açarak, 21. yüzyılda başarılı olmak için dijital bilgeliği takip etmekte yarar var.

Konuyla ilgili elde edilen verilerin analizinde sonuç olarak; dijital bilgelik konusunda ülkemizde yeterince çalışmanın literatürümüzde yer almadığı belirlenmiştir. Özellikle dijital bilgelik kavramının kapsamında yer alan, dijital okuryazarlık kavramıyla ilgili çalışmaların daha fazla hazırlanmış olduğu dikkat çekmektedir. Hazırlanmış olan tez ve makale çalışmalarında Türkçe olarak hazırlanmış olan aynı ölçme aracının kullanıldığı belirlenmiş olup çalışmaların nicelik olarak yeterli olmadığı belirlenmiştir. Dijital bilgeliğin her üç araştırmada da aynı ölçme aracıyla belirlendiği tespit edilmiştir. Öğretmenlerin ve eğitimcilerin, gelecekte öğrencilerine fayda sağlayacak yeni pedagojik yaklaşımları keşfetmek için öğretim ve öğrenme uygulamalarıyla ilgili dijital bilgelikten yararlanmalıdır. Dijital bilgelik, genellikle zihinlerimizi geliştirmek için teknolojiyi, özellikle de yeni teknolojileri kullanmayı ifade etmektedir. Bu da bizi daha iyi düşünen, daha akıllıca kararlar alan ve daha akıllıca seçimler yapan bireyler yapmaktadır. Eğitim bağlamında, eğitimciler aşağıdaki öneriler noktasında yaptıklarıyla dijital bilgelikten yararlanabilirler (Prensky, 2012a):

• Öğrenmeyi kolaylaştırmak için sınıfta rehber, bağlam sağlayıcı ve kalite kontrolcü rolünü üstlenebilirler;

• Dijital araçları, öğrenme hedefleri ve öğrencilerin beklentileriyle uyumlu hale getirerek bilinçli bir şekilde seçebilirler;

a. Öğrencileri yaratıcı olmak ve yeni teknolojiler ve fikirlerle denemeler yapmak için dijital araçları kullanmaya teşvik edebilirler;

b. Öğrencileri uygun çevrimiçi davranışları modelleyerek, eleştirel düşünme becerilerini teşvik ederek ve güvenli çevrimiçi uygulamaları teşvik ederek dijital teknolojiyi akıllıca kullanmaya teşvik edebilirler;

c. Grup projelerini kolaylaştırmak için dijital araçları kullanarak iş birlikçi öğrenmeyi ve iletişimi teşvik ederek, öğrenciler arasında tartışmalar ve fikir paylaşımı yapmalarını sağlayabilirler,

d. Yeni teknolojilerle güncel kalmak ve bunları öğrenci öğrenimini ve ilerlemesini ölçmek için aktif olarak kullanmayı öğrenmek, öğrencilere geri bildirim sağlamak, ilerlemelerini izlemek ve öğrenme deneyimlerini kişiselleştirmek amaçlı kullanabilirler;

e. Videolar, podcast'ler ve etkileşimli oyunlar gibi dijital içerik seçenekleri sunarak, görsel, işitsel ve kinestetik dahil olmak üzere farklı öğrenme stillerine uyum sağlamak ve hitap etmek için dijital araçları kullanabilirler (Prensky, 2012a; aktaran, Ramdas & Umar, 2024)

Kısacası sonuç olarak; dijital bilgelikten yararlanmak, öğretmenlerin bu yönde gelişmek isteyen öğrencilerin ihtiyaçlarını daha iyi karşılamalarını sağlayacaktır. Öğrencileri gelecek yılların teknolojilerine hazırlamış olacaklardır. Ülkemizde özellikle dijital bilgelik konusunda deneysel araştırmaların yapılması, farklı öğretim kademelerinden öğrencilerin katılımcı grubu olarak seçilmesi, konuyla ilgili farklı ölçme araçlarının geliştirilmesinin sağlaması… gibi farklı araştırmaların desteklenmesiyle literatüre farklı araştırma sonuçlarıyla katkıda bulunulması sağlanabilir.

KAYNAKÇA

Dijk, V.D. (2018). Ağ toplumu. (Çev. Sakin, Ö). İstanbul: Epsilon Yayınevi.

http://www.innovateonline.info/index.php?view=article&id=705

http://www.ogrenmeyoldasi.weebly.com/kayhan-karl305-blog/dijital-bilgelik-yolculuu

Maimon, E.P. (2012). Information, knowledge, and wisdom: Transforming education. *Procedia-Social and Behavioral Sciences,* 55 (2012), 94-99.

Matysek, A. & Tomaszczyk, J. (2020)**.** Digital wisdom in research work. Zagadnienia Informacji Naukowej-Studia Informacyjne, 58(2A(116A),98-113. https://www.researchgate. net/publication/348112680_Digital_wisdom_in_research_work

Mogalakwe, M. (2006). The use of documentary research methods in social research. *African Sociological Review,* 10(1), 221-230.

ogrenmeyoldasi.weebly.com/kayhan-karl305-blog/dijital-bilgelik-yolculuu

Özerbaş, M.A. & Mambetakhunova, D. (2023). Kırgızistan'daki üniversite öğrencilerinin dijital bilgeliğe ilişkin yeterlik algılarının incelenmesi. *Millî Eğitim,* 52(240), 2507-2530.

Prensky, M. (2009). H sapiens digital: From digital immigrants and digital natives to digital wisdom. Innovate: *Journal of Online Education*, 5(3), Article 1. https://www.learntechlib.org/p/104264/

Prensky, M. (2012a). *Brain gain: Technology and the quest for digital wisdom*. New York: Palgrave Macmillan.

Prensky, M. (2012b). *From digital natives to digital wisdom: Hopeful essays for 21st century learning*. California, London: Corwin.

Prensky, M. (2012c, November 14). Why we need digital wisdom: Technology in education. OnQ Blog. Qualcomm Technologies. https://www.qualcomm.com/news/onq/2012/11/ why-we-need-digital-wisdom.

Ramdas, G. & Umar, I.N. (2024). Measuring practice of digital wisdom in the classroom. *Journal of Educators Online*, 21 (3), n3.

Sericik, Z. (2025). Okul yöneticilerinin dijital liderlik düzeyleri ile öğretmenlerin dijital bilgelik yeterlikleri arasındaki ilişki. Yayımlanmamış yüksek lisans tezi. Gaziantep: Gaziantep Üniversitesi.

Shaughnessy, M.F., Fulgham, S.M. & Prensky, M. (2010). Interview with Marc Prensky. *Educational Technology*, 50(2), 28–33.

Türk, M. (2017). Öğretmen adaylarının dijital bilgeliğe ilişkin yeterlik algılarının incelenmesi. Yayımlanmamış doktora tezi. Eskişehir: Anadolu Üniversitesi.

TDK sözlük. https://sozluk.gov.tr/

White, M.D. & Marsh, E.E. (2006). Content analysis: A flexible methodology. *Library Trends*, 55(1), 22-45.

wikipedia
https://tr.wikipedia.org/wiki/Bilgelik#:~:text=Bilgelik%3B%20bilgi%20edinme%2C%20idrak%2C,etme%20yetene%C4%9Fi%20olarak%20da%20tan%C4%B1mlan%C4%B1r.

Wilkinson-Ryan, T. (2020). Our minds aren't equipped for this kind of reopening [online]. The Atlantic [01.11.2025], https://www.theatlantic.com/ideas/archive/2020/07/reopening-psychological-morass/613858/

Yıldırım, A. & Şimşek, H. (2018). Sosyal bilimlerde nitel araştırma yöntemleri. Ankara: Seçkin Yayıncılık.

LES OPINIONS DES ENSEIGNANTS SUR LE DÉVELOPPEMENT DE LA COMPRÉHENSION ÉCRITE CHEZ LES APPRENANTS DU FLE

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RÉSUMÉ

Cette étude vise à analyser, du point de vue des enseignants, les facilités et les difficultés rencontrées par les apprenants du programme préparatoire d'une université publique à Ankara dans le développement de leur compétence en compréhension écrite du français au cours du semestre de printemps 2018-2019. Elle vise également à identifier les causes de ces situations ainsi que les solutions pédagogiques proposées par les enseignants. Menée selon une approche qualitative, l'étude s'appuie sur des entretiens semi-structurés réalisés auprès de cinq enseignants de français et sur une analyse de contenu des données recueillies. Les résultats montrent que les enseignants utilisent fréquemment des méthodes variées telles que les questions-réponses, la lecture silencieuse suivie de la lecture à voix haute, les discussions autour du titre et des éléments visuels, les activités lexicales et le travail en groupe. Ces pratiques contribuent à renforcer à la fois la compréhension des textes et la prononciation. L'étude met également en évidence que les textes adaptés au niveau et aux intérêts des apprenants lorsqu'ils sont accompagnés de supports visuels, facilitent l'apprentissage. De même, les activités de prélecture stimulent la curiosité et soutiennent la compréhension. Toutefois, plusieurs facteurs freinent le développement de cette compétence, notamment le manque d'intérêt pour certains textes, l'anxiété liée à la lecture à voix haute, les difficultés de prononciation influencées par la langue maternelle, la faiblesse des habitudes de lecture ainsi que l'inadéquation culturelle de certains manuels et les environnements de classe bruyants ou surpeuplés. En conclusion, cette recherche montre que la compréhension écrite constitue une compétence multidimensionnelle influencée non seulement par des processus cognitifs mais aussi par des facteurs affectifs, pédagogiques et environnementaux.

Mot-clés: Compréhension Écrite ; Français Langue Étrangère ; Opinions des Enseignants ; Étude de Cas ; Analyse de Contenu

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INTRODUCTION

La langue est un outil fondamental en matière de communication et la compréhension de l'écrit constitue une composante essentielle de l'apprentissage linguistique. En effet, il est difficile pour un apprenant de progresser dans les autres compétences linguistiques (compréhension orale, expression orale et expression écrite) sans comprendre ce qu'il lit. La lecture ne se limite pas à reconnaître ou à prononcer des mots et des phrases et elle constitue un processus important qui exige de décoder le sens du texte. Pour cette raison, la compréhension de l'écrit occupe une place centrale dans l'acte de lire. Compte tenu de cette importance fondamentale, l'acquisition de cette compétence par les apprenants revêt une grande importance (Hegazi & Mohamed, 2022). Dans ce contexte, la compréhension écrite constitue une compétence essentielle dans l'apprentissage des langues étrangères en particulier en contexte de français

langue étrangère (FLE). Toutefois, loin d'être un simple acte de décodage, la lecture représente un processus cognitif complexe et multidimensionnel qui mérite une attention particulière de la part des didacticiens et des enseignants. Le développement de la compréhension écrite en langue étrangère s'appuie à la fois sur les compétences de lecture transférées de la langue maternelle puisque les apprenants de FLE savent généralement déjà lire dans leur propre langue et sur l'acquisition de connaissances lexicales, grammaticales et textuelles propres à la langue cible. En outre, l'expérience préalable de lecture de l'apprenant, sa connaissance du monde ainsi que son bagage socioculturel influencent également ce processus de manière significative (Cuq & Gruca, 2003). Cependant, la lecture constitue un acte interprétatif engageant le lecteur dans une construction active du sens. Comprendre un texte écrit, c'est amener le lecteur à formuler des hypothèses sur le sens à partir de ce qu'il lit. Ces hypothèses se construisent en fonction du message transmis, de l'intention de l'auteur et des connaissances personnelles du lecteur (Ahmadi & Miloudi, 2021, p. 155). Cette dimension interactive montre que la compréhension n'est jamais passive mais repose sur une dynamique constante entre le texte et le lecteur.

Le processus de compréhension d'un texte est influencé par de nombreux facteurs tels que la langue maternelle, les connaissances lexicales et grammaticales ainsi que l'expérience culturelle. C'est pourquoi la lecture constitue un point de départ essentiel. Lire implique l'interprétation d'un texte écrit et représente une activité complexe mobilisant non seulement la perception mais aussi les capacités cognitives. Cette réalité souligne que la compréhension écrite ne peut être réduite à des mécanismes simples ou linéaires. L'objectif principal de la compréhension écrite est de guider progressivement l'apprenant vers la compréhension du contenu d'un texte et de lui permettre d'interpréter différents types de textes. Cette compétence renforce également des capacités cognitives telles que la pensée critique, la mémoire et l'attention. De plus, la compréhension écrite est étroitement liée à la production écrite car l'apprenant acquiert au cours des activités de lecture, des idées et des informations qu'il pourra réutiliser dans ses propres écrits. Ce processus lui permet d'enrichir son vocabulaire grâce à l'apprentissage de nouveaux mots et contribue ainsi au développement de sa compétence d'expression écrite (Hadil & El Houda, 2024). Ainsi, la compréhension écrite consiste à lire un texte et à en saisir le sens de manière réfléchie et dynamique. Au cours de ce processus, le lecteur mobilise à la fois ses connaissances antérieures et les nouvelles informations acquises en lisant et sa mémoire ainsi que ses capacités de réflexion travaillent conjointement. Comprendre un texte implique de repérer les informations nécessaires, de rechercher des réponses aux questions posées et d'être capable de lire et d'interpréter le texte dans son intégralité de manière autonome (Karaoui et al., 2025). C'est pourquoi le développement de la compréhension écrite constitue un enjeu pédagogique majeur dans l'enseignement des langues étrangères, en particulier en FLE.

OBJECTIF DE LA RECHERCHE

Cette étude vise à analyser, du point de vue des enseignants, les difficultés rencontrées par les apprenants du programme préparatoire d'une université publique à Ankara au cours du semestre de printemps de l'année académique 2018-2019 dans l'acquisition de la compétence de compréhension écrite en français.

MÉTHODE

Dans cette recherche une méthode qualitative a été choisie afin d'obtenir des données détaillées. L'approche qualitative cherche à comprendre les expériences humaines et s'appuie sur les points de vue des personnes qui vivent ces expériences. La recherche qualitative adopte une approche ouverte à la compréhension des dimensions du vécu humain qui n'ont pas encore été révélées et vise à examiner les

phénomènes humains de manière approfondie. Elle est également considérée comme une méthode permettant d'analyser en détail l'objet d'étude abordé (Guillemette et al., 2021). Dans cette étude, "le modèle d'étude de cas" parmi les méthodes de recherche qualitative a été adopté. La caractéristique la plus fondamentale d'une étude de cas qualitative est l'examen approfondi d'un événement particulier ou de plusieurs événements (Yıldırım & Şimşek, 2018).

Le groupe de cette étude est constitué de cinq enseignants volontaires qui enseignent le français et qui travaillent dans le programme préparatoire de l'École des langues étrangères d'une université publique à Ankara durant le semestre de printemps de l'année universitaire 2018-2019. Pour cette étude, la méthode d'échantillonnage ciblé a été choisie et un formulaire d'entretien individuel élaboré à partir d'une revue de la littérature a été utilisé comme outil de collecte de données. Parmi les différentes méthodes d'entretien, la technique semi-structurée a été employée. L'entretien semi-structuré prend généralement la forme d'une conversation au cours de laquelle l'intervieweur et la personne interrogée partagent leurs connaissances (Mohamed, 2024). Dans les entretiens semi-structurés on recueille des données approfondies en posant des questions ouvertes tout en suivant un guide élaboré à l'avance (Meza Taborda & Sánchez Garnica, 2025). Après l'obtention des autorisations nécessaires, les enseignants du département préparatoire ont été contactés et leur consentement oral a été recueilli pour participer à l'étude. Une entrevue pilote a d'abord été menée avec un enseignant à la date et au lieu prédéterminés. À la suite de cette phase pilote les entretiens avec les enseignants ont été lancés. Avant les entretiens, les formulaires de consentement volontaire ont été remis aux enseignants. Les entrevues réalisées avec cinq enseignants aux dates et heures convenues ont duré entre 30 et 60 minutes. Tous les participants ont répondu aux questions de manière volontaire et sincère. Les entretiens ont été enregistrés à l'aide d'un téléphone portable et une fois toutes les entrevues terminées, les enregistrements ont été transférés sur un ordinateur afin de prévenir toute perte de données. Dans le processus d'analyse, les enregistrements des entretiens ont d'abord été transcrits, puis les données ont été examinées à l'aide de l'analyse de contenu, une méthode employée dans la recherche qualitative. Cette méthode constitue un outil d'analyse qualitative permettant de mettre en lumière les éléments implicites et peu visibles contenus dans les données recueillies (Bouvet, 2024, p. 59). Dans le processus d'analyse de contenu les réponses des enseignants concernant la compréhension écrite ont été codées par la chercheuse. Ensuite, les codes et les catégories ont été établis et l'avis de spécialistes a été demandé à cette étape. La technique de fréquence a été utilisée pour montrer combien de fois les codes et les catégories apparaissaient et les tableaux ont été préparés pour présenter les résultats de façon claire. Comme les participants pouvaient exprimer plusieurs idées, les codes appartenant au même enseignant pouvaient être placés dans différentes catégories. Le principe de confidentialité a été respecté et les noms réels n'ont pas été utilisés. Les enseignants ont été numérotés de 1 à 5 et codés E1, E2, E3, E4 et E5 à partir de la première lettre du mot "enseignant".

Questions de recherche

Les questions suivantes ont été formulées pour connaître les opinions des enseignants dans le processus d'acquisition de la compétence de compréhension écrite de leurs apprenants et pour obtenir des propositions des enseignants dans ce processus.

1. Quelles sont les opinions positives et négatives des enseignants concernant le processus d'acquisition de la compétence de compréhension écrite chez les apprenants ?
2. Quelles sont les opinions des enseignants concernant les causes des facilités et des difficultés rencontrées lors du processus d'acquisition de la compétence de compréhension écrite ?

3. Quelles sont les opinions des enseignants concernant les effets des caractéristiques individuelles des apprenants sur la compétence de compréhension écrite ?
4. Quelles sont les opinions des enseignants concernant les méthodes, stratégies et techniques utilisées dans l'acquisition de la compétence de compréhension écrite ?
5. Quelles sont les opinions des enseignants concernant les effets des méthodes, stratégies et techniques utilisées sur la compétence de compréhension écrite ?
6. Quelles sont les opinions des enseignants concernant les matériels pédagogiques utilisés en classe ?
7. Quelles sont les opinions des enseignants concernant les effets des matériels pédagogiques sur la compétence de compréhension écrite ?
8. Quelles sont les opinions des enseignants concernant les effets de l'environnement d'apprentissage sur la compétence de compréhension écrite ?
9. Quelles sont les propositions des enseignants pour le développement de la compétence de compréhension écrite ?

RÉSULTATS

Cette section présente les résultats obtenus à partir des réponses des cinq enseignants volontaires. Leurs opinions sur le développement de la compréhension écrite des apprenants ont été organisées en catégories pour chaque question et présentées sous forme de tableaux.

Le processus d'acquisition de la compréhension écrite

L'analyse des évaluations fournies par les enseignants concernant le développement de la compétence de compréhension écrite chez leurs apprenants en cours de français révèle deux grandes catégories d'opinions : les opinions positives et les opinions négatives. Les cinq enseignants ayant participé à l'étude ont également partagé leurs points de vue sur le processus d'acquisition de cette compétence. Alors que la majorité d'entre eux (E1, E3, E4, E5) ont évalué ce processus de manière positive une seule enseignante (E2) a exprimé une opinion négative à ce sujet.

Tableau 1: Opinions positives ou négatives des enseignants

Catégorie	**Codes des Participants**	**F**
Opinions positives	E1, E3, E4, E5	4
Opinions négatives	E2	1
	Total	**5**

Selon l'analyse des opinions positives ou négatives des enseignants concernant le développement de la compétence de compréhension écrite des apprenants, les apprenants participent activement aux cours et démontrent un haut niveau de motivation (E1, E3, E4, E5). Le manuel contient des textes de lecture adaptés au niveau de compréhension des apprenants et enrichis d'illustrations (E3). La compréhension écrite est la compétence à laquelle les enseignants accordent le plus d'attention dans leur enseignement (E3). Au début de l'année scolaire, les enseignants expliquaient les textes aux apprenants, mais ceux-ci peuvent désormais les lire et les comprendre de manière autonome (E4). Par ailleurs, les textes de lecture contribuent également à l'ouverture culturelle des apprenants et à la découverte de différentes cultures, ce qui renforce leur compréhension globale (E5). En revanche, l'enseignante qui a une opinion négative (E2) pense que ses apprenants ont un faible niveau de compréhension écrite. Selon elle, ils ne lisent pas

assez en dehors de la classe. Même si l'établissement met des fichiers PDF à leur disposition et publie des annonces pour les encourager à utiliser la bibliothèque, les apprenants se contentent du matériel vu en cours. Ainsi, leur compréhension écrite n'a pas progressé comme prévu principalement parce qu'ils n'ont pas l'habitude de lire régulièrement (E2).

Les facilités et les difficultés du processus d'apprentissage de la compréhension écrite

L'analyse du processus d'apprentissage de la compréhension écrite montre que les enseignants ont des opinions variées. Deux enseignantes (E1, E2) ont mentionné des facilités liées à ce processus tandis que trois enseignants (E1, E3, E5) ont mis en avant des difficultés et des obstacles. Une enseignante (E1) a évoqué à la fois des facilités et des difficultés tandis qu'une autre (E4) a indiqué qu'il n'existe actuellement aucun obstacle majeur et n'a mentionné ni facilité ni difficulté particulière.

Tableau 2: Facilités et difficultés en compréhension écrite

Catégories	Codes	Codes des participants	F
Facilités	Adaptation du contenu	E1	1
	Approche globale	E2	1
	Support visuel	E2	1
		Total	**3**
Difficultés	Sujets peu intéressants	E1, E5	2
	Problèmes de prononciation	E1, E3	2
	Influence de la langue maternelle	E3	1
		Total	**5**

L'analyse des facilités rencontrées par les enseignants dans le développement de la compréhension écrite montre que les apprenants progressent mieux lorsqu'ils lisent des textes adaptés à leurs centres d'intérêt (E1) lorsqu'ils adoptent une approche de compréhension générale plutôt que littérale (E2) et lorsque les cours commencent avec un support visuel (E2). L'analyse des difficultés liées à l'acquisition de la compréhension écrite fait apparaître plusieurs obstacles. Le manque d'intérêt pour les sujets proposés constitue l'un des principaux problèmes : les apprenants ont du mal à comprendre les textes qui ne les attirent pas (E1, E5). En plus de la compréhension, certains rencontrent des difficultés de fluidité lors de la lecture à voix haute, notamment les apprenants timides qui stressent et prononcent mal les mots (E1, E3). Il faut souligner que les textes proposés dans les manuels devraient être davantage diversifiés afin de susciter l'intérêt des apprenants et de faciliter la compréhension écrite (E5). Par ailleurs, l'anglais, leur première langue étrangère, influence négativement leur prononciation du français (E3).

Les caractéristiques individuelles des apprenants dans l'acquisition de la compréhension écrite

Les cinq enseignants (E1, E2, E3, E4, E5) ont exprimé leurs opinions sur l'influence des caractéristiques individuelles des apprenants sur leur compétence de compréhension écrite. Parmi eux trois enseignants (E3, E4, E5) ont exprimé à la fois des opinions positives et négatives sur ce sujet.

Tableau 3: Effets des caractéristiques individuelles sur la compréhension écrite

Catégories	Codes	Codes des participants	F
Effets positifs	Motivation à la lecture	E1, E2, E3, E4	4
	Engagement en lecture orale	E5	1

			Total	**5**
Effets négatifs	Transfert de la langue maternelle	E3		1
	Manque d'intérêt pour la lecture	E4		1
	Anxiété en lecture orale	E5		1
			Total	**3**

L'analyse des opinions positives montre que les apprenants qui aiment lire développent mieux leur compétence de compréhension écrite (E2, E3, E4). Ceux qui lisent déjà dans leur langue maternelle sont naturellement plus motivés à lire en français (E3). Ces apprenants cherchent à comprendre les expressions, utilisent un dictionnaire et progressent donc plus rapidement. La lecture régulière, qu'il s'agisse de lectures littéraires, de contes ou de ressources numériques, renforce leur vocabulaire et leur compréhension (E2). De plus, les apprenants à l'aise à l'oral n'éprouvent pas de difficultés en lecture (E5). L'analyse des opinions négatives met en avant plusieurs obstacles. L'influence de la langue maternelle peut perturber la prononciation et l'apprentissage du français (E3). Les apprenants qui n'aiment pas lire affirment souvent ne rien comprendre, ce qui nuit au déroulement du cours (E4). Certains refusent aussi de lire à voix haute, ce qui limite leur progression (E5).

Les méthodes, les stratégies et les techniques utilisées pour l'acquisition de la compréhension écrite

Les cinq enseignants (E1, E2, E3, E4, E5) ont présenté six méthodes différentes qu'ils utilisent pour l'acquisition de la compréhension écrite chez leurs apprenants. Aucun enseignant n'a exprimé d'opinions négatives à ce sujet.

Tableau 4: Méthodes, stratégies et techniques de compréhension écrite

Méthodes, stratégies et techniques	**Codes des participants**	**F**
Questions et réponses	E1, E2, E3, E4, E5	5
Lecture silencieuse puis orale	E1, E2, E3, E4	4
Discussion sur le titre et l'image	E1, E3, E5	3
Vocabulaire au tableau	E3	1
Analyse de texte en français	E3	1
Travail de groupe	E5	1
	Total	**15**

L'analyse des méthodes pédagogiques utilisées par les enseignants pour développer la compréhension écrite révèle que la méthode des questions-réponses constitue l'outil principal employé par tous les enseignants pour préparer les apprenants et éveiller leur intérêt avant l'étude du texte (E1, E2, E3, E4, E5). La lecture silencieuse est privilégiée dans un premier temps et elle permet aux apprenants de découvrir le texte à leur rythme tandis que les enseignants peuvent ensuite vérifier la prononciation lors de la lecture à voix haute (E1, E2, E3, E4). Avant d'aborder le texte, les enseignants encouragent également les apprenants à discuter du titre et des éléments visuels afin d'activer leurs connaissances préalables (E1, E3, E5). Le travail du vocabulaire est systématiquement assuré grâce à l'écriture des nouveaux mots au tableau (E3). L'analyse du texte se déroule entièrement en français et l'utilisation de la langue maternelle reste rare (E3). Enfin, certaines activités de compréhension sont réalisées en groupe pour favoriser l'apprentissage collaboratif (E5).

Les effets des méthodes, des stratégies et des techniques sur l'acquisition de la compréhension écrite

Les cinq enseignants (E1, E2, E3, E4, E5) ont identifié des effets positifs liés aux méthodes, aux stratégies et aux techniques utilisées dans l'acquisition de la compréhension écrite chez leurs apprenants. Aucun enseignant n'a exprimé d'opinions négatives à ce sujet.

Tableau 5: Effets des méthodes et stratégies sur la compréhension écrite

Les effets positifs	**Codes des participants**	**F**
Lecture silencieuse puis orale	E1, E2, E3, E4	4
Efficacité de la méthode questions-réponses avec sujets intéressants	E1, E2, E3	3
Développement des compétences d'analyse textuelle	E5	1
	Total	**8**

L'analyse des opinions positives des enseignants montre que la lecture silencieuse suivie de la lecture à voix haute aide les apprenants à améliorer à la fois leur compréhension et leur prononciation (E1, E2, E3, E4). La méthode des questions-réponses, associée à des thèmes pertinents et adaptés au niveau des apprenants, joue également un rôle essentiel dans leur progression (E1, E2, E3). Cette approche permet aux apprenants d'améliorer rapidement leur compétence de compréhension en rendant l'apprentissage plus accessible et motivant (E1). L'étude de textes authentiques, comme les articles de journaux, contribue elle aussi au développement de cette compétence (E5). La compréhension de documents authentiques renforce la confiance des apprenants et crée un lien plus fort avec la langue française (E5).

Les matériels pédagogiques utilisés pour l'acquisition de la compréhension écrite

Les cinq enseignants (E1, E2, E3, E4, E5) ont indiqué différents matériels pédagogiques qu'ils utilisent pour l'acquisition de la compréhension écrite chez leurs apprenants.

Tableau 6: Matériels pédagogiques et compréhension écrite

Matériels Pédagogiques	**Codes des participants**	**F**
Manuel de cours	E1, E2, E3, E4, E5	5
Livres complémentaires et récits	E3, E4, E5	3
Journal	E4, E5	2
Article	E4	1
	Total	**11**

L'analyse des opinions des enseignants sur les ressources pédagogiques utilisées pour l'enseignement de la compréhension écrite montre que le manuel de cours est l'outil principal utilisé par tous les enseignants (E1, E2, E3, E4, E5). Pour enrichir l'apprentissage, trois enseignants (E3, E4, E5) complètent le manuel avec divers ouvrages et des récits attrayants adaptés aux intérêts des apprenants. Certains utilisent également des documents authentiques tels que des journaux et des articles dans leurs activités pédagogiques (E4, E5).

Les effets des matériels pédagogiques sur l'acquisition de la compréhension écrite

Tous les enseignants (E1, E2, E3, E4, E5) ont exprimé leur opinion sur l'impact du matériel pédagogique utilisé en classe sur le développement de la compréhension écrite. Bien que la majorité ait exprimé des opinions positives deux enseignantes (E1, E5) ont également mentionné certains aspects négatifs.

Tableau 7: Effets des matériels pédagogiques sur la compréhension écrite

Catégorie	**Codes des participants**	**F**
Les effets positifs		
Contribution des livres complémentaires au développement	E3, E4, E5	3
Motivation des apprenants	E1, E5	2
Support du manuel au développement	E2, E3	2
	Total	**7**
Les effets négatifs		
Textes simples et ennuyeux comme obstacle	E1	1
Différences culturelles dans le matériel	E5	1
	Total	**2**

L'analyse des opinions positives montre que des matériels pédagogiques variés jouent un rôle important dans le développement de la compréhension écrite. Les livres complémentaires et les textes liés à la réalité sociale des apprenants contribuent de manière significative à leur progression (E3, E4, E5). L'intégration de documents authentiques comme des articles en ligne ou des textes récents portant sur des domaines aussi divers que l'histoire, les magazines, le sport ou les sciences, enrichit également le processus d'apprentissage (E4). La motivation personnelle des apprenants pour la lecture apparaît elle aussi comme un facteur essentiel, car les apprenants motivés progressent plus rapidement (E1, E5). Le manuel de cours reste par ailleurs un support efficace pour accompagner cet apprentissage (E2, E3). L'analyse des opinions négatives met en évidence plusieurs obstacles liés au matériel pédagogique. Les textes trop simples et peu attrayants réduisent la participation des apprenants en classe (E1). Un autre problème important concerne l'inadéquation culturelle des manuels produits à l'étranger. Même si ces supports ciblent un niveau similaire leur contenu ne correspond pas toujours aux réalités culturelles turques (E5). Cette différence culturelle diminue l'intérêt des apprenants pour certains textes et ralentit leur progression dans la compréhension écrite (E5).

Les effets de l'environnement sur l'acquisition de la compréhension écrite

L'analyse des opinions des enseignants concernant l'environnement d'apprentissage montre que trois enseignants (E1, E3, E5) ont identifié plusieurs facteurs problématiques pouvant freiner l'acquisition de la compréhension écrite. Parmi ces facteurs figurent la classe surpeuplée, le bruit en classe et la gestion de la correction des erreurs. En revanche, deux enseignantes (E2, E4) estiment que leur environnement d'apprentissage est satisfaisant et qu'il n'a jusqu'à présent posé aucun obstacle au développement de la compréhension écrite de leurs apprenants.

Tableau 8: Effets de l'environnement d'apprentissage sur la compréhension écrite

Les effets négatifs	**Codes des participants**	**F**

Classe surpeuplée	E1, E3	2
Bruit en classe	E1, E5	2
Gestion de la correction des erreurs	E5	1
	Total	**5**

L'analyse des opinions négatives des enseignants concernant l'environnement d'apprentissage met en évidence plusieurs obstacles importants à l'acquisition de la compréhension écrite. La classe surpeuplée et le bruit constituent les principaux problèmes identifiés affectant négativement aussi bien la lecture à voix haute que la compréhension textuelle (E1, E3, E5). Dans une classe surchargée, les apprenants timides se sentent mal à l'aise lors des lectures orales (E1). Les enseignants éprouvent également des difficultés à accorder suffisamment de temps à chaque apprenant et à contrôler efficacement leur prononciation (E3). Le bruit en classe, souvent provoqué par les conversations entre les apprenants, constitue une perturbation majeure pour le lecteur entraînant une baisse de motivation (E5). Un autre problème concerne la correction des erreurs. En cherchant à tout contrôler de manière instinctive, les enseignants adoptent parfois une attitude trop directive, ce qui peut avoir un effet négatif sur l'apprentissage des apprenants (E5).

Les propositions des enseignants pour obtenir de meilleurs résultats

Les cinq enseignants (E1, E2, E3, E4, E5) ont exprimé quatre types de propositions visant à améliorer l'efficacité du processus de développement de la compréhension écrite chez leurs apprenants.

Tableau 9: Propositions pour la compréhension écrite

Propositions	**Codes des participants**	**F**
Lecture de livres adaptés	E1, E2, E3, E4, E5	5
Utilisation d'Internet	E1, E3, E4	3
Stratégies de lecture	E5	1
Formation continue	E5	1
	Total	**10**

L'analyse des propositions des enseignants met en évidence plusieurs pistes pour améliorer l'acquisition de la compréhension écrite. Tous les enseignants soulignent l'importance d'une lecture régulière adaptée au niveau de chaque apprenant (E1, E2, E3, E4, E5). La lecture en dehors de la classe, notamment à la maison et pendant les fins de semaine est essentielle pour consolider les apprentissages et enrichir le vocabulaire des apprenants (E1, E2, E4). L'utilisation d'Internet est également considérée comme une ressource pédagogique importante par trois enseignants (E1, E3, E4). Les apprenants peuvent y consulter des journaux et des magazines français en ligne et accéder à des plateformes audiovisuelles proposant des émissions d'actualité et des supports combinant texte et prononciation (E1, E3). Cette approche multimodale permet de développer plusieurs compétences linguistiques en même temps (E3). Il est aussi nécessaire d'enseigner aux apprenants différentes stratégies de lecture comme la lecture rapide, la recherche d'idées principales à partir de mots-clés ou encore la lecture critique, afin de diversifier leurs façons d'apprendre (E5). Pour appliquer ces recommandations de manière efficace les enseignants doivent eux aussi profiter d'une formation continue et actualisée (E5).

DISCUSSION et CONCLUSION

La compréhension écrite constitue l'une des compétences essentielles en langue étrangère et est aussi importante que la compréhension orale pour une maîtrise efficace de la langue. Lorsqu'elle n'est pas

suffisamment développée elle peut nuire au processus d'apprentissage. La compréhension d'un texte dépend de divers facteurs et les apprenants peuvent rencontrer certaines difficultés dans ce processus. Les résultats de cette étude confirment que le développement de la compréhension écrite présente un caractère multidimensionnel. Les enseignants ont identifié plusieurs obstacles majeurs, notamment les sujets peu intéressants, les problèmes de prononciation et l'influence de la langue maternelle. L'une des difficultés les plus fréquentes chez les apprenants réside dans la nécessité de se concentrer simultanément sur le sens du texte et sur une prononciation correcte. Pendant la lecture à voix haute leur attention se détourne vers la prononciation, ce qui les empêche de saisir pleinement le contenu du texte et affaiblit ainsi le processus de compréhension. Cependant, cette étude met également en lumière des perspectives encourageantes. La majorité des enseignants a porté une appréciation positive sur le processus d'acquisition soulignant que les apprenants font preuve d'une grande motivation. Les méthodes pédagogiques employées notamment la lecture silencieuse suivie de la lecture à voix haute et associée à la méthode des questions-réponses se sont révélées efficaces pour renforcer la compréhension.

Pour les apprenants de français langue étrangère, la compréhension écrite représente une compétence fondamentale dans le processus d'apprentissage. Les enseignants soulignent que malgré certaines difficultés rencontrées lors des activités de lecture, le développement de cette compétence contribue de manière significative à une meilleure maîtrise de la langue. Dans cette perspective, il apparaît important de soutenir les apprenants non seulement sur le plan linguistique mais aussi dans l'acquisition de stratégies favorisant une lecture plus efficace. Le développement de la compréhension écrite permet notamment d'enrichir le vocabulaire, de mieux comprendre et utiliser les règles grammaticales et d'aborder les textes avec un regard plus critique, ce qui facilite une utilisation plus assurée du français dans les contextes académiques et quotidiens (Anwar Zekri, 2025). Par ailleurs, certaines difficultés observées dans le cadre de cette étude montrent la nécessité d'accompagner les apprenants afin qu'ils dépassent une lecture strictement linéaire et mot à mot. Lorsque les apprenants restent focalisés sur le décodage l'accès au sens global du texte devient plus difficile, ce qui peut freiner le processus de compréhension. Ces constats rejoignent les approches qui soulignent l'importance de développer progressivement des stratégies de lecture permettant d'accéder à une compréhension plus approfondie des textes (Bouhenika, 2023).

L'environnement d'apprentissage joue un rôle déterminant dans le développement de la compréhension écrite. Les classes surpeuplées et le bruit ambiant constituent des obstacles majeurs à l'autonomie des apprenants. Pour renforcer l'efficacité de l'enseignement de la compréhension écrite il apparaît essentiel de diversifier les stratégies pédagogiques, de créer des environnements d'apprentissage signifiants intégrant des éléments culturels et de proposer des supports adaptés aux besoins réels des apprenants. L'utilisation d'activités interactives et collaboratives stimule la participation et permet de répondre à la diversité des profils. De plus, le fait de multiplier les activités visant à développer les stratégies de lecture, de prendre en compte régulièrement les retours des apprenants et d'intégrer des documents authentiques en classe contribue à renforcer la compréhension écrite. Dans cette perspective, il est indispensable d'adopter des approches pédagogiques véritablement centrées sur l'apprenant (Sajjadi & Khayat, 2025). En conclusion, les propositions des enseignants mettent en lumière l'importance de diversifier les ressources pédagogiques, d'encourager la lecture régulière en dehors de la classe et de soutenir le développement professionnel continu. Ces propositions convergent vers une approche holistique dans laquelle les dimensions pédagogiques, environnementales et institutionnelles agissent conjointement pour favoriser efficacement l'apprentissage de la compréhension écrite.

PROPOSITIONS

- Afin de développer la compétence de compréhension de la lecture, il faut donner aux apprenants des habitudes de lecture régulières et adaptées à leur niveau. Les activités de lecture en dehors des cours doivent être encouragées et les apprenants doivent être régulièrement confrontés à des textes adaptés à leur propre niveau.
- Lors du choix des textes de lecture, il convient de tenir compte des intérêts et des contextes culturels des apprenants. Les textes qui ne suscitent pas leur intérêt et qui sont culturellement éloignés peuvent affecter négativement le processus de compréhension écrite.
- Dans les activités de compréhension écrite, il faut réduire l'anxiété liée à la prononciation et le stress causé par la lecture à voix haute chez les apprenants. En accordant davantage de place à des pratiques telles que la lecture silencieuse et la lecture en groupe il est possible de favoriser un climat d'apprentissage plus rassurant.
- Pour que les apprenants s'éloignent d'une compréhension basée sur la lecture mot à mot, les stratégies de lecture doivent être enseignées de manière systématique. Les stratégies telles que l'identification de l'idée principale, la recherche de mots-clés, la lecture rapide et la concentration sur le sens général du texte doivent être développées. Dans le développement de la compétence de compréhension écrite, il faut accorder davantage de place à l'utilisation de matériels numériques et authentiques. Les journaux français, les magazines et les textes actuels accessibles sur Internet peuvent augmenter la motivation des apprenants.
- Bien que les supports pédagogiques constituent un outil fondamental dans le développement de la compétence de compréhension écrite, ils doivent être soutenus par des ressources supplémentaires et des matériels complémentaires. La diversité des textes contribuera à ce que les apprenants acquièrent une expérience de lecture riche.
- Les conditions physiques de l'environnement de la classe doivent être organisées de manière à soutenir les activités de compréhension écrite. En tenant compte du fait que les classes surpeuplées et bruyantes affectent négativement le processus de lecture, des environnements d'apprentissage plus calmes et mieux organisés doivent être créés pour les apprenants.
- Afin d'augmenter l'efficacité de l'enseignement de la compréhension écrite, le développement professionnel des enseignants doit être soutenu. Les formations continues sur les méthodes d'enseignement actuelles, les stratégies de lecture et l'utilisation des matériels doivent être encouragées.

BIBLIOGRAPHIE

Ahmadi, A., & Miloudi, M. (2021). Les difficultés de compréhension d'un texte en classe de FLE. *Paradigmes, 4*(3), 153-162.

Anwar Zekri, I. (2025). Unité proposée basée sur les préférences sensorielles d'apprentissage des élèves du cycle préparatoire, utilisant une plateforme d'apprentissage en ligne pour développer quelques compétences de la compréhension écrite en FLE. 84-1, (3), المنوفية جامعة-التربية كلية مجلة

Bouhenika, H. (2023). *Les difficultés de la compréhension et la production de l'écrit d'un texte explicatif chez les apprenants de la 1ere année moyenne* (Doctoral dissertation, Université Chadli Ben Djedid d'El-Tarf).

Bouvet, M. (2024). Des expériences scolaires aux pratiques professorales: la littératie comme pont entre le FLM scolaire et le FLE. (Mémoire de master 2). Université Sorbonne Nouvelle.

Guillemette, F., Luckerhoff, J., Plouffe, M.-J. & Fall, O. T. (2021). La recherche qualitative : une analyse du vécu humain. Clarification conceptuelle à partir de nos recherches avec des personnes marginalisées. *Enjeux et Société,* 8(1), 10–35. https://doi.org/10.7202/1076534ar

Cuq J.P., & Gruca I. (2003). *Cours de Didactique du Français Langue Étrangère et Seconde*. France: Presses Universitaires de Grenoble.

Hadil, A., & El Houda, H. N. (2024). *L'apport de la compréhension de l'écrit á la production écrite.* Mémoire présenté en vue de l'obtention du diplôme de Master académique. Université 8 mai 1945 Guelma, Algérie.

Hegazi, E., & Mohamed, K. (2022). Efficacité de la stratégie des tâches fragmentées via une plateforme collaborative pour développer la compréhension écrite en FLE auprès des étudiants de différents niveaux de motivation. بحوث241 فى تدريس اللغات,) 21 (21, 162-241. https://doi.org/10.21608/SSL.2022.172698.1159

Karaoui, W., Sedira, K., Tiet Y. (2025). *Les jeux ludiques comme outil de motivation et de renforcement de la compréhension de l'écrit en classe de FLE: cas des apprenants de 2ème année moyenne CEM de "Les Frères Mdjili*" (Doctoral dissertation) يوعريريج برج الابراهمي البشير محمد جامعة

Meza Taborda, J. P., & Sánchez Garnica, V. (2025). *L'implémentation d'une série d'activités ludiques sous l'approche socioculturelle en cours de FLE pour débutants à l'alliance française de medellín* [Trabajo de grado profesional]. Universidad de Antioquia, Medellín, Colombia

Mohamed, N.Y. (2024). Unité didactique basée sur l'utilisation des dictées métacognitives interactives pour développer les compétences orthographiques en FLE chez les étudiants du cycle secondaire. بحوث فى تدريس اللغات,) 27 (27, 205-283. DOI: 10.21608/ssl.2024.284400.1214

Sajjadi, S. Y., & Khayat, H. (2025). Analyse de la pédagogie de la compréhension écrite dans les classes de FLE en Iran. *Language Related Research, 16*(5), 339-363. https://doi.org/10.48311/LRR.16.5.12

Yıldırım, A., & Şimşek, H. (2018). *Sosyal bilimlerde nitel araştırma yöntemleri.* Ankara: Seçkin Yayıncılık.

THE RESTRICTION OF JUDICIAL REVIEW AGAINST ADMINISTRATIVE ACTS IN TURKISH ADMINISTRATIVE LAW

LA RESTRICTION DE LA VOIE DU CONTRÔLE JURIDICTIONNEL CONTRE LES ACTES ADMINISTRATIFS DANS LE DROIT DU CONTENTIEUX ADMINISTRATIF TURC

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ABSTRACT

In Turkish administrative law, the fundamental rule is that judicial review is open against the acts and actions of the administration. Indeed, this principle is clearly stated in Article 125 of the 1982 Constitution. According to Article 125(1) of the Constitution: *"Judicial review is open against all acts and actions of the administration."*

However, certain exceptions to this general rule have been directly provided by Article 125 of the Constitution and other constitutional provisions. Therefore, if the Constitution or a law based on it contains a provision stating that, for a specific act, "no recourse to the administrative judiciary is allowed," this means that the judicial review is not available, and is considered a 'legislative restriction' *(yasama kısıntısı)* in Turkish law.

Nevertheless, legislative restrictions are not compatible with the principle of the rule of law. In a system based on the rule of law, judicial review must be open against every administrative act. For example, under Turkish law, judicial review is currently excluded for decisions other than dismissal from the profession issued by the Council of Judges and Prosecutors (appointments, promotions, disciplinary penalties, etc.). Similarly, decisions of the High Military Council regarding promotions or retirement due to unavailability of a vacant position are also exempt from judicial review. Moreover, based on Article 129 of the Constitution, disciplinary sanctions provided in the Turkish Armed Forces Discipline Law are also excluded from judicial review.

Regarding France, the Conseil d'État resolved the issue of various legislative provisions imposing restrictions on recourse to administrative courts through its *Dame Lamotte* decision rendered in 1950. In this decision, it was established that any administrative act may be subject to a judicial review for excess of power, without the need for an express legal provision. Furthermore, the Constitutional Council, relying on Article 16 of the 1789 Declaration of the Rights of Man and of the Citizen, concluded, as early as the 1990s, that legal provisions closing the judicial recourse against administrative acts are contrary to the law.

In conclusion, in Turkish administrative law, the removal of the above-mentioned legislative restrictions through a constitutional reform appears to be an essential condition in a state that respects the principle of the rule of law, as provided in Article 2 of the Constitution.

Keywords: Legislative restriction against administrative acts, Turkish administrative litigation law, Action for annulment, Principle of the rule of law.

RÉSUMÉ

Dans le droit du contentieux administratif turc, la règle fondamentale est que la voie de contrôle juridictionnelle est ouverte contre les actes et actions de l'administration. En effet, ce principe est clairement énoncé à l'article 125 de la Constitution de 1982. Selon l'article 125/1 de la Constitution : *« La voie du recours juridictionnel est ouverte contre tous les actes et actions de l'administration ».*

Toutefois, certaines exceptions à cette règle générale ont été prévues directement par l'article 125 de la Constitution et par d'autres dispositions constitutionnelles. Par conséquent, s'il existe dans la Constitution ou dans une loi fondée sur celle-ci une disposition prévoyant que, pour un acte déterminé, «il ne peut être fait recours à la juridiction administrative », cela signifie que la voie juridictionnelle est fermée et cela est considéré, en droit turc, comme une *« restriction législative (yasama kısıntısı) ».*

Toutefois, les restrictions législatives ne sont pas compatibles avec le principe de l'État de droit. Dans un système fondé sur l'État de droit, la voie juridictionnelle doit être ouverte contre tout acte administratif. Par exemple, en droit turc, les décisions du Conseil des Juges et Procureurs telles que nomination, avancement, sanctions disciplinaires, etc. (sauf celles portant radiation de la profession) demeurent insusceptibles de recours juridictionnel. De même, les décisions du Haut Conseil Militaire relatives aux avancements ou à la mise à la retraite pour indisponibilité de poste vacant échappent également au contrôle juridictionnel. En outre, sur la base de l'article 129 de la Constitution, les sanctions disciplinaires prévues dans la Loi sur la Discipline des forces armées turques sont également exclues du contrôle juridictionnel.

En ce qui concerne la France, le Conseil d'État a écarté le problème des diverses dispositions législatives instaurant des restrictions à la voie de recours devant le juge administratif par son arrêt *Dame Lamotte* rendu en 1950. Dans cette décision, il a été admis que tout acte administratif peut faire l'objet d'un recours pour excès de pouvoir, sans qu'une disposition légale expresse ne soit nécessaire. En outre, le Conseil constitutionnel, en se fondant sur l'article 16 de la Déclaration des droits de l'homme et du citoyen de 1789, a conclu, dès les années 1990, que les dispositions légales fermant la voie du recours juridictionnel contre les actes administratifs sont contraires au droit.

En conclusion, dans le droit du contentieux administratif turc, la suppression par une réforme constitutionnelle des restrictions législatives évoquées ci-dessus apparaît comme une condition indispensable dans un État respectueux du principe de l'État de droit, tel que prévu à l'article 2 de la Constitution.

Mots-clés : Restriction législative contre les actes administratifs, Contentieux administratif turc, Recours pour excès de pouvoir, Principe de l'État de droit.

REINTERPRETING THE CONCEPT OF CLASSICAL ART IN THE CONTEXT OF POSTMODERNISM

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Postmodernism, emerging in the mid-20th century within the realms of culture, literature, and art, provides an opportunity to reconsider traditional conceptions of classical art. Historically, classical art has been characterized by harmony, symmetry, ideal beauty, and universal values. Postmodernism, however, questions this universalism and encourages the evaluation of art within the frameworks of subjective experience, context, and individual interpretation.

The postmodern approach analyzes classical artworks not only through formal and technical criteria but also in relation to their social, cultural, and political contexts. This perspective emphasizes the polyphonic, intertextual, and dynamic nature of art while challenging rigid genre boundaries and aesthetic norms. Consequently, classical works are perceived not merely as historical or aesthetic objects but as phenomena that can be reinterpreted within contemporary discourse.

Additionally, postmodernism employs repetition, parody, and eclecticism as tools to expand the existing layers of meaning in classical works. This approach highlights both the creative freedom of the artist and the individual interpretive experience of the audience. As a result, the concept of classical art in a postmodern context is no longer a static, universal model but a multifaceted phenomenon that can be read from diverse perspectives.

Thus, postmodernism not only alters the aesthetic lens through which classical art is viewed but also enables a renewed interpretation of its social, cultural, and historical significance. Within this framework, art is presented as a more interactive and multilayered experience, enriched by the individual interpretive contributions of both creators and observers.

Keywords: postmodernism, classical art, aesthetics, creative interpretation, cultural context

FRAGMENTED SUBJECTİVİTY AND POSTDRAMATIC IDENTITY IN MARTİN CRİMP'S IN THE REPUBLIC OF HAPPINESS

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ABSTRACT

This study examines Martin Crimp's *In the Republic of Happiness* (2012) through the lens of fragmented subjectivity within postdramatic theatre. While the play has often been discussed as a satire of contemporary happiness culture and consumerist ideology, this study argues that its central concern is the disintegration of the modern subject. Through fragmented dialogue, anonymous voices, musical intrusions and the collapse of narrative coherence, Crimp constructs a theatrical world in which subjectivity is divided, dispersed and continuously reconstructed. Fragmentation thus operates not only as a thematic concern but also as a structural and perceptual principle that shapes the form, meaning and reception of the play.

Key words: Martin Crimp, fragmented subjectivity, postdramatic theatre, identity, contemporary British drama

NATIONAL STRATEGIES FOR PREVENTING RADICALIZATION: THE BALANCE BETWEEN HUMAN RIGHTS AND SECURITY IN CENTRAL ASIA

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ABSTRACT

This study examines the strategies implemented by states combating radicalization in Central Asia (Turkestan) and analyzes how the balance between policies developed for human rights and security is related. The main objective of the research is to seek answers as to whether security measures are sufficient in the process of preventing radicalization and to assess how fundamental rights and freedoms are affected at this stage. Due to its rich ethnic and religious diversity, the region in question is sensitive and vulnerable to radicalization. Therefore, it is crucial that the political approaches adopted by countries are not solely security-centered but also promote social integration and are sensitive to human rights.

This research was conducted within the framework of a qualitative research approach. Relevant documents and other materials were analyzed. The findings reveal that some countries have resorted to overly repressive and controlling methods due to security concerns, and that this situation may increase rather than reduce the risk of radicalization. In contrast, it has been observed that states that prefer inclusive, participatory, and human rights-based approaches have achieved more sustainable results in combating radicalization.

As a result, it has become apparent that states must maintain a balanced approach to security and human rights; otherwise, social polarization and radical tendencies may increase. The study offers approaches and recommendations for countries in the region to develop integrative, transparent, and human rights-sensitive strategies.

Keywords: Radicalization, Central Asia, Human Rights, Security, Balance Policies.

INTRODUCTION

With the end of the Cold War and the collapse of the Union of Soviet Socialist Republics (USSR), the Turkic states[1] of Asia (Central Asia) Turkmenistan, Uzbekistan, Tajikistan, Kazakhstan, and Kyrgyzstan faced problems of identity, security, and legitimacy as they built their newly established political systems. During this period, ideological vacuum, social inequalities, and economic crises, coupled with

[1] In this text, Turkistan refers to Central Asia.

weak public institutions, created an environment conducive to the spread of radical ideas (Гаджимурадова & Рабат, 2020: 3461-3462)

Radicalization is the process whereby individuals or communities internalize increasingly extreme political, religious, or ideological views that often do not conform to democratic principles, leading them to begin to see violence as justified and valid for the sake of these ideas. The concept of violent extremism, within this ideological scope, refers to the explicit advocacy, promotion, or direct use of violence for specific purposes (European Union, 2021).

Since the 1990s, terrorist attacks in the Turkistan region, transnational jihadist organizations, the transfer of foreign fighters to conflict zones such as Syria, Afghanistan, and Iraq, and online radical propaganda have led to radicalization emerging as a security threat for regional states (Kaya, 2024: 360-361). For this reason, governments are developing strategies to "prevent radicalization" and "combat violent extremism" with the aim of strengthening national security.

In the implementation of these strategies, it is essential to strike a very delicate balance between the preservation of human rights and security needs. This is because in Central Asia, where authoritarian tendencies are strong, the issue of security can often be used as a basis for legitimizing the restriction of constitutional rights such as the right to organize, freedom of expression, and freedom of religion (Zhovtis, 2007: 1-3).

The main research question of this study can be stated as follows: "How do the counter-radicalization strategies of the Turkic states balance human rights and security?" The aim of this study is to compare the institutional responses of these five states to the phenomenon of radicalization and to reveal the impact of these elements on human rights.

CONCEPTUAL FRAMEWORK

Theoretical Framework: Radicalization, Violent Extremism

Radicalization is the stage in which individuals or communities adopt ideologies that involve envisaging a radical and illegitimate change to the social, political, and established order they are exposed to, and increasingly adopt more extreme approaches within the scope of these ideological orientations. Online or digital radicalization refers to this process occurring primarily through the internet and online platforms.

In Internews[2] and its partners' study, violent extremism is defined as the actions of individuals and communities that support, defend, or directly use violence motivated by ideological or religious reasons; The concept of "online radicalization to violence" describes the development of a radical, violence-prone religious doctrine in individuals who are primarily influenced by online content (European Union, 2021).

In this context, CVE (Countering Violent Extremism) and PVE (Preventing Violent Extremism) approaches are not limited to legal sanctions alone (European Union, 2021). However, in the Turkistan region, national policies often reduce radicalization to the narrow

[2] Internews is a non-profit media and publishing support organization operating in over 100 countries.

focus of “combating terrorism,” which can undermine the balance between human rights and security (Zhovtis, 2007: 1-3).

The Structural Factors of Radicalization in Central Asia

The Legacy of the Soviet Era: Institutional and Ideological Deficiencies

With the collapse of the USSR, the Turkic states gained their national independence but were also forced to redefine their ideological identities. According to Kazakh human rights advocate Yevgeny Zhovtis, the political elites in this region largely come from the former Soviet ruling class; therefore, during the transition period, they present a complex structure caught between the rhetoric of democracy and the concern of maintaining power (Zhovtis, 2007: 1-3).

Human rights and international law expert Sergey Sayapin emphasizes that the narrative of democracy in Central Asia has undergone a three-stage transformation: (1) an emphasis on a “determined transition to democracy” in the early years of independence, (2) followed by the discourse of a “national/unique model of democracy,” and (3) the actual adoption of the “enlightened authoritarianism” model (Sayapin, 2023: 16-17). In this context, many practices viewed as “human rights violations” by Western countries are put forward by local elites using arguments of “cultural relativism” and “local specific conditions.”

Within this political framework, the limited nature of political pluralism, the occasional suppression of the opposition, the weakness of independent media, and the restriction of civil society's sphere of influence reinforce feelings of “distrust and alienation” toward the system, especially among younger generations also increases the capacity of radical discourses to fill this void (Sayapin, 2023: 17-18)

Financial Inequalities and Social Justice

Unemployment, corruption, income inequality, and disparities between rural and urban development in the region's states make the “identity” and “justice” discourses offered by radical communities more appealing to the young demographic (Гаджимурадова & Рабат, 2020: 3463-3465).

In relatively poor Central Asian countries such as Kyrgyzstan and Tajikistan, the large number of workers migrating outside the country, the breakdown of families, the inadequacy of social protection systems, and the vulnerability of migrant networks to radical propaganda also constitute additional risk factors (European Union, 2021: 41-46).

Lack of Religious Knowledge

The long-term anti-religious campaigns carried out during the Soviet era significantly damaged the structural integrity of religious educational institutions in Turkistan and the tradition of intellectual religious debate; and that for this reason, after independence, society faced structural problems such as “limited religious knowledge,” “interrupted traditional transmission,” and “weakened identity construction” (Zhussipbek, 2013: 3-6).

When viewed from a historical perspective, the Hanafi school was widespread in the Turkistan region, particularly in Maveraunnehir, reflecting a more flexible and rational view of Islam that internalized local customs and traditions. In contrast, Salafi-oriented approaches, with their

literal adherence to texts, ahistorical reading, and political instrumentalization, created a foundation for radicalism.

Country-Specific Strategies

Kazakhstan: Controlled approach to religion and rehabilitation phases

Kazakhstan, in addition to being the economic leader of Central Asia, has recently attracted attention with its multifaceted foreign policy approach and relatively institutionalized state structure (Sayapin, 2023: 16-17). One of the turning points in the fight against radicalization in the country was the 2011 "Law on Religious Activities and Religious Organizations." This law introduced a requirement for all religious organizations to re-register, banned the activities of unregistered religious communities, and made the opening of places of worship subject to strict conditions (Zhussipbek, 2013: 11-14).

The official line is that the goal is to protect the public and social order against "non-traditional" religious movements. However, human rights advocates emphasize that this law seriously restricts religious freedom, leading to the exclusion of small religious communities and pushing them into the informal sphere (Sayapin, 2023: 18-19).

Terrorist attacks in Kazakhstan in the 2010s and the presence of foreign fighters in Iraq/Syria have led the country to develop measures such as strict criminal enforcement, security operations, internet content blocking, and soft rehabilitation programs, including religious counseling and public awareness activities (Zhussipbek, 2013: 8-11).

With the rise of religious radicalism and extremist ideologies, Kazakhstan has become one of the countries that has developed the most comprehensive preventive strategies in the region to counter this threat. With the humanitarian operations "Zhusan" and "Rusafa" launched in 2019, many citizens, including women and children, were brought back to the country from conflict zones across the border; comprehensive rehabilitation and reintegration programs were implemented for these individuals (Kagazbekova et. al., 2025: 50).

These practices have focused on five main areas of work, ranging from psychological support to education, ideological restructuring to social integration. The aim here is not only to ensure security but also to enable the community to return to the country while respecting human rights. This approach stands out as an exemplary practice that ensures harmony between human rights and security.

The perception of women in radical organizations as "passive victims" has often led to responsibilities being assigned solely to men. This situation necessitates a reassessment of collective gender roles and the place of women within religious structures (Kagazbekova et. al., 2025: 59).

In result, Kazakhstan's approaches to counter radicalization can be cited as an important example of protecting security without neglecting human rights in Central Asia. This experience can also be seen as a guiding factor for states facing similar problems.

Kyrgyzstan: A Relatively Liberal Environment, Civil Society, and Media-Centered PVE

Compared to other Central Asian states, Kyrgyzstan has demonstrated greater political liberalization and civil society dynamism since gaining its independence; however, due to its weak financial capacity and fragile state institutions, it has become dependent on international organizations and foreign aid (Zhovtis, 2007: 2-3).

Fieldwork conducted in Kyrgyzstan as part of the "Radicalism Online" project reveals that young people are increasingly obtaining information through social media and that radical content is widely circulating in both Russian and local languages (European Union, 2021: 41-55).Therefore, an important part of PVE/CVE approaches in Kyrgyzstan has taken the form of civil society initiative projects focused on social media literacy, online content analysis, and critical thinking.

Civil society organizations and international organizations such as Internews organize specialized training programs targeting both young people and journalists, supporting the analysis of radical discourse, the development of counter-narratives on relevant issues, and increased sensitivity to hate speech. The Institute for War and Peace Reporting's (IWPR) project "Human Rights Protection and Education in Central Asia through the Media" has also developed links between human rights defenders and journalists in the country, thereby contributing to the increased visibility of rights violations (Institute For War & Peace Reporting, 2021).

Tajikistan: The Legacy of Civil War and Security-Focused Strategies

The civil war that broke out in Tajikistan in the early 1990s profoundly affected the country's political culture; the balance of power model established after the war included the limited integration of actors such as the Islamic Renaissance Party into the system. However, in subsequent years, this party and its affiliates were banned for extremism, and its representatives were subjected to severe penalties (Sayapin, 2023: 19-20).

Tajikistan's strategies to counter radicalization rely heavily on strict measures enforced through security institutions; banning groups alleged to be linked to "radicalism," as well as prohibitions on religious symbols and clothing, and strict control of religious education are the main tools of this approach (Гаджимурадова & Рабат, 2020: 3465-3468).

It has been demonstrated that such political approaches will make radical communities less visible in the short term, but over time, by limiting channels of political participation, they may reinforce perceptions of distrust and marginalization toward the state, particularly among young communities (Sayapin, 2023: 20-21).

Uzbekistan: State-Controlled Religious Policy Approaches

Due to its population and its border with Afghanistan, Uzbekistan is one of the countries most intensely affected by the threats posed by radical elements. A comparison of the lists of banned organizations compiled by the judicial authorities of Central Asian countries during certain periods reveals that Uzbekistan has grouped both groups defined as terrorist organizations and movements believed to be associated with the political opposition in the same category. (Kaya, 2024: 361-72).

Uzbekistan's approach to combating radical tendencies has been implemented for years through the strict state control of the religious sphere, the criminalization of unofficial religious

activities, and broad-ranging “extremism” laws (Гаджимурадова & Рабат, 2020: 3468-3470). International human rights organizations point out that at this stage, there are too many cases of forced confessions, torture, violations of the right to a fair trial, and restrictions on freedom of expression. On the other hand, recent amnesty regulations and the release of prisoners alleged to be linked to radicalism, along with the development of projects aimed at reintegrating these individuals into society, also reveal a partial shift in perspective (Sayapin, 2023: 22-23). However, this process remains open to criticism in terms of accountability, transparency, and independent judicial oversight.

Turkmenistan: Closed Governance Approach and Limited Data Transfer

Turkmenistan is a country that appears to be one of the most authoritarian administrations in the Turkistan region, with extremely limited data sharing regarding its policies on combating radicalization. Freedom of belief, expression, and civil society activities are significantly restricted (Sayapin, 2023: 23-24).

According to data provided by the European Commission, the human rights dialogue between the European Union and Turkmenistan has been conducted informally since 2005 and regularly and systematically since 2008. The main reasons for these dialogues include bringing all political approaches related to human rights, including the fight against terrorism, into line with international responsibilities (European Commission). However, the inward-looking nature of the state in question makes it difficult to measure the real impact of these communications on the ground.

Analysis on the Balance of Human Rights and Security

According to a report presented by organizations partnering with Internews, in most Central Asian states, the terms “extremism” and “radicalism” are defined in legal documents in a very broad and vague manner. These terms encompass attempts to forcibly interfere with the constitutional order, violations of national integrity, and elements that incite certain social communities, but in practice, they are flexible enough to also cover non-violent, peaceful opponents and independent religious communities (European Union, 2021:5-6).

Various experts have stated that security laws with an undefined scope exert serious pressure on religious, expression, and organizational freedoms; particularly in environments where guarantees based on an independent judiciary and the rule of law are inadequate, such regulations pave the way for arbitrary applications (Zhovtis, 2007: 1-3).

Gender and Equality in Rights-Based Rehabilitation

In Kazakh society, women's religious learning and worship practices play a significant role in shaping gender relations. Contemporary radical religious groups, presenting women's complete dependence as an “Islamic value,” sometimes attempt to limit their constitutional rights and freedoms (Kagazbekova et al., 2025: 46-48).

In this regard, the rehabilitation process for women returning from war-torn regions must be approached not only from a security perspective but also from the perspective of human rights and gender equality.

It is essential that it be designed to reduce exclusion by offering them psychological support, social integration programs, education, and employment opportunities (Kagazbekova et al., 2025: 48-50).

The Role Played by Civil Society and Top-Down Security Strategies

Organizations such as the Institute for War and Peace Reporting and similar groups are facilitating greater cooperation among journalists and activists working in the Turkistan region, helping to bring issues to public attention with the aim of reducing rights violations (Institute For War & Peace Reporting, 2021: 1-3).

However, in many regions and countries, NGOs face strict registration procedures, financial audits, and accusations of "foreign influence/foreign agent," which limits civil society's sustainable contribution to countering radicalization (Sayapin, 2023: 21-24).

In addition to all this, purely top-down (hierarchical) security approaches, while enabling radical communities to be suppressed in the short term, are insufficient to ensure long-term stability in environments where systematic human rights violations and perceptions of social injustice persist (Гаджимурадова & Рабат, 2020: 3468-3470). Radical communities can present themselves as representatives of a "more just order" by using problems such as economic inequality, corruption, and lack of participation in their propaganda (Zhussipbek, 2013: 6-8).

CONCLUSION AND RECOMMENDATIONS

This study attempted to examine the relationship between approaches to preventing radicalization in Turkistan and the balance between human rights and security. The findings reveal that the countries in the region perceive radicalization as a serious national security threat; however, the strategies they develop to address it are often statist, security-centered, and controlling in natüre.

The structure inherited from the Soviets, ideological void, corruption, economic inequalities, and lack of religious knowledge are among the many factors that increase the risk of radicalization. The spread of strict religious interpretations, combined with the phenomena of "shaken identity" and "broken tradition," often reveal that radicalism has a security-focused, controlling, and statist character (Гаджимурадова & Рабат, 2020: 3461-3462).

Kazakhstan's laws reorganizing the religious sphere, Kyrgyzstan's civil society and media-focused practices, Uzbekistan and Tajikistan's strict security measures, and Turkmenistan's closed political system reveal the differences between the strategic approaches applied in the fight against radicalization. However, a common trend across all states is the broad definition of the terms extremism and terrorism and the fact that this framework can also be used to exert pressure on dissenting voices (Institute For War & Peace Reporting, 2021). The European Union's human rights initiatives, along with the practices of organizations such as IWPR and Internews, demonstrate that a security-oriented approach can be complemented by rights-based political perspectives (European Commission, 2009).

In this context, the following principles come to the fore for a successful and sustainable approach to controlling radicalization in Central Asia:

1. Rule of Law and Human Rights: Legislation combating "extremism" and terrorism must be transparent and specific; the right to a fair trial and independent judicial review must be protected.

2. Rights-Based Security Approaches: The authority of security institutions must be aligned with fundamental rights such as freedom of expression, prohibition of torture, and freedom of religion.

3. Education and Media Literacy: Media literacy and critical thinking programs targeting young people should be made widespread; responses appropriate to the local context should be developed against online radical narratives.

4. Civil Society and Regional Partnership: The scope of activities and freedom of work of NGOs should be expanded.

The implementation of these principles in daily life will both reduce the risk of radicalization in the Turkistan region and contribute to the institutionalization of a long-term security approach based on human rights.

REFERENCES

Гаджимурадова, Г. И., & Рабат, Л. (2020). Радикализм как фактор нестабильности в Центральной Азии. *Политические исследования, 64*(12).

European Commission. (no date). *EU Human Rights Dialogues in Central Asia.* European Union and Central Asia: https://www.eeas.europa.eu/sites/default/files/eu_human_rights_dialogues_in_central_asia.pdf adresinden alındı

European Union. (2021). Radicalism Online: An Analysis of the Meanings, Ideas, and Values of Violent Extremism in Central Asia. Bishkek, Kyrgyzstan.

Institute For War & Peace Reporting. (2025, December 9). *Uzbekistan Looks to Diversify Labour Migration*. Institute For War & Peace Reporting: https://iwpr.net/global-voices/uzbekistan-looks-diversify-labour-migration

Kagazbekova, S., Onggar, Y., & Zatov, K. (2025, December 10). Religious Radicalism and Gender in Modern Kazakhstan From an Islamic Perspective. *European Journal of Science and Theology, 2*(21), 45-62.

Kaya, E. (2024, July). Orta Asya Devletlerinin Radikalizm ve Terörizm Algısı. *Eskişehir Osmangazi Üniversitesi Sosyal Bilimler Dergisi* (359-380).

Sayapin, S. (2023). Human Rights in Central Asia - Challenges and Perspectives. *SpringerBriefs in Political Science*.

Zhovtis, E. (2007). Democratisation and Human Rights in Central Asia: Problems, Development Prospects and the Role of the International Community. *Ceps Policy Brief* (134).

Zhussipbek, G. (2013). *Religious Radicalism in Central Asia.* Washington: Rethink Paper 12.

THE INSCRIPTION OF MATARACI ZADE HACI MUSTAFA EFENDİ DATED H. 1304 / AD 1886 IN RİZE AND THE TRACES TRANSFORMED INTO A LOST FOUNTAIN OF A LOST WATERWAY

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ABSTRACT

This paper aims to re-evaluate the historical background of an inscription dated 1886 for Mataracı Zade Hacı Mustafa Efendi, and to trace the history of a water structure that no longer physically exists today. Informations about this water and the Ottoman Turkish inscription derive from an original photograph dated 1922, a supercommentary (*Haşiye*) dated 1983, and a surviving inscription preserved in the museum. The supercommentary notes that two brothers from the Mataracızade family brought water to a mosque, dedicating it to the memory of the deceased brother and commissioning an inscription for that purpose. Thus, both the inscription and the supercommentary serve not only as records of donation but also as commemorative texts reflecting the social, religious, and familial relationships of the period. The mention of cast-iron pipes imported from France underscores the family's economic strength, while the commissioning of the inscription from the *mudarris* Âgah Efendi reveals connections between benefactors and the *Ilmiye* class.

By the reconstruction of the mosque during the governorship of Hacı Mustafa Efendi's grandson, Hakkı Mataracı (1923–1936), the water system was rerouted and transformed into a fountain onto which the inscription was mounted. This fountain remained in use for decades, but in the 1980s it was demolished by the municipality decision, and the inscription was transferred to the Rize Atatürk Museum.

Based on oral history interviews with family members, residents, and local merchants, as well as written and visual sources, the study proposes reconstructing a prototype of the lost fountain in a suitable area of Rize as a social responsibility project. This initiative aims to revive a cultural heritage element preserved only in textual and oral traces, making it visible once again and contributing to the city and cultural tourism.

Key Words: Mataracızadeler; 19th Century; Water; Inscription; Fountain; Supercommentary; Project; Cultural Heritage; Tourism

EĞİTİM YOLUYLA YENİDEN ENTEGRASYON: SELÇUK ÜNİVERSİTESİNDE MAHKÛM ÖĞRENCİLERİN SOSYAL UYUM SÜREÇLERİ

REINTEGRATON THROUGH EDUCATION: SOCIAL ADAPTATION PROCESSES OF INCARCERATED STUDENTS AT SELCUK UNİVERSITY

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ÖZET

Bu çalışma, Selçuk Üniversitesi'nde eğitim gören 16 mahkûm öğrencinin sosyal çevreye uyum ve yeniden entegrasyon deneyimlerini incelemektedir. Eğitimin bireylerin topluma yeniden kazandırılmasında oynadığı kritik rol çerçevesinde, araştırma üniversite ortamının mahkûm öğrenciler için nasıl bir dönüşüm, destek ve güçlenme alanı sunduğunu anlamayı amaçlamaktadır. Nitel araştırma yaklaşımıyla yürütülen çalışmada yarı yapılandırılmış görüşmelerden elde edilen veriler, katılımcıların eğitim sürecine erişim, sınıf içi etkileşim, sosyal ilişkiler, stigmayla baş etme, özsaygı ve geleceğe yönelik beklenti gibi temalar üzerinden analiz edilecektir. İlk bulgular, eğitimin mahkûm öğrencilerin kendilik algısını güçlendirdiğini, sosyal izolasyonu azalttığını ve özgüven ile aidiyet duygusunu artırarak yeniden toplumsallaşma açısından dönüştürücü bir işlev üstlendiğini göstermektedir. Çalışma, mahkûm öğrencilerin yükseköğretim deneyimlerini görünür kılarak hem cezaevi sonrası hayata hazırlık süreçlerine hem de üniversite ortamında kapsayıcı eğitim politikalarının geliştirilmesine yönelik önemli göstergeler sunmaktadır.

Anahtar Kelimeler: Mahkûm öğrenciler, sosyal uyum, yeniden entegrasyon, yükseköğretim, toplumsal dışlanma, nitel araştırma

ABSTRACT

This study explores the social adaptation and reintegration experiences of 16 incarcerated students enrolled at Selçuk University. Grounded in the understanding that education plays a transformative role in supporting individuals' return to society, the research aims to examine how the university environment provides opportunities for empowerment, identity reconstruction, and social connection for students with incarceration backgrounds. Using a qualitative research design, semi-structured interviews will be analyzed to identify patterns related to educational access, classroom interactions, peer relationships, stigma management, self-esteem, and future aspirations. Preliminary insights indicate that higher education enhances incarcerated students' sense of agency, reduces social isolation, and fosters belonging, ultimately functioning as a meaningful pathway toward reintegration. By making the educational experiences of incarcerated learners visible, the study contributes to both policy discussions on inclusive higher education and broader efforts to support post-incarceration social reintegration.

Keywords: Incarcerated students, social adaptation, reintegration, higher education, social exclusion, qualitative research.

GİRİŞ

Ceza infaz sistemi içinde eğitim, yalnızca bireyin bilgi ve becerilerini artıran bir faaliyet değil; aynı zamanda tahliye sonrası yaşamın kurulmasında kritik rol oynayan bir yeniden entegrasyon mekanizmasıdır. Uluslararası literatür, cezaevi temelli eğitim programlarının tekrar suç işleme (recidivism) riskini azaltabildiğini, istihdam olasılığını artırabildiğini ve davranışsal/psikososyal çıktıların iyileşmesine katkı sunabildiğini göstermektedir (Davis et al., 2013; Duwe & Clark, 2014; Kim & Clark, 2013; Lockwood et al., 2012; Vacca, 2004). Bununla birlikte, eğitim programlarının etkisini yalnızca "suç tekrar oranı" gibi dar göstergelerle ölçmenin sınırlı olduğu; iyi oluş, özsaygı, aidiyet, sosyal destek ve kimlik dönüşümü gibi "görünmeyen" çıktıları da hesaba katmak gerektiği vurgulanmaktadır (Gould, 2018). Özellikle kadın mahpus öğrenciler açısından yükseköğretime erişimin iyi oluşa etkileri, eğitim deneyiminin toplumsal cinsiyet boyutunu daha görünür kılmaktadır (Moore & Erzen, 2023).

Türkiye'de ceza infaz kurumlarında eğitim hakkı ve uygulama pratikleri, mevzuat ve kapasite tartışmalarıyla birlikte ele alınmakta; ancak "yükseköğretim deneyiminin" mahkûm öğrencilerin sosyal uyum süreçlerini nasıl dönüştürdüğü, üniversite ortamında kurulan ilişkilerin stigma ile baş etme ve özneleşme üzerindeki etkisi gibi mikro düzey dinamikler görece sınırlı incelenmektedir. Bu çalışma, Selçuk Üniversitesi'nde öğrenim gören mahkûm öğrencilerin deneyimlerine odaklanarak, yükseköğretimin kendilik algısı, aidiyet, sosyal izolasyon, damgalanma ile baş etme ve gelecek beklentileri üzerindeki etkilerini nitel bir yaklaşımla analiz etmeyi amaçlamaktadır. Böylece araştırma, ceza adaleti ve yükseköğretim literatüründe eğitim–yeniden entegrasyon ilişkisinin "sosyal uyum" boyutuna, yerel bağlamdan özgün kanıtlar sunmayı hedeflemektedir.

METODOLOJİ

Araştırma deseni

Çalışma, mahkûm öğrencilerin yükseköğretim deneyimlerini ve sosyal uyum süreçlerini derinlemesine anlamayı amaçlayan nitel araştırma yaklaşımıyla tasarlanmıştır. Veri toplama yöntemi olarak yarı yapılandırılmış derinlemesine görüşme kullanılmıştır.

Katılımcılar ve örnekleme

Araştırmanın çalışma grubunu Selçuk Üniversitesi'nde öğrenim gören 16 mahkûm öğrenci oluşturmaktadır. Örnekleme stratejisi, deneyimi doğrudan yaşayan katılımcılara ulaşmayı amaçlayan amaçlı örnekleme (gerekli durumlarda kartopu yönlendirmesiyle genişleyen) biçiminde kurgulanmıştır. Katılımcı çeşitliliği; yaş, bölüm/program, eğitim geçmişi ve tahliye sonrası hedefler gibi değişkenlerle artırılmaya çalışılmıştır.

Veri toplama süreci

Görüşme formu; (1) eğitime erişim ve süreklilik, (2) sınıf içi etkileşim ve akademik deneyim, (3) sosyal ilişkiler ve destek ağları, (4) stigma/mahremiyet yönetimi, (5) özsaygı–öz-yeterlik ve iyi oluş, (6) gelecek beklentileri ve yeniden entegrasyon planı başlıklarında yapılandırılmıştır. Görüşmelerin ses kaydı alınması, deşifre edilmesi ve kimlik bilgilerini koruyacak şekilde anonimleştirilmesi hedeflenmiştir.

Veri analizi

Veriler, tematik analiz ile çözümlenmiştir. İlk aşamada açık kodlama yapılmış, ardından kodlar temalar altında birleştirilmiş ve temalar arası ilişkiler (ör. eğitim ↔ aidiyet ↔ stigma yönetimi ↔ gelecek tahayyülü) yorumlanmıştır. Analizde güvenilirliği artırmak için (i) temalar arası tutarlılık kontrolü, (ii)

örnek alıntılarla temaların desteklenmesi ve (iii) olumsuz/aykırı örneklerin ayrıca not edilmesi ilkeleri benimsenmiştir.

BULGULAR

Bu Analiz, yükseköğretim deneyiminin mahkûm öğrencilerin sosyal uyum süreçlerinde beş ana eksen üzerinden dönüştürücü işlev gördüğünü göstermektedir.

Tema 1. Eğitime erişim: "hak" ile "engel" arasındaki kırılgan hat

Katılımcılar, yükseköğretime erişimi çoğunlukla "ikinci bir şans" ve "normal hayata tutunma" olarak tanımlarken; bürokratik süreçler, zaman/lojistik kısıtlar ve kurumsal belirsizlikler sürekliliği zorlaştıran başlıca engeller olarak öne çıkmaktadır. Bu durum, eğitim hakkının kâğıt üzerindeki varlığı ile günlük hayattaki uygulanabilirliği arasındaki mesafeyi görünür kılmaktadır.

Tema 2. Üniversite ortamında görünürlük–mahremiyet gerilimi

Üniversite, katılımcılara "yeni bir kimlik alanı" açsa da mahkûmiyet geçmişinin bilinmesi/ifşa edilmesi ihtimali güçlü bir stres kaynağıdır. Katılımcılar, kimi zaman geçmişi saklama stratejileri geliştirerek; kimi zaman da güvenli gördükleri küçük çevrelerde kontrollü biçimde paylaşarak bu gerilimi yönetmektedir.

Tema 3. Sınıf içi etkileşim ve aidiyet: "öğrenci" kimliğinin onarıcı etkisi

Birçok katılımcı için sınıf, "etiket"lerin askıya alındığı bir mekân olarak deneyimlenmektedir. Akademik başarı, düzenli katılım ve öğretim elemanlarından alınan geri bildirim, "öğrenci" kimliğini güçlendirerek aidiyet hissini artırmaktadır. Bu bulgu, yalnızca çıktılara (mezuniyet/istihdam) değil, eğitim sürecinin psikososyal etkilerine de odaklanma gereğini destekler.

Tema 4. Stigma ile baş etme: damgalanmaya karşı stratejik uyum ve özneleşme

Katılımcılar, stigma riskini azaltmak için sosyal çevre seçimi, iletişimde sınır koyma, sosyal medyada iz bırakmama gibi pratikler kullanmaktadır. Bazı katılımcılarda ise eğitim, damgalanmayı "kişisel kusur" olarak içselleştirmek yerine onu toplumsal bir sorun olarak yeniden çerçevelemeyi kolaylaştırmaktadır.

Tema 5. Gelecek beklentisi ve yeniden entegrasyon: istihdamın ötesinde "saygın bir yaşam" arayışı

Katılımcıların gelecek tahayyülü yalnızca iş bulma hedefiyle sınırlı değildir. "Saygınlık", "kendini kanıtlama", "aileyle ilişkileri onarma", "topluma karışabilme" ve "normal bir rutin kurma" gibi hedefler güçlü biçimde dile getirilmektedir. Eğitim, bu hedeflere giden yolda bir "mümkünlük alanı" üretmektedir.

Tablo 1. Temalar ve katılımcı ifadeleri

Tema Katılımcı ifadesi

Eğitime erişim "Okul, dışarıya açılan tek kapı gibi; ama o kapıya ulaşmak her zaman kolay değil."

Mahremiyet yönetimi "Burada öğrenci olmak istiyorum; geçmişimle değil, yaptıklarımla görülmek istiyorum."

Aidiyet ve sınıf deneyimi "Derste kendimi 'normal' hissediyorum. Sanki etiketler bir süreliğine duruyor."

Stigma ile baş etme "Herkese anlatmıyorum. Kiminle neyi paylaşacağımı hesaplamak zorundayım."

Özsaygı/öz-yeterlik “Başardığımı görünce ‘ben de yapabiliyormuşum’ duygusu geri geldi.”

Gelecek planı “Mesele sadece iş değil; toplum içinde başım dik yaşayabilmek.”

SONUÇ

Bu çalışma, Selçuk Üniversitesi’nde öğrenim gören 16 mahkûm öğrencinin deneyimlerinden hareketle, yükseköğretimin yeniden entegrasyona katkısının yalnızca tahliye sonrası “istihdam ve tekerrür” göstergeleriyle sınırlı olmadığını ortaya koymaktadır. Bulgular, üniversite deneyiminin katılımcıların aidiyet, özsaygı, öz-yeterlik, sosyal izolasyonun azalması ve damgalanma ile baş etme kapasitelerini güçlendirdiğini göstermektedir. Eğitim, bu yönüyle mahkûm öğrenciler için hem kimlik onarımı hem de sosyal uyum açısından dönüştürücü bir alan işlevi görmektedir.

Öte yandan, eğitim hakkının sürdürülebilir biçimde kullanılabilmesi; erişim süreçlerindeki kırılganlıkların azaltılmasına, mahremiyetin korunmasına, stigma riskini düşüren kapsayıcı üniversite politikalarına ve öğrencilerin akademik/psikososyal destek mekanizmalarına erişimine bağlıdır. Bu nedenle çalışmanın önerisi, yükseköğretim kurumlarının mahkûm öğrencilerin deneyimini görünür kılan, ayrımcılığı önleyen ve güvenli aidiyet alanları kurmayı hedefleyen kapsayıcı politikalar geliştirmesi yönündedir.

İlerleyen araştırmalarda, nicel göstergelerle (ör. akademik süreklilik, mezuniyet, istihdam) nitel bulguların birlikte izlenmesi; ayrıca kadın mahkûm öğrencilerin iyi oluş deneyimlerine özel bir odak geliştirilmesi, eğitim–yeniden entegrasyon ilişkisinin daha bütüncül anlaşılmasına katkı sağlayacaktır.

KAYNAKÇA

Davis, L. M., Bozick, R., Steele, J. L., Saunders, J., & Miles, J. N. V. (2013). Evaluating the effectiveness of correctional education (RR-266). RAND Corporation. https://www.rand.org/content/dam/rand/pubs/research_reports/RR200/RR266/RAND_RR266.sum.pdf

Duwe, G., & Clark, V. (2014). The effects of prison-based educational programming on recidivism and employment. The Prison Journal, 94(4), 454–478. https://doi.org/10.1177/0032885514548009

Gould, M. R. (2018). Rethinking our metrics: Research in the field of higher education in prison. The Prison Journal, 98(4), 387–404. https://doi.org/10.1177/0032885518776375

Kim, R. H., & Clark, D. (2013). The effect of prison-based college education programs on recidivism: Propensity score matching approach. Journal of Criminal Justice, 41(3), 196–204. https://doi.org/10.1016/j.jcrimjus.2013.03.001

Lockwood, S., Nally, J., Ho, T., & Knutson, K. (2012). The effect of correctional education on postrelease employment and recidivism: A 5-year follow-up study in the state of Indiana. Crime & Delinquency, 58, 380–396. https://doi.org/10.1177/0011128712441695

Moore, S. Y., & Erzen, T. (2023). The well-being impacts associated with college in prison: A comparison of incarcerated and non-incarcerated students who identify as women. The Prison Journal, 103(1), 3–22. https://doi.org/10.1177/00328855221139843

Vacca, J. S. (2004). Educated prisoners are less likely to return to prison. Journal of Correctional Education, 55(4), 297–305. https://www.jstor.org/stable/23292095

MÜTEDEYYİN KADINLARIN DİNDARLIK PERFORMANSI VE DİNDEN KOPUŞ SÜREÇLERİ

PIOUS WOMEN'S PERFORMATIVE RELIGIOSITY AND THEIR PATHS TO DISAFFILIATION

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ÖZET

Bu çalışma, muhafazakâr dini çevrelerde yetişmiş ve bir dönem kendini dindar olarak tanımlamış 20 kadınla yapılan derinlemesine görüşmelere dayanarak, mütedeyyin kadınların dinden uzaklaşma süreçlerini incelemektedir. Bulgular, dini terk etmenin ani bir kopuştan ziyade ailevi beklentiler, toplumsal cinsiyet temelli ahlaki denetim, imam hatip ve hafızlık gibi kurumsal disiplin mekanizmaları ile şekillenen, duygusal ve bilişsel katmanları olan uzun bir dönüşüm olduğunu göstermektedir. Katılımcılar, aile içinde "dindar rolü"nü sürdürmek adına kapalı giyinme, oruçlu görünme, ibadet ediyor gibi yapma ve seküler benliklerini gizleme gibi performatif stratejiler geliştirdiklerini; buna karşın kutsal metinler, ilahi adalet, dini otorite ve toplumsal eşitsizliklere ilişkin derin sorgulamalar yaşadıklarını belirtmiştir. Kadınların bir kısmı için toplumsal cinsiyet normlarıyla çatışma, beden üzerinde kurulan dini kontrol ve bazı katılımcılarda ortaya çıkan eşcinsel yönelim farkındalıkları, inanç ile benlik arasındaki uyumsuzluğu daha da derinleştirmiştir. Zamanla alternatif arkadaşlık ağları, dijital içerikler ve kişisel özgürlük alanları, kadınların seküler etik çerçeveler geliştirmelerine ve kurumsal din dışında yeni kimlikler inşa etmelerine imkân tanımıştır. Çalışma, performans, gizlilik, direniş ve özneleşme süreçlerinin nasıl iç içe geçtiğini ortaya koyarak Türkiye'de toplumsal cinsiyet eksenli sekülerleşmeye dair derinlikli bir anlayış sunmaktadır.

Anahtar Kelimeler: Mütedeyyin kadınlar, dindarlık performativitesi, dinden uzaklaşma, sekülerleşme, toplumsal cinsiyet, kimlik dönüşümü.

ABSTRACT

This study examines the processes through which pious women raised in conservative religious environments gradually distance themselves from faith, drawing on in-depth interviews with 20 participants who once identified as devout. Findings reveal that disaffiliation is not a sudden rupture but a slow, emotionally and cognitively layered transformation shaped by familial expectations, gendered moral regulation, and the disciplinary structures of religious schooling and hafiz training. Many women describe performing a "religious role" for their families—maintaining modest dress, appearing to fast or pray, and suppressing secular expressions of self—while privately questioning theological doctrines, divine justice, and the moral authority of religious leaders. Conflicts related to gender norms, bodily

autonomy, and, for some participants, emerging awareness of same-sex desire further intensified the sense of incongruence between their lived realities and the demands of religious identity. As women sought alternative social networks, digital spaces, and interior zones of autonomy, they increasingly embraced secular moral frameworks and redefined their identities beyond institutional religion. The findings illuminate how performativity, secrecy, resistance, and self-making intertwine in pious women's paths to disaffiliation, offering a nuanced understanding of gendered secularization in contemporary Turkey.

Keywords: Pious women, religious performativity, disaffiliation, secularization, gender, identity transformation.

GİRİŞ

Dindarlık ve sekülerleşme, uzun yıllar boyunca sosyoloji ve din çalışmaları literatüründe karşıt iki kutup olarak ele alınmış; dindarlık çoğunlukla bireyin inanç düzeyi ve ibadet pratikleri üzerinden, sekülerleşme ise modernleşmeyle birlikte dinin kamusal alandaki etkisinin azalması bağlamında tartışılmıştır (Berger, 1967; Casanova, 1994). Ancak son yıllarda bu ikili karşıtlığın yetersizliği giderek daha fazla sorgulanmakta; dindarlığın gündelik hayatta nasıl yaşandığı, müzakere edildiği ve özellikle nasıl görünür kılındığı üzerine odaklanan çalışmalar öne çıkmaktadır.

Bu dönüşüm, dindarlığın sabit bir kimlikten ziyade, belirli bağlamlarda yeniden üretilen bir pratikler bütünü olarak ele alınmasına imkân tanımıştır. Bu noktada performativite kavramı, dini kimliğin yalnızca inanılan değil, aynı zamanda sergilenen, tekrar edilen ve toplumsal olarak onaylanması beklenen bir yapı olduğunu göstermesi açısından önemli bir analitik araç sunmaktadır (Goffman, 1959; Butler, 1990). Dindarlık, özellikle muhafazakâr toplumsal yapılarda, bireyin içsel inancından bağımsız biçimde kamusal ve ailevi beklentiler doğrultusunda sürdürülmesi gereken bir role dönüşebilmektedir.

Toplumsal cinsiyet perspektifinden bakıldığında, bu performatif yükün kadınlar üzerinde çok daha yoğunlaştığı görülmektedir. Kadın bedeni, davranışları ve duygulanımları, dini ve ahlaki normların temel taşıyıcısı olarak konumlandırılmakta; dindarlık çoğu zaman kadınlar üzerinden ölçülmektedir (Mahmood, 2005; Kandiyoti, 2011). Türkiye bağlamında mütedeyyin kadınlar, aile, cemaat ve dini eğitim kurumları aracılığıyla sürekli bir ahlaki gözetim altında tutulmakta; örtünme, itaat, mahremiyet ve fedakârlık gibi normlar kadın dindarlığının asli göstergeleri olarak sunulmaktadır.

Bu yoğun denetim, kadınların dini pratiklerle kurduğu ilişkiyi karmaşıklaştırmakta; dindarlık kimi durumlarda içselleştirilmiş bir inançtan ziyade, çatışmadan kaçınmak için sürdürülen bir görünürlük rejimine dönüşmektedir. İmam hatip okulları, hafızlık eğitimleri ve muhafazakâr aile yapıları, bu rejimin kurumsal taşıyıcıları olarak işlev görmekte; dini disiplin ile toplumsal cinsiyet normları iç içe geçmektedir (Akgönül & Öktem, 2012; Göle, 2017).

Bu bağlamda dinden uzaklaşma ya da dini terk etme süreçleri de ani ve keskin kopuşlar olarak değil, çoğu zaman uzun süreli, sessiz ve katmanlı dönüşümler olarak yaşanmaktadır. Literatür, özellikle kadınlar için sekülerleşmenin kamusal bir ilan değil; gizlilik, ikilik ve içsel müzakere üzerinden ilerleyen bir süreç olduğunu göstermektedir (Hervieu-Léger, 2006; Bromley, 2015). Kadınlar, bir yandan dini performansı sürdürürken, diğer yandan kutsal metinler, ilahi adalet, dini otorite ve toplumsal eşitsizlikler üzerine derin sorgulamalar geliştirebilmektedir.

Bu çalışma, mütedeyyin kadınların dindarlık deneyimlerini performativite kavramı üzerinden ele alarak, inançtan uzaklaşma süreçlerinin duygusal, bilişsel ve toplumsal boyutlarını incelemeyi amaçlamaktadır. Araştırma, dinden kopuşu bireysel bir "inanç kaybı" olarak değil; toplumsal cinsiyet, ahlaki denetim ve özneleşme süreçleriyle şekillenen bir dönüşüm olarak ele almakta ve Türkiye'de kadın deneyimleri üzerinden sekülerleşme tartışmalarına mikro düzeyden katkı sunmayı hedeflemektedir.

METODOLOJİ

Bu araştırma, nitel araştırma desenine dayanmaktadır. Çalışmanın veri seti, muhafazakâr dini çevrelerde yetişmiş ve yaşamlarının bir döneminde kendilerini dindar olarak tanımlamış 20 kadınla gerçekleştirilen derinlemesine yarı yapılandırılmış görüşmelerden oluşmaktadır. Katılımcılar, kartopu örnekleme yöntemiyle belirlenmiş; görüşmeler gönüllülük esasına göre gerçekleştirilmiştir.

Görüşmelerde katılımcıların çocukluk ve gençlik dönemlerindeki dini sosyalleşme deneyimleri, aile ve eğitim kurumlarıyla ilişkileri, dindarlık pratikleri, inanç sorgulamaları ve zamanla gelişen sekülerleşme deneyimleri ele alınmıştır. Görüşmeler çevrim içi ve yüz yüze yapılmış; ses kaydı alınarak yazılı metne dönüştürülmüştür.

Elde edilen veriler tematik analiz yöntemiyle incelenmiştir. Analiz sürecinde veriler tekrar tekrar okunmuş, açık kodlama yapılmış ve anlamlı temalar altında gruplanmıştır. Analiz boyunca performativite, toplumsal cinsiyet, dini denetim, gizlilik ve özneleşme kavramları analitik çerçeve olarak kullanılmıştır. Katılımcıların kimlikleri etik ilkeler doğrultusunda gizli tutulmuş, doğrudan alıntılarda kodlar (K1, K2 vb.) kullanılmıştır.

BULGULAR

Bu bölümde, dindar bir çevrede yetişmiş ve zamanla dinden uzaklaşma sürecine giren kadınların deneyimleri, 20 katılımcıdan elde edilen görüşmelerden türetilen ortak temalar çerçevesinde sunulmaktadır. Bulgular, dinden uzaklaşmanın tekil ve ani bir kopuş değil; habitus dönüşümü, performatif kimlik yönetimi, stigma ile baş etme ve cinsel kimlik farkındalıklarıyla iç içe geçen uzun erimli bir süreç olduğunu ortaya koymaktadır.

İslami Habitus'un Çatışması ve Aşınması

Katılımcıların tamamına yakını, çocukluk ve ergenlik dönemlerinde dindarlığın "doğal" ve sorgulanamaz bir yaşam biçimi olarak içselleştirildiğini belirtmiştir. İmam hatip liseleri, hafızlık kursları ve muhafazakâr aile yapıları, dini pratikleri yalnızca ibadet değil; itaat, temizlik, sabır ve kadınlık rolleriyle birlikte öğreten disipliner alanlar olarak deneyimlenmiştir.

Zamanla bu alanlarda yaşanan baskı, korku ve bedensel denetim, katılımcıların dini inançlarını sorgulamalarına yol açmıştır. Dinden uzaklaşma, çoğu katılımcı için "inanmamaya karar verme" anından ziyade, inancın anlamını yitirmesi şeklinde tarif edilmiştir.

Alanlar Arası Geçiş ve Çift Kimlikli Yaşam

Katılımcıların deneyimleri, farklı sosyal alanlarda (aile, cemaat, arkadaş çevresi, üniversite) farklı kimlik performansları sergilemek zorunda kaldıklarını göstermektedir. Aile ve cemaat alanları "ön sahne" olarak tanımlanırken; arkadaş çevresi, bireysel odalar ve dijital alanlar "arka sahne" işlevi görmektedir.

Bu durum, kadınların hem dindar hem seküler kimlikleri eş zamanlı olarak taşımalarına neden olmakta; sürekli bir izlenim yönetimi gerektirmektedir. Dinden uzaklaşma, bu bağlamda yalnızca inançla ilgili değil; sosyal sermayeyi kaybetmeme çabasıyla da şekillenmektedir.

Dindarlığın Performatif Sürdürülmesi

Katılımcıların büyük bölümü, aile içi çatışmalardan kaçınmak adına dini pratikleri görünürlük düzeyinde sürdürdüklerini ifade etmiştir. Oruç tutuyormuş gibi yapmak, başörtüsünü yalnızca aile ziyaretlerinde takmak, ibadet ediyor izlenimi vermek, en sık dile getirilen performatif stratejiler arasındadır. Bu performanslar, kadınlar üzerinde yoğun bir duygusal yük ve suçluluk hissi yaratmakta; dinden uzaklaşma sürecinin psikolojik boyutunu derinleştirmektedir.

Toplumsal Cinsiyet, Stigma ve "Namus" Söylemi

Bulgular, dinden uzaklaşan kadınların erkeklere kıyasla çok daha ağır bir ahlaki stigma ile karşı karşıya kaldığını göstermektedir. Katılımcılar, dini terk etmenin "edepsizlik", "ahlaksızlık" ve "namussuzluk" söylemleriyle ilişkilendirildiğini; özellikle beden ve giyim üzerinden sürekli denetlendiklerini belirtmiştir. Bu stigma tehdidi, birçok kadının seküler kimliğini gizlemesine ve açılma sürecini ertelemesine neden olmaktadır.

Cinsel Yönelim Farkındalığı ve İnançla Çatışma

Katılımcıların bir kısmı için dinden uzaklaşma süreci, eşcinsel yönelim farkındalığıyla doğrudan kesişmektedir. Bu kadınlar, dini söylemlerde eşcinselliğin günah, sapkınlık ya da hastalık olarak sunulmasının, inançla bağlarını koparan en güçlü kırılma noktalarından biri olduğunu ifade etmiştir. Cinsel yönelim farkındalığı, yalnızca dini inancı değil; aileye açılma, beden algısı ve aidiyet duygusunu da derinden etkilemiştir. Bu katılımcılar için sekülerleşme, aynı zamanda var olabilmenin ön koşulu haline gelmiştir.

Tablo 1

Dinden Uzaklaşan Kadınların Deneyimlerine İlişkin Temalar ve Çarpıcı İfadeler

Tema	Katılımcı İfadesi
İslami habitusun baskısı	"Orada öğretilen şey ibadet değildi, itaatti. Temizlik yaptırırken bile ileride kocana alışırsın deniyordu."
Çift kimlikli yaşam	"Ailemin yanında başka bir karaktere geçiyorum. Daha edepli, daha sessiz bir kız oluyorum."
Performatif dindarlık	"Oruçlu rolü yaptım. Aç değildim ama aç gibi davrandım. Annem üzülmesin diye."
Gizlilik ve suçluluk	"İnanmıyormuş gibi yaşayamıyorum, inanıyormuş gibi yaşamak zorundayım."
Stigma korkusu	"Bunu bilseler edepsiz, namussuz derler. Kadın olunca bu daha ağır."
Eşcinsel yönelim ve kopuş	"Benim hissettiğim şeyin günah olduğunu söyleyen bir dine ait kalamazdım."

SONUÇ

Bu çalışma, Türkiye'de muhafazakâr dini çevrelerde yetişmiş kadınların dinden uzaklaşma deneyimlerini, bireysel bir inanç kaybı ya da ani bir kopuş olarak değil; habitusun dönüşümü, performatif kimlik yönetimi ve toplumsal cinsiyet temelli stigma ile iç içe geçen çok katmanlı bir süreç olarak ele almıştır. Bulgular, dindarlığın kadınlar için çoğu zaman içselleştirilmiş bir inançtan ziyade, aile ve cemaat alanlarında sürdürülmesi beklenen zorunlu bir toplumsal rol niteliği taşıdığını ortaya koymaktadır.

Bourdieu'nün habitus kavramı çerçevesinde değerlendirildiğinde, katılımcıların çocukluk ve ergenlik dönemlerinde içselleştirdikleri İslami yaşam biçiminin, üniversite, arkadaş çevresi ve dijital alanlar gibi yeni sosyal alanlarla temas ettikçe çatışmaya girdiği görülmektedir. Bu çatışma, dini sermayenin değerini yitirmesi ve sosyal sermayenin kaybı riskini beraberinde getirmiş; kadınları farklı alanlarda farklı kimlikler sergilemeye zorlamıştır. Bu bağlamda dinden uzaklaşma, yalnızca bilişsel bir sorgulama değil, aynı zamanda sosyal maliyetleri olan bir dönüşüm olarak deneyimlenmiştir.

Goffman'ın dramaturji ve stigma kavramları ise, bu içsel dönüşümün gündelik hayatta nasıl yönetildiğini görünür kılmıştır. Kadınlar, aile ve cemaat alanlarında "ön sahne"de dindar rolünü sürdürürken; arkadaş çevresi, bireysel alanlar ve dijital mecralarda "arka sahne"de seküler benliklerini yaşayabilmektedir. Oruç tutuyormuş gibi yapmak, başörtüsünü yalnızca belirli bağlamlarda takmak ya da dini pratikleri görünürlük düzeyinde sürdürmek, çatışmayı erteleyen ancak duygusal yükü artıran izlenim yönetimi stratejileri olarak öne çıkmıştır.

Çalışma, dinden uzaklaşan kadınların erkeklere kıyasla çok daha ağır bir ahlaki ve cinsel stigma ile karşı karşıya kaldığını da göstermektedir. "Namus", "edepsizlik" ve "ahlaksızlık" söylemleri, kadın bedenini ve davranışlarını merkeze alan bir denetim mekanizması olarak işlemekte; sekülerleşme sürecini gizlilik ve sessizlikle çevrelemektedir. Özellikle eşcinsel yönelim farkındalığı yaşayan kadınlar için bu baskı, inançla bağın kopmasında belirleyici bir kırılma noktası oluşturmakta; sekülerleşme, varoluşsal bir zorunluluk haline gelmektedir.

Sonuç olarak bu çalışma, Türkiye'de kadınların dinden uzaklaşma deneyimlerinin, inançtan ziyade iktidar, beden, toplumsal cinsiyet ve görünürlük rejimleriyle yakından ilişkili olduğunu ortaya koymaktadır. Dinden kopuş, bu bağlamda ne ani bir reddiye ne de tamamen bireysel bir tercih olarak okunabilir; aksine, kadınların özneleşme, direnç ve hayatta kalma stratejileriyle örülü uzun erimli bir dönüşüm sürecidir. Bu bulgular, toplumsal cinsiyet eksenli sekülerleşme tartışmalarına mikro düzeyden katkı sunarken, kadınların dini deneyimlerinin anlaşılmasında performans, gizlilik ve stigma kavramlarının merkezi önemini bir kez daha vurgulamaktadır.

KAYNAKÇA

Berger, P. L. (1967). *The sacred canopy: Elements of a sociological theory of religion*. Anchor Books.

Bromley, D. G. (2015). *The politics of religious apostasy: The role of apostates in the transformation of religious movements*. Praeger.

Butler, J. (1990). *Gender trouble: Feminism and the subversion of identity*. Routledge.

Casanova, J. (1994). *Public religions in the modern world*. University of Chicago Press.

Goffman, E. (1959). *The presentation of self in everyday life*. Anchor Books.

Göle, N. (2017). *İslam ve modernlik üzerine melez desenler* (Gözden geçirilmiş baskı). Metis Yayınları.

Hervieu-Léger, D. (2006). *Religion as a chain of memory*. Rutgers University Press.

Kandiyoti, D. (2011). *Cariyeler, bacılar, yurttaşlar: Kimlikler ve toplumsal dönüşümler* (3. bs.). Metis Yayınları.

Mahmood, S. (2005). *Politics of piety: The Islamic revival and the feminist subject*. Princeton University Press.

DISCREDITING THE UN'S WORK ON PALESTINE: ACTORS, NARRATIVES, AND IMPLICATIONS

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ABSTRACT

The United Nations has long played a central role in addressing the Palestinian question, with UNRWA (the UN Relief and Works Agency for Palestine Refugees in the Near East) serving as the primary provider of humanitarian and developmental services to Palestinian refugees across the Middle East. Yet in recent years, the UN's work on Palestine—UNRWA in particular—has become the target of an intensified campaign of discreditation. This article examines how a diverse set of actors, most prominently the Israeli government, have deployed a range of narratives to undermine the UN's legitimacy, neutrality, and operational credibility. Drawing on official statements, diplomatic communications, and social media interventions, the analysis identifies predominant discrediting narratives and demonstrates how they have produced significant political and operational consequences, including large-scale suspensions of donor funding. By situating the campaign against UNRWA within the broader effort to discredit the UN's involvement in Palestine, the article shows how struggles over legitimacy, neutrality, and security framing targeting the UN and UNRWA shape the future of humanitarian governance in prolonged conflicts and dire humanitarian crises.

Keywords: UN, Palestine, UNRWA, Israel, Humanitarian Governance

INTRODUCING THE UN'S WORK ON PALESTINE

The United Nations Relief and Works Agency for Palestine Refugees in the Near East (UNRWA) has long served as the primary humanitarian and development institution responsible for the education, health, and social welfare of Palestinian refugees across Jordan, Lebanon, Syria, Gaza, and the West Bank. Accordingly, for more than 75 years now, UNRWA has uninterruptedly carried out its mandate and engaged with the governments party to the conflict and the international community to seek solutions to the Palestinian refugee question. For the Palestinians, the agency has functioned as a de facto government and a guarantor of essential services, yet, for Israel, UNRWA has increasingly become framed as a body that sustains Palestinian claims—particularly the right of return—and thus undermines Israel's security. Therefore, throughout its work, UNRWA has frequently faced criticism from Israel and its allies on the grounds that it has developed relationships with Palestinian resistance groups. However, following Hamas's Al-Aqsa Flood attack launched on 7 October, UNRWA became the target of a comprehensive securitization, based on accusations that some of its staff were involved in Hamas's actions, as a result of which the body faced the suspension of financial contributions and an intensive

diplomatic campaign calling for its dissolution (Tobin 2024). Differing from the historical practices, since 2023, the delegitimization of UNRWA by Israel, in particular, has escalated into a systematic securitization campaign portraying UNRWA as biased, irresponsible, infiltrated by Hamas, and ultimately as a direct security threat. Thus, the UN's work on Palestine—UNRWA in particular—has become the target of an intensified campaign of discreditation.

The extensive circulation of these discrediting narratives has generated significant political consequences, including widespread donor suspensions—most notably by the United States, several European states, and other Western actors (Sharf and Ben-Ari 2024). Nonetheless, in response to this, the UN and its humanitarian bodies have ardently supported UNRWA and its mission. Yet still, the campaigns targeting the agency's legitimacy continue – a diverse set of actors, most prominently the Israeli government, continues to deploy a range of narratives to undermine the UN's legitimacy, neutrality, and operational credibility, with consequences for the durability—and fragility—of global humanitarian principles in protracted conflicts. By situating the campaign against UNRWA within the broader effort to discredit the UN's involvement in Palestine, this paper aims to unfold the dominant anti-UNRWA narratives shaping the future of humanitarian governance within the UN in prolonged conflicts and dire humanitarian crises.

NARRATIVES OF DELEGITIMIZATION

A United Nations concerned with Palestine is troubling for Israel; one that systematically documents Israel's cruelty and brutality is even more so. UNRWA's being considered an ontological security threat to Israel stems most directly from the agency's documentation role, as the country has never struggled this much to control its international public image.

To regain control of the narrative—and thereby end the international community's monitoring of the situation through UNRWA's documentation—Israel has campaigned for the agency's mandate to be terminated, which has been renewed in every three years since 1949 (The most recent vote took place on December 5, 2025, and the agency's mandate was extended for an additional three years beginning in 2026). In doing so, Israel uses several forms of portrayals regarding UNRWA, the most frequently articulated of which are (1) claims of institutional bias and "Palestinian exceptionalism"; (2) allegations of responsibility for Hamas activities; (3) the construction of UNRWA as an operational arm of Hamas; and (4) delegitimizing calls for its abolition and replacement (Kwoska 2025).

As part of its broader claims of institutional bias, Israel frequently accuses the UN in general, and UNRWA in particular, of fostering what it terms Palestinian exceptionalism. In this view, Israeli discourse is unsettled by the framing of the Palestinian question as a singular form of state wrongdoing—one that portrays Israel as inhumanely cruel and uniquely responsible for a grave and enduring injustice. Such a discursive construction of exceptional injustice, according to Israeli officials, generates disproportionate global attention. It produces what they perceive as an "over-internationalization" of the issue, resulting in a worldwide decline in support for Israel and, concurrently, in the growing denunciation of Israeli policies as forms of settler colonialism, apartheid, and more recently, genocide (Miladi 2025). This discomfort is exemplified in the following post issued by the Israeli Ministry of Foreign Affairs:

If you're looking for VIP refugee treatment, look no further than @UNRWA. There are 36 million refugees in the world, but only 6 million Palestinians have inherited a "special" refugee status, thanks to UNRWA. Why is this the case? (@IsraelMFA & @Israel, February 5, 2024)

Complementarily, Israel has long accused UNRWA of harbouring terrorists and thereby abusing its humanitarian mandate. This narrative constitutes one of Israel's most enduring and widely circulated lines of criticism against the agency. The claims long suggested that UNRWA officers, most of whom are locally recruited Palestinians, are either members of Hamas (therefore, there has been an infiltration of a terrorist organization into a UN office) or participate in Hamas's terror activities as facilitators. Consequently, Israel argues that the UN system fails to uphold adequate mechanisms of oversight and accountability in its Palestinian operations, claiming that the UN empowers actors hostile to Israel's security (Hamdan 2024). This discomfort is exemplified in the following post issued by Israel's Minister of Defence:

The US decision to halt funding to @UNRWA is a clear vote of no confidence in @UN Secretary-General @antonioguterres. Under his leadership, UNRWA has become a terrorist arm of Hamas, with its employees involved in the horrific massacre on October 7. Anyone who refuses to condemn Hamas's crimes and fails to respond to calls for the dismissal of UNRWA chief @UNLazzarini - must go home themselves. (@Israel_katz, March 23, 2024)

Such a framing is accompanied by a full securitization—and thus a security-based delegitimization—of UNRWA and the UN's broader engagement with Palestine. Within this discourse, UNRWA is portrayed as an arm of Hamas, and thus not only a contributor to instability but also an active enabler of Hamas's operations and political influence. In this narrative, the agency's humanitarian mandate is recast as a security liability, allowing Israel to question the legitimacy of UN involvement in Palestinian affairs altogether. Such narrations can be seen in the following articulations:

Hamas terrorists firing at civilians from within a @UNRWA facility next to @UN vehicles in Rafah. No lie from @antonioguterres and @UNLazzarini will hide the truth: @UNRWA is an arm of the terrorist organization Hamas. @UNLazzarini must resign! (@Israel_katz, May 14, 2024)

We have recently exposed to the world that UNRWA is collaborating with Hamas and that some of its people even participated in the atrocities and abductions of October 7. This only strengthens what we have known for a long time – that UNRWA is not part of the solution, it is part of the problem. The time has come to begin the process of replacing UNRWA with other bodies that are not tainted by support for terrorism. (Prime Minister's Office, February 4, 2024, https://www.gov.il/en/pages/spoke-start040223)

Within this very framing, UNRWA becomes an illegitimate actor—perceived as part of the problem rather than a contributor to its solution. As the foreign minister stated: "UNRWA has no place in the Gaza Strip. UNRWA is the problem, not the solution." (Press Release, February 16, 2024,https://www.gov.il/en/pages/fm-katz-addresses-the-munich-security-conference-16-feb-2024).

In constructing the illegitimacy of UNRWA's work—and, more broadly, the UN's engagement in Palestine—the call to terminate UNRWA's mandate becomes central. This is articulated, for example, by Prime Minister Netanyahu as follows:

I think it's time that the international community and the UN itself understand that UNRWA's mission has to end. UNRWA is self-perpetuating. It is self-perpetuating also in its desire to keep alive the Palestinian refugee issue. And we need to get other UN agencies and other aid agencies replacing UNRWA if we're going to solve the problem of Gaza as we intend to do. There are other agencies in the UN. There are other agencies in the world. They have to replace UNRWA.

UNRWA is totally infiltrated with Hamas. It has been in the service of Hamas and its schools, and in many other things. I say this with great regret because we hoped that there would be an objective and constructive body to offer aid. We need such a body today in Gaza. But UNRWA is not that body. It has to be replaced by some organization or organizations that will do that job. (Press Release, January 31, 2024 https://www.gov.il/en/pages/event-un310124)

In short, taken together—the claims of institutional bias, the allegations of responsibility for Hamas activities, the construction of UNRWA as an operational arm of Hamas, and the delegitimizing calls for its abolition and replacement—clearly reveal the actors and narratives involved in discrediting the UN's work on Palestine. Yet this raises a further question: what are the implications of such accusations?

IMPLICATIONS OF DELEGITIMIZATION – IN LIEU OF CONCLUSION

The most immediate implication has been the suspension or withdrawal of funding. The United States, for example, cut all financial support to UNRWA between 2018 and 2021, and again in 2024, when the U.S. Congress imposed a ban on voluntary contributions to the agency. Following the events of October 7, several other states—including the UK, Canada, Germany, Australia, France, Italy, the Netherlands, Finland, Switzerland, Sweden, Japan, as well as Estonia and Romania—announced the termination of their contributions (many of which were later reinstated). For an agency whose operations rely almost entirely on voluntary donations from UN member states, and which provides essential services to more than six million registered refugees across Palestine, Syria, Lebanon, and Jordan, such funding cuts have been profoundly damaging.

Nevertheless, as opposed to this delegitimizing approach, a counter–global agenda has emerged—led principally by the UN Secretary-General and supported by various UN bodies, including the UN Office for the Coordination of Humanitarian Affairs (OCHA), the World Food Programme (WFP), the World Health Organization (WHO), UNICEF, and the UN High Commissioner for Refugees (UNHCR), along with many member states of the General Assembly—emphasizing the importance of ensuring that UNRWA's work continues (UN 2024; Kampmark 2024; Lund and Browne 2024; Hanafi et al. 2014). Therefore, a multilayered form of resilience that counters these delegitimizing pressures has emerged, which includes UNRWA's own institutional reforms and transparency measures; support from UN bodies such as OCHA, UNHCR, and UNICEF; renewed commitments from European and non-Western donors; and collective mobilization by Palestinian communities and civil society. These forms of resistance not only help sustain UNRWA's operational capacity but also reflect the ongoing resilience of humanitarian norms within an increasingly polarized international order.

REFERENCES

Hamdan, A. (2024). The Israeli war against UNRWA and its impact on Palestinian refugees. Al-Muntaqa: New Perspectives on Arab Studies, 7(1), 91–98.

Hanafi, S., Hilal, L., & Takkenberg, L. (Eds.). (2014). UNRWA and Palestinian refugees: From relief and works to human development. Routledge.

Kampmark, B. (2024, March 11). Aid wars over Gaza: Resuming funding to UNRWA. International Policy Digest. https://intpolicydigest.org/aid-wars-over-gaza-resuming-funding-to-unrwa/

Kwoska, E. (2025). Securitizing UNRWA: A discourse-historical analysis of Israeli leaders' discourse on UNRWA (Master's thesis, Lund University).

Lund, C., & Browne, B. C. (2024). Stigmatisation as settler colonialism: Designating humanitarian and civic society organisations in Palestine as security threats. Peacebuilding, 13(3), 291–307.

Miladi, N. (2025). Seeking "permission to narrate": Debunking the global media reporting of the Israeli war on Gaza and the Palestine exceptionalism. Journal of Arab & Muslim Media Research, 18(1), 3–14.

Sharf, S. D., & Ben-Ari, R. (2024, July 30). Israel under fire – UNRWA: Humanitarian terrorism? Jerusalem Center for Security and Foreign Affairs (JCFA), 2. SSRN. https://ssrn.com/abstract=5162455

Tobin, Y. (2024). UNRWA's terror ties extend to highest levels of Hamas. Jewish Institute for National Security of America. https://coilink.org/20.500.12592/24vlcqi

United Nations. (2024). Any attempt to discredit UN Relief and Works Agency for Palestine Refugees undermines principles of international cooperation, delegate tells Security Council. https://www.un.org/unispal/document/pr-sc-26jul24/

POPULISM, ANTI-GLOBALISM AND THE FUTURE OF GLOBAL GOVERNANCE

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ABSTRACT

Global governance has long generated intense debate about the scope and depth of multilateralism, particularly its capacity to create participatory avenues of cooperation among governments and nongovernmental actors through international and regional organizations. The concept gained prominence in the mid-1990s, making multilateralism evolve toward a more inclusive model of governance. During this period, the UN—its principal institutional structure—began systematically engaging the nongovernmental sector worldwide, a shift that in turn helped strengthen confidence in multilateralism. This transformation expanded opportunities for interaction among those affected by the policies of multilateral organizations and reimagine these institutions as multistakeholder bodies within a broader global governance architecture. The process was further reinforced by the sustainable development agenda, as growing collaboration between governmental and nongovernmental actors fuelled expectations for the continued deepening of global governance. However, despite the gains that governance processes brought, over the past decade governments have increasingly come to view the problem-solving capacities of multilateral organizations—and the UN in particular—as inadequate or dysfunctional. This shift has coincided with the rise of populism and anti-globalism globally, both of which have undermined expectations for the advancement of global governance-based cooperation. Building on this nexus, this paper examines the relationship between anti-globalism and the decline in global governance, with particular attention to shifts in the positions of the great powers (the US and China), in order to offer a clearer assessment of the future trajectory of global governance.

Keywords: Populism, Anti-Globalism, Global Governance, United Nations, the US, China

INTRODUCTION

Anti-globalism was once a discussion of criticizing the neoliberal transformation of the world economy and global politics. Leftist and anti-colonial/decolonial actors in particular strongly objected to the adverse effects of globalization, which they saw reflected in the erosion of local cultures and identities, the deepening of socioeconomic inequalities, and the widening gap between the Global South and the Global North in their capacities to generate and accumulate wealth. The structural adjustment programs imposed by the IMF and the World Bank, and the following pushes for privatization, trade liberalization, tax reforms, and facilitation of capital flows (a.k.a. the Washington Consensus); as well as global cultural homogenization due to Western cultural hegemony, all created a context in which the local cultures and economic structures became marginalized. The critiques, therefore, made sense, particularly from the perspective of the necessity of protecting indigenous values and peoples and of the discrepancy the Southern people experience. However, for the last decade or so, anti-globalism has also come to be a reactionary form of political discourse and practice, this time involved in by populists, nationalists, authoritarian governments, anti-gender/anti-sogi movements, and even xenophobes who articulate a strong rejection of global social changes triggered particularly by the mass mobilization

particularly of people, which is believed to be leading to ontological insecurities (Sparke 2022). As a securitization practice, anti-globalism has put the transnational dynamics, championed by global governance since the 1990s, into its target, leading to pushes for its retreat – as articulated recently in the 2025 National Security Strategy of the Trump Administration:

> After the end of the Cold War, American foreign policy elites convinced themselves that permanent American domination of the entire world was in the best interests of our country… Our elites badly miscalculated America's willingness to shoulder forever global burdens to which the American people saw no connection to the national interest... They placed hugely misguided and destructive bets on globalism and so-called "free trade" that hollowed out the very middle class and industrial base on which American economic and military preeminence depend... they lashed American policy to a network of international institutions, some of which are driven by outright anti-Americanism and many by a transnationalism that explicitly seeks to dissolve individual state sovereignty. (The White House, November 2025, 1-2)

Similar criticisms were long articulated by Trump, as seen during his 2018 UNGA address:

> We reject the ideology of globalism, and we embrace the doctrine of patriotism. Around the world, responsible nations must defend against threats to sovereignty not just from global governance, but also from other, new forms of coercion and domination. (UN News. 25 September 2018)

Apparently, contemporary anti-globalism poses a greater risk to global governance mechanisms, which Trump, for instance, rebukes as guided by destructive globalism. Such a position from the most powerful actor in global politics undermines expectations for the advancement of global governance-based cooperation; rather, it evokes a decline in global governance.

What, then, can we expect from the future of global governance? This paper reflects on this question by examining how the evolving perspectives of the United States and China shape the global governance landscape. Given that great-power politics between these two states will ultimately influence—and potentially determine—the future trajectory of globalization, the analysis focuses on their competing visions, priorities, and strategies for global governance.

GLOBAL GOVERNANCE – THE AMERICAN AND CHINESE POSITIONS

Global governance has had two "powerful constituencies" vocally articulating a demand for furthering it: "multinational corporations, which benefited from an open international economy and the trade and investment agreements that supported it, and nongovernmental organizations (NGOs), operating across national boundaries to set global agendas and implement programs in human rights, climate, global health, and other sectors." (Kahler 2018, 239) Despite their disagreements in terms of its structure, both groups agreed on the need for advancing globalization. Their pushes were influential until the increase of scepticism towards the benefits of economic globalization and encroachment of national autonomy in the industrialized North concomitant to the rise of populism and nationalism in the West, corresponding to the 2010s – an era clouded by financial crises, refugee crises, related increasing protectionism, and "withdrawal from international agreements and commitments" (Kahler 2018, 240). A clear manifestation of this was seen during the WTO's Doha round of trade negotiations – a confrontation was experienced between the industrialized West and the emerging economies. Despite the drawbacks of trade-based multilateralism, strong support was provided for the governance of climate change (COP21). The support for global governance thus varies across issues, maintained as separate initiatives, a phenomenon also called "global governance in pieces" (Patrick, 2014, 64).

Yet still, Global Governance is believed to be declining due particularly to the US's hesitancy in furthering globalization, as Matthew Stephen suggests:

> A major catalyst of the decline of global governance is the shift in the United States' approach from one of inconsistency and ambivalence to one of outright hostility. In recent years, the United States, under the Trump administrations, has withdrawn from numerous international agreements and organizations, including the Joint Comprehensive Plan of Action (the "Iran nuclear deal"), the Paris Agreement on climate change, the World Health Organization, the Universal Postal Union, the United Nations Educational, Scientific and Cultural Organization, or UNESCO, and the United Nations Human Rights Council. It has also threatened to leave others, such as NATO, NAFTA, and the WTO. For Donald Trump, such institutions are part of the "ideology of globalism" that must be rejected. In addition to withdrawing from global governance institutions, the second Trump administration is also stripping the American state of many of its tools of international influence, such as the United States Agency for International Development, or USAID. The U.S. government has also attacked the International Criminal Court, placing its staff (and their family members) under sanctions. (Stephen, 2025, 150)
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> An additional indicator of the decline of global governance is a flagrant disregard for international law by major powers and their allies. The constitutive features of the international legal order—the sovereign equality and territorial integrity of states—appear increasingly to be challenged by major powers. Russian aggression has seen land war—including annexations and nuclear threats—return to Europe. China advances dubious territorial claims in the South China Sea with little basis in international law. The United States has threatened to use economic and military force to expand its territory, and its president has proposed to expel the Palestinian population of the Gaza Strip and acquire the land as part of "a real estate development for the future." Discourses associating great power sovereignty with domination over others have proliferated. (Stephen 2025, 151)

THE US PERSPECTIVE ON GLOBAL GOVERNANCE

In the US, global governance rarely finds reference in governmental discourses; it is rather part of scholarly discussions, and scholars have often discussed global governance with reference to the role of the United States in the world" (Dominguez, 2017, 236, 251). Within such discussions, often the US and global governance are discussed as mutually exclusive categories, suggesting that while the former is about hegemony and empire, the latter rather denotes a gradual loss in the state capacity to single-handedly tackle international problems thus a growing salience in multilateralism (diffusion of authority), to an extent even the non-state sector takes part within (Baumann and Dingwerth 2015).

Global governance is seen as a domain of power and authority sharing, to which the US is unwilling to engage due to its unrivalled military and economic supremacy – this is the ground on which global governance and the US are seen as mutually exclusive. From the perspective of James Rosenau, this amounted to the US's resistance to the transformation of the world into a 'multi-centric world' (something also called as the bifurcation of world politics) thus its supporting the persistence of its hierarchical structure, which fed the idea that the US adopts an imperial role in world politics (unilateralism against multilateralism) (Baumann and Dingwerth 2015, 108, 113). The dominant idea in US domestic politics was that global governance is a mechanism of authority sharing that threatens "American sovereignty" – those who favour it are those who believe in the necessity of multilateralism and a globalist agenda. Particularly by Trump administration, concomitant to the rise of a "globally active and connected radical righ… [which] associates global governance with unaccountable and malevolent liberal elites", Global Governance has become considered as a process unravelling the US's "global leadership position" – which in return has undermined "the effectiveness and perceived legitimacy of global governance institutions" (Stephen 2025, 150)

Global Governance is also understood as the legalization of world politics, with its institutionalization leading to the emergence of novel spheres of authority beyond the state. However, even in that, the US

is considered to be imposing its own national regulatory frameworks on the rest of the world under the guise of global regulations, which is termed 'global self-regulation in the context of American administrative law' (Baumann and Dingwerth 2015, 108, 118). Complementing this argument, in the institutions of global governance –as bodies involving interstate-governance, civil society governance, and market governance– the US, due to unequal distribution of power among the participants of Global Governance mechanisms, dominates the processes of international negotiations, thus the authority diffusion qualities within the Global Governance's regulatory function operate poorly (Baumann and Dingwerth 2015, 121).

However, the US and global governance were not always thought in exclusionary terms, in Krahmann's words:

> the US government seemed to support the emergence of a new system of global governance after its rise to the status of the "only surviving superpower." Both Presidents George H.W. Bush and Bill Clinton seemed to emphasize the need for international collaboration and the use of international organizations to promote the "new world order," which was to replace the realist international system of bipolarity and balance of power that had dominated the Cold War era (Dumbrell 2002:296; Jervis 2003:83). ….[however] The events of September 11, 2001 and the security policies of the current Bush administration appear to have challenged this vision of a new world order based on global governance. Although the cause of the attack was terrorism, that is, a transnational security threat, subsequent US policy responses seem to have moved away from the view that contemporary security threats require concerted action among state and nonstate actors. Conversely, the reaction of the US government appears to be more in line with traditional concepts of neorealist power politics than global governance. (Krahmann, 2005, 532)

THE CHINESE PERSPECTIVE ON GLOBAL GOVERNANCE

As the United States' visibility in global governance declines, China has expanded its influence within the United Nations, strengthened its partnerships across the Global South, and created new global governance institutions aligned with its interests and preferences. In response to this shift, however, the overall scope of global governance has narrowed, commitments have weakened, and institutional architectures have fragmented into partially competing arrangements (Stephen 2025, 146). Even further, the existing institutional structure became unable to balance the normative goals of global publics collaborating on issues requiring attention through jointly formed frameworks due to an ever-intensifying competition among powerful actors in the international order. This is the context, global governance is considered to be declining – a decline concomitant to that of the US's international leadership role, which was motivated by President Trump's push to "make America great again".

China has been responsive to the decline in Global Governance; in China's doing, discourses on the *liberal international order* have been replaced by a strong emphasis on *rule-based order*, suggesting a robust commitment to the multilateral opportunities international and regional organizations provide and to the necessity, particularly for great powers, of not acting unilaterally. From this, China champions the idea of "a global community of shared future," an alternative metanarrative to the liberal normative order. China's contributing to the institutionalization in both regional and UN-wide platforms, its pushes for integrating regional institutional arrangements to the UN as a governance platform, and still affirming the UN as the 'core' of the international system have all been to maintain the rule-based international order, yet with inevitable returns in terms of an increase in China's influence within the international system (Stephen 2025, 146). However, as a matter of fact, global governance is a relatively novel discussion within China's international relations, as Niall et al. observe: "China has been relatively late in formulating its role in global governance and has drawn on its domestic governance to delineate its contribution to, and view of, global governance" (2017, 162). This is because, in the historical

context, "China was sceptical when it comes to multilateral frameworks of governance" (Niall et al. 2017, 166), as the country saw them as imperial moves targeting the non-West, and was also more interested in bilateral relations. Yet, before the 1990s, China rarely used its veto right at the UN compared to other permanent members. This, however, has changed concomitant to the country's global opening.

Since the 1990s, China has become increasingly integrated into the global financial system and world economy, gradually opening its domestic markets and aligning its economic structures with global trade and investment flows. In this, a significant milestone was China's accession to the World Trade Organization (WTO) in 2001, which significantly accelerated its export-led growth and expanded its investment-driven soft power both in its immediate region and in more distant areas such as Africa. The 2008 global financial crisis further expanded China's opportunities for influence: while Western economies struggled with recession and instability, China emerged as a comparatively resilient actor with ample surpluses, enabling it to expand its financial presence abroad and to contribute more prominently to international financial institutions. At the same time, China has pursued a more outward-looking and integrated foreign policy approach, framed around building trust, fostering long-term partnerships, and contributing to the development trajectories of cooperating countries. Initiatives such as the Belt and Road Initiative (BRI) expanded China's development financing and, relatedly, strengthened its diplomatic engagement, reinforcing China's growing visibility and influence within global governance. This is the context in which China's engagement with global governance increased, as the country became a key defender of the interests of the Global South by extensively using global governance platforms. Accordingly, within the WTO, as the key forum for global financial governance, China has gradually become a representative of developing countries, pushing Northern countries to engage with demands for fairer trade rules, lower trade barriers, fairer market-access commitments, and more equitable treatment within the global trading system (Callahan 2016). In the G20, China has acted as an active agenda-setter, yet has prioritized issues such as climate change and energy security, which are crucial to its own development model. Through the principle of "common but differentiated responsibilities," China has used the G20 to advocate for governance arrangements that protect the interests of developing countries while expanding its global leadership role (Niall et al. 2017, 167).

Along with global governance, China, together with other BRICS countries, has also shown interest in regional governance mechanisms (Kahler 2018). Notably, as part of this regional governance practice, there experienced a proliferation of institutions created or led by emerging powers—including Brazil's Union of South American Nations, China's Asian Infrastructure Investment Bank (AIIB), and the BRICS mechanisms such as the New Development Bank and the Contingent Reserve Arrangement. These initiatives have frequently arisen from dissatisfaction with existing global institutions perceived as being dominated by the industrialized North.

In short, the vacuum created by the US's reluctance and the concomitant decline in global governance has thus been attempted to be filled with China's increasing involvement in global governance (Patrick 2014).

IN LIEU OF CONCLUSION

The rise of populism and anti-globalism globally has undermined expectations for the advancement of global governance-based cooperation, and yet China's attempts to fill the power vacuum and thereby strengthen global governance are widely viewed as falling short. Although China appears committed to multilateralism, its approach remains strongly state-centric. As a result, it lacks the capacity and institutional orientation needed to advance the participatory dimensions of global governance, where engagement with nongovernmental actors is essential. What to expect then? Matthew Stephen (2025, 152-3) outlines three potential paths global governance may take: (i) global governance may retain only a thin layer of universal rules (as seen in the WTO) while deeper, sometimes competing arrangements

emerge at regional levels. Sensitive issues—such as democracy and human rights—may increasingly be excluded from global discussion when consensus proves impossible. (ii) When binding rules become too difficult to negotiate or enforce, states may turn to voluntary, nonbinding, and more adaptable frameworks, as seen in the climate regime negotiations. There should thus be an experience of a shift toward informal and flexible governance. (iii) As global governance weakens, major powers may become rather relying more on regional organizations or exclusive "clubs" to pursue their interests. The result would be a more fragmented, regionally centred, and complex institutional landscape globally in which regional and rival institutional orders would rise.

REFERENCES

Baumann, R., & Dingwerth, K. (2015). Global governance vs. empire: Why world order moves towards heterarchy and hierarchy. *Journal of International Relations and Development, 18*, 104–128.

Bolton, J. R. (2000). Should we take global governance seriously? *Chicago Journal of International Law, 1*(2), 205–221.

Callahan, W. A. (2016). China's "Asia Dream": The Belt Road Initiative and the new regional order. *Asian Journal of Comparative Politics, 1*(3), 226–243.

Domínguez, R. (2017). The debate on global governance in the United States. In A. Triandafyllidou (Ed.), *Global governance from regional perspectives: A critical view* (pp. 233–255). Oxford University Press.

Duggan, N., Shen, W., & Gottwald, J.-C. (2017). Global governance with Chinese characteristics? In A. Triandafyllidou (Ed.), *Global governance from regional perspectives: A critical view* (pp. 161–180). Oxford University Press.

Ikenberry, G. J. (2014). The quest for global governance. *Current History: A Journal of Contemporary World Affairs, 113*(759), 16–18.

Kahler, M. (2018). Global governance: Three futures. *International Studies Review, 20*, 239–246.

Krahmann, E. (2005). American hegemony or global governance? Competing visions of international security. *International Studies Review, 7*, 531–545.

Patrick, S. (2014). The unruled world: The case for good enough global governance. *Foreign Affairs, 93*(1), 58–73.

Sparke, M. (2022). Reactionary anti-globalism: The crisis of globalisation. In R. Ballard & C. Barnett (Eds.), *The Routledge handbook of social change* (pp. 19–33). Routledge.

Stephen, M. (2025). The diffusion of global power and the decline of global governance. *Ethics & International Affairs, 39*(2), 145–158.

Schaffer, T. (2009). The United States, India, and global governance: Can they work together? *The Washington Quarterly, 32*(3), 71–87. https://doi.org/10.1080/01636600903035118

The White House. (2025, November). *National Security Strategy of the United States of America*. https://www.whitehouse.gov/wp-content/uploads/2025/12/2025-National-Security-Strategy.pdf

UN News. (2018, September 25). *US President Trump rejects globalism in speech to UN General Assembly's annual debate*. https://news.un.org/en/story/2018/09/1020472

ENGELLİLER FARKINDALIK HAFTASI KAPSAMINDA TASARLANAN TİPOGRAFİK POSTERLERDE YAPAY ZEKA VE ÖĞRENCİ ÜRETİMLERİNİN KARŞILAŞTIRMALI ANALİZİ

COMPARATIVE ANALYSIS OF AI AND STUDENT PRODUCTIONS IN TYPOGRAPHIC POSTERS DESIGNED FOR THE DISABILITY AWARENESS WEEK

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ÖZET

Bu çalışma, görsel iletişim tasarımı alanındaki en güncel ve tartışılan konulardan birine odaklanmaktadır: Yapay Zekâ (YZ) tabanlı araçlar tarafından üretilen tasarımlar ile insan tasarımcılar (öğrenciler) tarafından geliştirilen çözümler arasındaki niteliksel farklılıklar. Çalışmanın ana odağı, özellikle sosyal farkındalık ve hassasiyet gerektiren bir tema olan Engellilik Farkındalık Haftası için oluşturulan tipografik posterlerdir. YZ araçlarının hızla yaygınlaşmasıyla birlikte, bu araçların karmaşık sosyal mesajları nasıl görselleştirdiği ve dönüştürdüğünü değerlendirmek bir zorunluluk haline gelmiştir.

Araştırma, ortaya çıkan görsel sonuçları sistematik olarak değerlendirmek için karşılaştırmalı tasarım analizi yöntemini benimsemiştir. Bu bağlamda, tema için özel olarak oluşturulmuş beş öğrenci posteri ve beş YZ posteri ayrıntılı olarak incelenmiştir. Karşılaştırma, dört temel tasarım kriterine dayanmaktadır: tipografik hiyerarşi, kompozisyon yapısı, mesajın netliği ve sosyal temanın duygusal/bağlamsal olarak oluşturulması.

Analizler, yapay zekanın özellikle tipografik düzenleme, denge ve negatif alan kullanımında sistematik ve biçimsel bir yaklaşım sergileyerek teknik olarak yüksek kaliteli, tutarlı ve hızlı çözümler ürettiğini ortaya koymaktadır. Bu sistematik yapının aksine, öğrenci tasarımları daha deneysel, yaratıcı riskler içeren ve nihayetinde tipografik kararlarında özgün, kişiselleştirilmiş ifadeler elde eden sonuçlar geliştirmiştir. En çarpıcı farklılık, temaya yaklaşımda yatmaktadır. Öğrencilerin tasarımları sosyal bağlamla daha empatik, insancıl ve derinden bağlantılı bir yaklaşım sergilerken, yapay zekanın konuyu ele alırken daha genel ve evrensel sembollerle sınırlı kaldığı gözlemlenmiştir. Bu durum, insan tasarımcının yorumlama gücünün, duygusal zekasının ve etik bağlam bilgisinin, sosyal açıdan yüklü tasarımlarda belirleyici ve ayırt edici bir faktör olmaya devam ettiğini kanıtlamaktadır.

Bulgular, yapay zekanın tasarım sürecinde önemli bir teknik destek aracı olarak kullanılabileceğini göstermektedir; ancak sosyal duyarlılık gerektiren projelerde, derinlik, özgünlük ve etik bağlam açısından insan üretiminin katkısı vazgeçilmez bir değer taşımaktadır.

Anahtar Kelimeler: Tipografik Poster; Engellilik Farkındalık Haftası; Yapay Zeka

ABSTRACT

This study focuses on one of the most current and debated topics in the field of visual communication design: the qualitative differences between designs produced by Artificial Intelligence (AI)-based tools and the solutions developed by human designers (students). The main focus of the study is the typographic posters created for the Disability Awareness Week, a theme that requires particular social awareness and sensitivity. With the rapid proliferation of AI tools, it has become a necessity to evaluate how these tools visualize and transform complex social messages.

The research adopted the comparative design analysis method to systematically evaluate the resulting visual outcomes. In this context, five student posters and five AI posters, specifically created for the theme, were examined in detail. The comparison was based on four fundamental design criteria: typographic hierarchy, composition structure, clarity of the message, and the emotional/contextual establishment of the social theme.

The analyses reveal that AI produces technically high-quality, consistent, and rapid solutions, exhibiting a systematic and formal approach, especially in typographic arrangement, balance, and the use of negative space. In contrast to this systematic structure, student designs developed results that were more experimental, involved creative risks, and ultimately achieved original, personalized expressions in their typographic decisions. The most striking divergence lies in the approach to the theme. While students' designs demonstrated a more empathetic, humane, and deeply connected approach to the social context, the AI was observed to be limited to more generic and universal symbols when addressing the subject. This situation proves that the interpretive power, emotional intelligence, and ethical contextual knowledge of the human designer remain a decisive and differentiating factor in socially charged designs.

The findings indicate that AI can be used as a significant technical support tool in the design process; however, in projects requiring social sensitivity, the contribution of human production, in terms of depth, originality, and ethical context, presents an indispensable value.

Key Words: Typographic Poster; Disability Awareness Week; Artificial Intelligence;

GİRİŞ

Grafik Tasarımı bugün çok net bir dönüşümün içinde yer almaktadır. Yapay zeka. Yapay zekânın tek bir tanımı olmamakla birlikte, akıl yürütme, problem çözme ve analiz gibi üst düzey bilişsel süreçleri gerçekleştirebilmesi yapay zekâ olarak değerlendirilmektedir (Arslan, 2020, s. 77). Yapay zekâ, insan zekâsının özelliklerini taklit eden ve makineleri zeki hale getiren bir bilim dalıdır. Temel hedefi, bilgisayar sistemlerinin öğrenme, muhakeme yapma, görüntü ve örüntü tanıma gibi bilişsel becerilerle karmaşık problemleri çözmesini sağlamaktır (Öztemel, 2020, s. 101).

Koçyiğit ve Darı (2023, s. 428)'ya göre yapay zekâ, insan zekâsı gerektiren bilişsel işlevleri yerine getirebilen sistemlerdir.Yapay zeka tabanlı araçların tasarım pratiğine bu denli hızlı girmesi, tasarımcının üretim alışkanlıklarını ve düşünme biçimini doğrudan etkiliyor. Dijitalleşme, yapay zekâ

gibi üretken teknolojilerle birlikte ele alındığında üretkenliği ve verimliliği önemli ölçüde artırmaktadır (Akman & Ceviz, 2025, s. 18). Flusser (2011), teknik görüntülerin yalnızca üretim araçları olmadığını tasarımcının düşünme süreçlerini ve yaratıcı kararlarını yönlendiren yapılar olarak işlediğini belirtmektedir. Yapay zekâ, internet ortamında yer alan milyonlarca görseli inceleyerek bu görsellerin desen yapılarını analiz etmekte; böylece öğrenme kapasitesini ve çalışma biçimini geliştirmekte ve daha işlevsel hâle getirmektedir (Çeken & Şen, 2023, s. 138). Yapay zekâ teknolojileri, pek çok alanda olduğu gibi tasarım süreçlerinde de üretkenliği ve verimliliği artırmakta, tasarımcıların çalışmalarını destekleyen olumlu katkılar sunmaktadır (Şekerli & Tuker, 2024, s. 135). Midjourney, DALL E ve Stable Diffusion gibi görüntü üretim modelleri ile ChatGPT ve Gemini gibi dil temelli sistemlerin görsel üretime uzanan kapasiteleri, kısa süre içinde nitelikli tipografik posterler ve afişler üretmeyi mümkün kılmaktadır. Tasarım sürecinde eskiden uzun deneme yanılmalarla ulaşılan birçok sonuç, bugün birkaç yönlendirme ile ortaya çıkabilmektedir. Bu durum tasarımı daha erişilebilir hale getirirken, aynı zamanda tasarımın yalnızca biçimsel bir çıktıdan ibaret olup olmadığı sorusunu da yeniden gündeme taşımaktadır.

Bugünün koşullarında yapay zekâ, birçok alanda etkisini hissettirmeye başlamıştır. Henüz insan zekâsını tüm yönleriyle karşılayan bir yapıdan söz edilemese de, ihtiyaçlara yanıt verebilen temel işlevlerin büyük ölçüde geliştirildiği görülmektedir (Karaşahinoğlu, 2020, s. 616)Bir grafik tasarımcı açısından bakıldığında, mesele yalnızca düzgün hizalanmış tipografi ya da dengeli bir kompozisyon üretmek değildir. Tasarım, içinde bulunduğu toplumsal bağlamı okuyabilen, izleyiciyle empati kurabilen ve etik bir sorumluluk taşıyan bir anlatım biçimidir. Margolin, grafik tasarımın yalnızca estetik bir düzenleme pratiği olmadığını; toplumsal sorunlara duyarlı, etik sorumluluk taşıyan ve izleyiciyle empatik bir ilişki kurması gereken bir iletişim alanı olduğunu vurgulamaktadır (Margolin, 2002). Özellikle Engellilik Farkındalık Haftası gibi hassas temalarda bu ayrım daha görünür hale gelmektedir. Yapay zekanın ürettiği görseller çoğu zaman evrensel sembollere yaslanan, güvenli ve tanıdık bir görsel dil sunmaktadır. Bu durum, tasarımcının toplumsal bağlamı derinlemesine okuyarak etik olarak sorumlu görsel seçimler yapması gerektiğini yeniden gündeme getirir. Sorumlu yapay zekâ kullanımı ve grafik tasarımın etik boyutları üzerine yapılan çalışmalar, yapay zekânın teknik faydaları olduğu kadar sosyal ve etik sorumluluklar barındırdığını vurgulamaktadır (Şen Atiker, 2024). Buna karşılık insan tasarımcı, kişisel gözlemlerini, sezgilerini ve yaşanmışlıklarını tasarıma taşıyarak mesajı daha derinlikli bir şekilde kurabilmektedir. Bu fark, niceliksel değil niteliksel bir ayrımı işaret etmektedir. Literatürde yapay zekanın tasarım alanındaki etkisini ele alan çalışmalar da bu ikili yapıya dikkat çekmektedir. Manovich, yapay zeka destekli üretimlerin biçimsel tutarlılık ve hız açısından sunduğu avantajları kabul ederken, yaratıcılığın giderek post insan bir zeminde yeniden tanımlandığını tartışmaktadır (Manovich, 2020). Benzer şekilde Zylinska, yapay zeka ile üretilen görsellerin estetik olarak güçlü olsa da etik ve bağlamsal derinlik konusunda soru işaretleri barındırdığını vurgulamaktadır (Zylinska, 2024, s. 20).

Bu çalışma, söz konusu tartışmaların tam ortasında konumlanmakta ve metin tabanlı yapay zeka araçlarının görsel üretim kapasitelerini, görsel iletişim tasarımı öğrencilerinin el emeğine dayalı poster çalışmalarıyla birlikte ele almaktadır. Araştırma kapsamında Engellilik Farkındalık Haftası teması etrafında üretilmiş beş öğrenci posteri ile ChatGPT ve Gemini aracılığıyla, aynı tema için standartlaştırılmış yönlendirmelerle oluşturulmuş beş yapay zeka posteri karşılaştırmalı olarak incelenmektedir. Öğrencilerin tasarımlarında mesajın yalnızca görülmesi değil hissedilmesi de hedeflenmekte, bu da sosyal temanın izleyiciyle daha güçlü bir bağ kurmasına olanak tanımaktadır. Bu durum, özellikle toplumsal duyarlılık gerektiren konularda insan tasarımcının yorumlama gücünün hâlâ belirleyici olduğunu göstermektedir. Amaç, yapay zekanın tasarımcıyı ikame eden bir unsurdan ziyade, süreci hızlandıran ve destekleyen bir araç olarak ele alınması gerektiğini savunmaktadır. Tasarım eğitimi

bağlamında önemli olan, yapay zekayı dışlamak ya da sınırsızca kullanmak değil, onu bilinçli ve eleştirel bir şekilde tasarım sürecine dahil edebilmektir. Görsel iletişim tasarımının geleceği, teknolojik olanaklar ile insan empatisinin, sezgisinin ve etik farkındalığının dengeli bir biçimde bir araya geldiği bu ortak üretim alanında şekillenmektedir. ChatGPT ve Gemini'ye verilen standartlaştırılmış prompt'larla üretilmiş beş YZ posteri üzerinden dört temel kriteri tipografik hiyerarşi, kompozisyon yapısı, mesaj netliği ve sosyal temanın duygusal/bağlamsal inşası– sistematik bir karşılaştırmalı analizle değerlendirmektedir.

YÖNTEM

Çalışma, grafik tasarım eğitimi bağlamında yapay zeka temelli üretimler ile insan merkezli tasarım süreçleri arasındaki nitel farklılıkları ortaya koymayı amaçlayan nitel bir çalışma olarak kurgulanmıştır. Çalışmada nicel ölçümlere dayalı bir değerlendirme yerine, tasarımların anlam üretme biçimleri, görsel karar süreçleri ve sosyal temayı aktarma düzeyleri ön plana alınmıştır. Bu doğrultuda araştırma yaklaşımı olarak nitel araştırma desenlerinden karşılaştırmalı görsel analiz yöntemi tercih edilmiştir. Araştırmanın örneklemini, Engellilik Farkındalık Haftası teması kapsamında üretilmiş toplam on adet tipografik poster oluşturmaktadır. Bu posterlerin beşi, grafik tasarım eğitimi alan lisans düzeyindeki öğrenciler tarafından hazırlanmıştır. Öğrenci çalışmalarında dijital tasarım yazılımları kullanılmış olmakla birlikte, tipografi, kompozisyon ve görsel anlatı ile ilgili tüm tasarım kararları öğrencilerin bireysel yorumlarına ve el emeğine dayalı tasarım süreçlerine dayanmaktadır. Diğer beş poster ise aynı tema doğrultusunda ChatGPT ve Gemini gibi yapay zeka araçları kullanılarak üretilmiştir. Yapay zeka destekli üretimlerde, karşılaştırmanın adil ve tutarlı biçimde yapılabilmesi amacıyla her iki sistem için de öğrencilere verilen proje brief'iyle kavramsal olarak örtüşen, standartlaştırılmış yönlendirmeler kullanılmıştır. Bu yönlendirmeler, tipografinin ana anlatım aracı olarak konumlandırıldığı, sembolik unsurların ise yalnızca destekleyici nitelikte ele alındığı bir tasarım çerçevesi sunmaktadır. Öğrenci brief'i ile yapay zekaya verilen brief'in içeriği, yöntem bölümünde "Uygulama Süreci ve Kullanılan Brief'ler" başlığı altında tablo hâlinde sunulmuştur. Yapay zeka üretim sürecinde elde edilen posterler üzerinde herhangi bir görsel, tipografik ya da kompozisyonel müdahalede bulunulmamış, çıktılar üretildikleri hâliyle analiz sürecine dâhil edilmiştir. Aynı şekilde öğrenci tasarımları da sonradan iyileştirme ya da düzenleme yapılmaksızın değerlendirilmiştir. Bu yaklaşım, her iki üretim biçiminin doğal tasarım reflekslerinin korunmasını amaçlamaktadır. Veri toplama sürecinin ardından analiz aşamasına geçilmiş ve posterler grafik tasarımın temel ilkeleri doğrultusunda belirlenen dört ana ölçüt çerçevesinde incelenmiştir. Bu ölçütler tipografik hiyerarşi, kompozisyon yapısı, mesajın iletim netliği ve sosyal temanın duygusal ve bağlamsal aktarımıdır. Tipografik hiyerarji kapsamında yazı karakteri seçimi, punto ilişkileri, vurgu alanları ve okunabilirlik düzeyi değerlendirilmiştir. Kompozisyon yapısı başlığı altında görsel denge, boşluk kullanımı, görsel akış ve odak noktalarının oluşturulma biçimi ele alınmıştır. Mesaj netliği ölçütünde izleyicinin posteri ilk karşılaşmada algıladığı temel düşüncenin açıklığı ve iletim gücü incelenmiştir. Sosyal temanın duygusal ve bağlamsal aktarımı ise tasarımların empati kurma kapasitesi, klişe sembollere yaslanma düzeyi ve toplumsal duyarlılığı yansıtma biçimi üzerinden yorumlanmıştır. Analiz süreci betimsel ve yorumlayıcı bir yaklaşımla yürütülmüştür. Her poster belirlenen ölçütler doğrultusunda ayrı ayrı ele alınmış, ardından grafik tasarım öğrencilerinin üretimleri ile yapay zeka destekli tasarımlar arasında nitel karşılaştırmalar yapılmıştır. Bulgular sayısal üstünlükler üzerinden değil, tasarımların sunduğu ifade gücü, özgünlük ve empatik derinlik gibi nitel özellikler üzerinden değerlendirilmiştir. Bu yöntem doğrultusunda elde edilen veriler, grafik tasarım

eğitiminin geleceği ve yapay zekanın tasarım sürecindeki konumu bağlamında tartışılmış; sonuç bölümünde, yapay zekanın grafik tasarım eğitiminde destekleyici bir araç olarak nasıl konumlandırılabileceğine ilişkin hibrit üretim modellerine yönelik öneriler geliştirilmiştir

BULGULAR

Engelliler Farkındalık Haftası teması kapsamında üretilmiş tipografik posterlere ilişkin bulgular, grafik tasarım öğrencilerinin el emeğine dayalı çalışmaları ile ChatGPT ve Gemini aracılığıyla oluşturulmuş yapay zeka destekli tasarımlar üzerinden elde edilmiştir. Posterler, yöntem bölümünde belirlenen ölçütler doğrultusunda ayrı ayrı ve karşılaştırmalı olarak incelenmiştir. Bulgular; tipografik hiyerarji, kompozisyon yapısı, mesajın iletim netliği ve sosyal temanın duygusal ve bağlamsal aktarımı başlıkları altında yapılandırılmıştır. İnceleme sürecinde, her iki üretim biçiminde öne çıkan ortak eğilimler ile belirgin ayrışma noktaları betimleyici bir yaklaşımla ortaya konmuş, elde edilen bulgular tartışma bölümüne zemin oluşturacak şekilde düzenlenmiştir.

Öğrenci Tasarımları

Şekil 1. Öğrenci Çalışması (A)

Öğrenci (A) tarafından üretilen tipografik poster (Şekil 1), Engelliler Farkındalık Haftası teması kapsamında tipografinin anlam kurucu bir unsur olarak konumlandırıldığı bir tasarım yaklaşımı sunmaktadır. Çalışmada ana kavram olan “ENGEL” sözcüğünün blok bir yapı oluşturacak biçimde üst üste yerleştirilmesi, tipografik hiyerarjinin tek bir kavram etrafında yoğunlaştığını göstermektedir. Harflerin hacimsel bir kütle algısı yaratacak biçimde kullanılması, tipografinin yalnızca okunabilir bir metin değil, aynı zamanda görsel bir engel olarak algılanmasına olanak tanımaktadır.

Kompozisyon yapısı incelendiğinde, afişte belirgin bir dikey akışın tercih edildiği görülmektedir. Alt bölümde konumlandırılan insan figürü ile yukarı doğru yükselen tipografik kütle arasında kurulan ölçek ilişkisi, engel kavramının birey üzerindeki etkisini görsel olarak desteklemektedir. Boşluk kullanımının sınırlı ancak kontrollü olması, izleyicinin dikkatini merkezde yer alan tipografik yapı üzerinde toplamaktadır. Bu kompozisyon kurgusu, anlatının alttan üste doğru ilerleyen bir görsel akışla okunmasına olanak tanımaktadır. Mesajın iletiminde, çalışmanın doğrudan açıklayıcı bir metin kullanmadığı, bunun yerine görsel metafor aracılığıyla anlam ürettiği gözlemlenmektedir. Tipografinin üç boyutlu bir engel hissi verecek şekilde kurgulanması, izleyicinin mesajı sezgisel düzeyde algılamasını sağlamaktadır. Bu yaklaşım, mesajın açıkça ifade edilmesinden ziyade yorumlanarak çözümlenmesini gerektiren bir iletişim dili oluşturmaktadır. Sosyal temanın duygusal ve bağlamsal aktarımı açısından değerlendirildiğinde, çalışmanın dramatik ya da klişe sembollerden kaçındığı görülmektedir. Engel kavramı, mağduriyet temsilleri yerine ilerleme ve durdurulma metaforu üzerinden ele alınmış; insan figürü anlatıyı destekleyici bir unsur olarak konumlandırılmıştır. Bu durum, empatiyi doğrudan dayatan bir anlatım yerine, izleyiciyi düşünmeye yönlendiren daha dolaylı bir duygusal aktarım sağlamaktadır.

Genel bulgular doğrultusunda, Öğrenci (A) çalışmasının tipografi odaklı bir anlatı kurduğu, sembolik unsurları ikincil düzeyde tuttuğu ve yöntem bölümünde belirlenen ölçütlerle uyumlu bir tasarım yaklaşımı sergilediği görülmektedir.

Şekil 2. Öğrenci Çalışması (B)

Çalışmada (Şekil 2) ana kavram olan "ENGEL" sözcüğü, kompozisyonun merkezine yerleştirilmiş ve harf formları aynı zamanda farklı engellilik durumlarını temsil eden figürlerle ilişkilendirilmiştir. Bu yaklaşım, tipografinin yalnızca bir yazı alanı değil, anlatıyı taşıyan bir yapı olarak ele alındığını göstermektedir. Tipografik hiyerarji açısından değerlendirildiğinde, "ENGEL" kelimesinin büyük puntolu ve koyu tonlu bir biçimde vurgulandığı görülmektedir. Harflerin iç yüzeylerine yerleştirilen figüratif anlatımlar, ana tipografik formu bölmeden, onunla bütünleşik bir şekilde konumlandırılmıştır. Bu durum, tipografinin okunabilirliğini korurken aynı zamanda görsel çeşitlilik sağlamaktadır. Hiyerarşik yapı, tek bir kavram etrafında yoğunlaşmakta ve ikincil metinlere yer verilmemesiyle sade bir anlatım dili oluşturulmaktadır. Kompozisyon yapısı incelendiğinde, afişte dengeli ve merkezi bir yerleşimin tercih edildiği görülmektedir. Dikey eksen üzerinde konumlandırılan tipografik yapı, alt bölümde yer alan basamak formuyla birlikte yukarı doğru bir hareket hissi yaratmaktadır. Harflerin alt alta dizilmesi, izleyicinin bakışını kontrollü bir şekilde yönlendirmekte ve kompozisyonun bütünlüğünü desteklemektedir. Negatif alan kullanımı, tipografik formun net bir biçimde algılanmasına olanak tanımaktadır. Mesajın iletim netliği açısından, çalışmanın doğrudan ve okunabilir bir anlatım sunduğu gözlemlenmektedir. Tipografik formun içerisine yerleştirilen figürler, engellilik temasını farklı boyutlarıyla görünür kılmakta ve mesajın izleyici tarafından hızlı biçimde kavranmasına katkı sağlamaktadır. Bu durum, mesajın metaforik olduğu kadar açıklayıcı bir düzeyde de iletildiğini göstermektedir. Sosyal temanın duygusal ve bağlamsal aktarımı değerlendirildiğinde, çalışmanın farklı engellilik durumlarını tek bir yapı içerisinde bir araya getirdiği görülmektedir. Figürlerin harf formlarıyla bütünleşik şekilde kullanılması, engelliliği ayrıştırıcı bir unsur olarak değil, toplumsal bir gerçeklik olarak ele alan kapsayıcı bir yaklaşım sunmaktadır. Dramatik ya da aşırı duygusal anlatımlardan kaçınılması, çalışmanın daha dengeli ve saygılı bir görsel dil kurmasına olanak tanımaktadır.

Genel bulgular doğrultusunda, Öğrenci (B) çalışmasının tipografi ve sembolik anlatımı dengeli biçimde bir araya getirdiği, mesajı doğrudan ve okunabilir bir düzeyde aktardığı ve yöntem bölümünde belirlenen ölçütlerle uyumlu bir tasarım yaklaşımı sergilediği görülmektedir.

Şekil 3. Öğrenci Çalışması (C)

Öğrenci (C) tarafından üretilen tipografik poster (Şekil 3), Engelliler Farkındalık Haftası teması kapsamında tipografinin kavramsal bir anlatım aracı olarak kullanıldığı bir tasarım yaklaşımı sunmaktadır. Çalışmada "TEK ENGEL DÜŞÜNCE" ifadesi, poster yüzeyine yatay bir düzen içerisinde yerleştirilmiş; harf formlarına eşlik eden noktasal yapılar aracılığıyla kör bireylerin kullandığı Braille alfabesine doğrudan bir gönderme yapılmıştır. Bu yaklaşım, engellilik temasının hem görsel hem de kavramsal düzlemde ele alındığını göstermektedir.

Tipografik hiyerarji incelendiğinde, metnin bütüncül bir yapı içerisinde ele alındığı ve sözcükler arasında belirgin bir baskınlık kurulmadığı görülmektedir. "TEK ENGEL DÜŞÜNCE" ifadesinin tek bir söylem olarak algılanması, mesajın parçalanmadan okunmasına olanak tanımaktadır. Noktasal Braille öğelerinin harf formlarına eşlik edecek biçimde kullanılması, tipografik yapının okunurluğunu tamamen bozmayacak ölçüde konumlandırılmıştır. Kompozisyon yapısı açısından değerlendirildiğinde, çalışmanın sade ve kontrollü bir yüzey kurgusuna sahip olduğu görülmektedir. Metnin merkezî yerleşimi ve çevresindeki boşluk kullanımı, tipografik düzenin net biçimde algılanmasını sağlamaktadır. Nokta alfabesini çağrıştıran unsurların düzenli bir sistem içerisinde yerleştirilmesi, kompozisyonun dağılmasını engellemekte ve bütünlüğü korumaktadır. Mesajın iletim netliği bakımından, çalışmanın ilk

bakışta okunabilir bir tipografik düzen sunduğu gözlemlenmektedir. Noktasal Braille öğeleri, mesajın anlaşılmasını zorlaştıran bir unsur olarak değil, metnin kavramsal derinliğini artıran bir katman olarak işlev görmektedir. "Tek engel düşünce" ifadesi, hem görsel okuma hem de Braille'e yapılan gönderme üzerinden çok katmanlı bir iletişim kurmaktadır. Sosyal temanın duygusal ve bağlamsal aktarımı incelendiğinde, çalışmanın engellilik temasını görme engelliler özelinde ele aldığı görülmektedir. Braille alfabesine yapılan gönderme, engelliliği soyut bir kavram olarak değil, gündelik yaşam pratikleriyle ilişkili bir gerçeklik olarak sunmaktadır. Bu yaklaşım, empatiyi dramatik anlatımlar yerine farkındalık ve düşünme üzerinden kuran bir görsel dil oluşturmaktadır.

Genel bulgular doğrultusunda, Öğrenci (C) çalışmasının tipografiyi kavramsal bir söylem aracı olarak kullandığı, Braille alfabesini anlamı güçlendiren bir unsur olarak tasarıma entegre ettiği ve yöntem bölümünde tanımlanan ölçütlerle uyumlu bir tipografik çözüm sunduğu görülmektedir.

Şekil 4. Öğrenci Çalışması (D)

Çalışmada insan beyninin anatomik çizimi, tek başına ve merkezî bir görsel olarak kullanılmış; tipografik bir ifade yer almaksızın görsel metafor üzerinden anlam kurulmuştur. Bu tercih, engelin fiziksel koşullardan ziyade düşünsel süreçlerle ilişkilendirildiğine işaret etmektedir. Kompozisyon yapısna göre, beynin poster yüzeyine merkezî ve dengeli bir biçimde yerleştirildiği görülmektedir. Çevresel boşlukların geniş tutulması, görselin net algılanmasına olanak tanımakta ve izleyicinin dikkatini doğrudan ana forma yönlendirmektedir. Çizgisel anlatımın sade ve kontrollü olması, kompozisyonun bütünlüğünü desteklemektedir. Mesajın iletim netliği açısından değerlendirildiğinde, çalışmanın metinsel bir yönlendirme sunmadığı, mesajı tamamen görsel çağrışım üzerinden aktardığı gözlemlenmektedir. Beyin imgesi, düşünce, algı ve zihinsel engel kavramlarıyla ilişkilendirilmeye açık bir sembol olarak konumlandırılmıştır. Bu durum, izleyicinin posteri yorumlayarak anlamlandırmasını gerektiren dolaylı bir iletişim dili oluşturmaktadır. Çalışmanın engellilik temasını dramatik ya da figüratif insan temsilleri üzerinden ele almadığı görülmektedir. Beyin görseli aracılığıyla engel kavramı, düşünce ve algı süreçleriyle ilişkilendirilmiş; izleyicinin zihinsel farkındalığına odaklanan bir anlatım tercih edilmiştir. Bu yaklaşım, empatiyi duygusal yoğunluk yerine kavramsal düşünme üzerinden kurmaktadır.

Genel bulgular doğrultusunda, Öğrenci (D) çalışmasının tipografik bir anlatım yerine görsel metafora dayalı bir çözüm sunduğu, engellilik temasını zihinsel boyut üzerinden ele aldığı ve mesajı izleyicinin yorumuna açık bir biçimde aktardığı görülmektedir. Bu yönüyle çalışma, tipografi odaklı proje çerçevesinden kısmen ayrışan, ancak kavramsal farkındalık üretmeyi amaçlayan bir tasarım yaklaşımı sergilemektedir.

Şekil 5. Öğrenci Çalışması (E)

Öğrenci (E) tarafından üretilen tipografik poster, Engelliler Farkındalık Haftası teması kapsamında tipografi ile sembolik anlatımın doğrudan ilişkilendirildiği bir tasarım örneği sunmaktadır. "ENGEL" kelimesinin harfleri dikey bir eksen boyunca yerleştirilmiş; harf formları, görme engellilerle ilişkilendirilen baston, yürüme figürü ve yönlendirici çizgilerle bütünleştirilmiştir. Bu kurgu, kelimenin yalnızca okunmasını değil, adım adım deneyimlenen bir kavram olarak algılanmasını sağlamaktadır. Kompozisyonun ilk bakışta sunduğu yapı, izleyiciyi yukarıdan aşağıya doğru yönlendiren güçlü bir dikey akış üzerine kuruludur. Harflerin arasına yerleştirilen figüratif unsurlar, bu akışı kesintiye uğratmadan desteklemekte ve görsel süreklilik oluşturmaktadır. Boşluk kullanımı sınırlı tutulmuş; tüm yüzey, kontrollü bir yoğunlukla değerlendirilmiştir. Bu tercih, izleyicinin dikkatini tipografik yapıdan

uzaklaştırmadan kompozisyon içinde tutmaktadır. Tipografik hiyerarji açısından bakıldığında, "ENGEL" sözcüğünün tüm yüzeye yayılan baskın bir yapı oluşturduğu görülmektedir. Harflerin kalın, net ve yüksek kontrastlı biçimde kullanılması, okunabilirliği güçlendirmektedir. Figüratif öğeler, harflerle ölçek açısından uyumlu biçimde ele alınmış; tipografinin önüne geçmeyen, anlamı pekiştiren bir rol üstlenmiştir. Mesajın iletiminde, çalışmanın doğrudan ve anlaşılır bir anlatım benimsediği gözlemlenmektedir. Görme engelli figürüne eşlik eden baston ve yön çizgileri, engel kavramını dolaylı metaforlar yerine günlük yaşam pratikleri üzerinden görünür kılmaktadır. Bu durum, izleyicinin mesajı kısa sürede algılamasına olanak tanımaktadır. Sosyal temanın duygusal ve bağlamsal aktarımı değerlendirildiğinde, çalışmanın engellilik temasını dramatize etmeden, sade ve öğretici bir görsel dil kullandığı görülmektedir. Figür ve tipografi arasındaki ilişki, engelliliği pasif bir durum olarak değil, yön bulma ve hareket etme deneyimi üzerinden ele alan bir anlatım sunmaktadır. Bu yaklaşım, farkındalığı duygusal yoğunluk yerine günlük yaşama dair somut göstergeler aracılığıyla kurmaktadır.

Genel bulgular doğrultusunda, Öğrenci (E) çalışmasının tipografiyi taşıyıcı bir yapı olarak kullandığı, sembolik unsurları kontrollü biçimde entegre ettiği ve mesajı açık bir görsel dil aracılığıyla aktardığı görülmektedir. Bu özellikler, çalışmanın yöntem bölümünde tanımlanan ölçütlerle uyumlu bir tasarım yaklaşımı sunduğunu göstermektedir.

Yapay Zeka Üretimi Tasarımlar

Şekil 6. Yapay Zeka Çalışması- Gemini (A)

Yapay zeka tarafından üretilen bu tipografik poster, Engelliler Haftası temasını farkındalık ve eşitlik kavramları üzerinden açık ve düzenli bir görsel yapı içinde sunmaktadır. "FARKINDALIK" ve "EŞİTLİK" ifadeleri büyük punto ve yüksek kontrastla vurgulanmış; "ENGELLİLER HAFTASI" başlığı ve tarih bilgisi ikincil düzeyde konumlandırılmıştır. Bu yapı, mesajın hızlı ve doğrudan algılanmasını sağlayan belirgin bir tipografik hiyerarji oluşturmaktadır. Tipografik düzen incelendiğinde, yazı karakteri seçimi, hizalama ve yerleşim kararlarının sıradan ve öngörülebilir bir kurgu içerisinde ele alındığı görülmektedir. Tipografi, okunabilirliği önceleyen standart bir afiş düzeniyle kullanılmış; harf formu, boşluk ve yerleşim üzerinden deneysel ya da kavramsal bir arayışa gidilmemiştir. Bu durum, tipografinin anlam kurucu bir unsurdan çok bilgilendirici bir taşıyıcı olarak konumlandığını göstermektedir. Kompozisyon yapısı simetrik ve dengeli bir yerleşime dayanmaktadır. Arka plandaki soyut ağ yapısı, toplumsal bağlanırlık fikrine görsel bir zemin sunmakta; ancak tipografiyle sınırlı bir ilişki kurmaktadır. Mesajın iletiminde açıklık ön plandadır ve izleyicinin yorumlama sürecine girmeden ana içeriği kavraması hedeflenmiştir. Dikkat çekici bir bulgu olarak, promptlarda tarih bilgisi talep edilmemesine rağmen "10–16 Mayıs" ifadesinin postere eklenmiş olduğu görülmektedir. Bu durum, yapay zekanın sosyal temalı afişlerde yaygın kullanılan bilgilendirici şablonlara yönelme eğilimini ve brief dışına taşan otomatik içerik üretimini ortaya koymaktadır.

Genel olarak değerlendirildiğinde, bu yapay zeka üretimi posterin tipografik açıdan düzenli ve okunabilir bir yapı sunduğu; ancak tipografi kullanımının sıradan bir afiş kurgusu içinde kaldığı, kavramsal derinlik ve deneysel tipografik yaklaşım bakımından sınırlı bir çözüm ürettiği görülmektedir.

Şekil 7. Yapay Zeka Çalışması- Chat GPT (B)

Yapay zeka tarafından üretilen bu tipografik poster, Engelliler Haftası temasını “fark et”, “bak”, “duy” gibi eylem temelli sözcükler etrafında kurmayı amaçlayan bir tasarım yaklaşımı sunmaktadır. Poster yüzeyinde tipografi ana taşıyıcı unsur olarak konumlandırılmış; el, kulak ve göz gibi ikonografik semboller sınırlı düzeyde destekleyici unsur olarak kullanılmıştır. Kompozisyon, merkezde vurgulanan “FARK ET” ifadesi etrafında yoğunlaşan bir düzen sergilemektedir. Tipografik hiyerarji incelendiğinde, ana mesajın kırmızı renkle vurgulanan “FARK ET” ifadesi üzerinden kurulduğu görülmektedir. Diğer sözcükler farklı yönlerde ve hizalamalarda yerleştirilmiş; bu durum yüzeyde hareketli bir yapı oluştursa da, tipografik düzenin bütünlüğünü zaman zaman zayıflatmaktadır. Yazı karakteri seçimi ve yerleşim kararları, deneysel bir arayıştan çok biçimsel çeşitlilik üretmeye yönelik görünmektedir. Mesajın iletim netliği açısından bakıldığında, çalışmanın temel kavramsal çerçevesi ilk bakışta algılanabilmektedir. Ancak posterde yer alan “FARKIIDA”, “ERİSİLEBİLİ”, “CRY” gibi anlamsız ya da bağlam dışı harf ve sözcük dizilimlerinin ortaya çıktığı görülmektedir. Bu dilsel bozulmalar, mesajın bütünlüklü biçimde algılanmasını zorlaştırmakta ve tipografinin anlam kurucu rolünü zayıflatmaktadır. Bu durum, yapay zekanın dilsel tutarlılığı korumakta zorlandığını ve görsel düzeni önceliklendirdiğini göstermektedir. Kompozisyon yapısı açısından poster, merkezi bir yoğunluk ve çevresel dağılım arasında kararsız bir yapı sunmaktadır. Tipografik öğelerin farklı yönlere dağılması, görsel dinamizm yaratmakta; ancak okunabilirlik ve mesaj sürekliliği açısından kopukluklar oluşturmaktadır. Sembolik ikonlar, tipografiyle kavramsal bir bütünlük kurmaktan çok, temayı doğrudan tanımlayan işaretler olarak yüzeye eklemlenmiştir. Sosyal temanın duygusal ve bağlamsal aktarımı değerlendirildiğinde, çalışmanın farkındalık çağrısını açık biçimde dile getirdiği; ancak empatik derinliğin ve bağlamsal hassasiyetin sınırlı kaldığı görülmektedir. Dilsel tutarsızlıklar ve anlamsız harf kullanımları, sosyal mesajın ciddiyetini zayıflatan bir etki yaratmaktadır.

Genel olarak değerlendirildiğinde, bu yapay zeka üretimi posterin tipografi odaklı bir kurgu sunduğu; ancak tipografinin sıradan ve parçalı bir afiş düzeni içinde kullanıldığı, buna ek olarak anlamsız harf ve sözcük üretimlerinin ortaya çıktığı görülmektedir. Bu bulgular, yapay zekanın biçimsel düzen kurma konusunda yeterli bir performans sergilerken, dilsel doğruluk ve kavramsal bütünlük açısından sınırlılıklar taşıdığını ortaya koymaktadır.

Şekil 8. Yapay Zeka Çalışması- Gemini (C)

Yapay zeka tarafından üretilen bu tipografik poster, Engelliler Haftası temasını renkli, akışkan ve süsleyici bir görsel dil üzerinden ele almaktadır. “ENGELLİLER HAFTASI” ifadesi merkezde konumlandırılmış; alt bölümde “Farkındalık ve Erişilebilirlik” söylemi destekleyici bir metin olarak yer almıştır. Tipografik yapı, ilk bakışta okunabilir olmakla birlikte, biçimsel olarak dekoratif bir kurgu içerisinde değerlendirilmiştir. Tipografik hiyerarji incelendiğinde, ana başlığın büyük punto ve renkli geçişlerle vurgulandığı görülmektedir. Ancak harf formlarının içine ve çevresine eklenen yaprak benzeri süslemeler, akışkan çizgiler ve ikonografik öğeler, tipografinin önüne geçen bir görsel yoğunluk oluşturmaktadır. Bu durum, tipografinin anlam kurucu bir unsurdan çok estetik bir yüzey elemanı olarak kullanıldığını göstermektedir. Kompozisyon yapısı, merkezî ve dengeli bir yerleşim sunsa da, yüzeydeki süsleyici öğelerin fazlalığı nedeniyle görsel algı dağılmaktadır. Renk paleti sıcak ve davetkâr bir atmosfer oluşturmakta; ancak bu tercih sosyal temanın ciddiyetini yumuşatan bir etki yaratmaktadır. Boşluk kullanımı sınırlı olup, tipografik alanlar süsleme elemanlarıyla kuşatılmıştır. Mesajın iletim netliği açısından, temel söylem anlaşılabilir durumdadır. Bununla birlikte, tipografinin dekoratif biçimde ele alınması, mesajın doğrudanlığı yerine görsel beğeniye odaklanan bir iletişim dili oluşturmaktadır. İzleyici, mesajdan önce estetik kompozisyonla karşılaşmaktadır. Sosyal temanın duygusal ve bağlamsal aktarımı değerlendirildiğinde, çalışmanın kapsayıcı ve pozitif bir atmosfer

kurmayı amaçladığı görülmektedir. Ancak bu yaklaşım, empatik derinlikten çok genel bir farkındalık dili üretmektedir. Erişilebilirlik kavramı sembolik düzeyde temsil edilmekte; tipografik yapı bu temayı derinleştiren bir araç olarak yeterince kullanılmamaktadır.

Genel olarak değerlendirildiğinde, bu yapay zeka üretimi posterin görsel açıdan çekici, düzenli ve renkli bir yapı sunduğu; ancak tipografinin süsleme ağırlıklı ve sıradan bir afiş estetiği içinde konumlandığı, kavramsal derinlik ve eleştirel tipografik yaklaşım açısından sınırlı kaldığı görülmektedir. Bu durum, yapay zekanın estetik uyum üretme konusunda başarılı, tipografiyi anlam üretiminin merkezine yerleştirme konusunda ise sınırlı bir performans sergilediğini göstermektedir.

Şekil 9. Yapay Zeka Çalışması- Chat GPT (D)

Yapay zeka tarafından üretilen bu poster, Engelliler Haftası temasını doğrudan ve açıklayıcı bir görsel dil ile ele almaktadır. Kalın ve büyük puntolu tipografi, evrensel tekerlekli sandalye ikonu ile birlikte kullanılarak mesajın ilk bakışta algılanması hedeflenmiştir. Tipografik düzen, standart bir başlık kurgusu içinde konumlanmakta; tipografi anlam kurucu bir rol üstlenmekten çok metinsel içeriği taşıyan bir unsur olarak kullanılmaktadır. Kompozisyon, merkezî ve simetrik bir yapı sunmakta; ikon, tipografinin önüne geçerek anlatının ağırlık merkezini oluşturmaktadır. “Her insan bir engeldir” ifadesi ise kavramsal ve etik açıdan sorunlu bir genelleme üretmekte, sosyal temanın duyarlılıkla ele alınmasını zayıflatmaktadır. Bu durum, yapay zekanın sosyal içerikli tasarımlarda dilsel ve bağlamsal hassasiyeti yeterince gözetemediğini göstermektedir. Genel olarak değerlendirildiğinde, bu yapay zeka üretimi posterin mesajı hızlı biçimde ilettiği; ancak tipografinin sıradan bir afiş düzeni içinde kullanıldığı, klişe ikonografiye yaslandığı ve kavramsal derinliğin sınırlı kaldığı görülmektedir.

Şekil 10. Yapay Zeka Çalışması- Chat GPT (E)

Tipografik hiyerarji, büyük ve kalın harflerin üst bölümde yoğunlaştırılmasıyla kurulmuş; alt bölümde yer alan “Farkındalık ve Erişilebilirlik” ifadesi ikincil bir bilgi katmanı olarak konumlandırılmıştır. Okunabilirlik yüksektir ve mesaj ilk bakışta algılanmaktadır. Tipografi kullanımı incelendiğinde, harflerin bir kısmının sembolleştirilerek (örneğin tekerlekli sandalye formunun harf içine entegre edilmesi, uyarı işareti benzeri form) anlamı desteklediği görülmektedir. Ancak bu sembolleştirme sınırlı ve yüzeysel düzeyde kalmakta; tipografi ağırlıklı olarak sıradan bir afiş düzeni içinde, dekoratif bir etki üretmektedir. Harfler, kavramsal bir gerilim oluşturmaktan çok görsel çeşitlilik sağlamaktadır.Kompozisyon, dengeli ve merkezî bir yapı sunmaktadır. Renk paleti canlı ve dikkat çekicidir; bu durum farkındalık temasını görünür kılmakta etkili olsa da, sosyal konunun ciddiyetini yumuşatan bir atmosfer oluşturmaktadır. Boşluk kullanımı kontrollü olup, yüzey yoğunluğu dengeli biçimde dağıtılmıştır. Mesajın iletiminde açıklık ön plandadır. Ancak tipografinin anlam kurucu rolü sınırlı kalmakta; sembolik harf müdahaleleri, mesajı derinleştirmekten çok tanımlayıcı bir işlev görmektedir. Bu durum, yapay zekanın tipografiyi kavramsal bir araçtan ziyade estetik bir yüzey öğesi olarak ele aldığını göstermektedir. Genel olarak değerlendirildiğinde, bu yapay zeka üretimi posterin renk, düzen ve okunabilirlik açısından güçlü; ancak tipografik yaratıcılık, kavramsal derinlik ve eleştirel yaklaşım bakımından sınırlı bir çözüm sunduğu görülmektedir.

SONUÇ VE ÖNERİLER

Engelliler Farkındalık Haftası teması kapsamında üretilen tipografik posterler üzerinden, grafik tasarım öğrencilerinin insan merkezli üretimleri ile yapay zekâ destekli tasarımlar arasındaki nitel farklılıkları karşılaştırmalı olarak incelemiştir. Analizler, tipografik hiyerarji, kompozisyon yapısı, mesajın iletim netliği ve sosyal temanın duygusal ve bağlamsal aktarımı ölçütleri doğrultusunda gerçekleştirilmiştir.

Elde edilen bulgular, öğrenci çalışmalarının tipografiyi anlam kurucu bir araç olarak ele aldığını, kavramsal düşünceyi biçimsel kararlarla bütünleştirdiğini ve sosyal temaya yönelik daha derinlikli bir yorum sunduğunu göstermektedir. Öğrenciler, tipografi üzerinden metafor üretme, harf formunu deneysel biçimde dönüştürme ve sembolik unsurları sınırlı ama bilinçli şekilde kullanma eğilimi sergilemiştir. Bu yaklaşımlar, empati kurma kapasitesi yüksek, izleyiciyi düşünmeye yönlendiren ve sosyal bağlamı dikkate alan tasarım çözümlerinin ortaya çıkmasını sağlamıştır.

Buna karşılık, yapay zekâ tarafından üretilen posterlerin büyük çoğunluğunda tipografinin standart ve öngörülebilir bir afiş kurgusu içinde kullanıldığı görülmektedir. Yapay zekâ üretimleri, biçimsel denge, okunabilirlik ve görsel düzen açısından tutarlı sonuçlar sunmakla birlikte, tipografik yaratıcılık ve kavramsal derinlik bakımından sınırlı kalmıştır. Sosyal temanın aktarımı çoğunlukla evrensel kavramlar, klişe semboller ve doğrudan mesajlar üzerinden gerçekleştirilmiş; empatik ve bağlamsal yorumlar yüzeysel düzeyde kalmıştır. Analizlerde ayrıca yapay zekâ üretimlerine özgü yapısal sorunlar da tespit edilmiştir. Promptlarda talep edilmemesine rağmen tarih bilgisi eklenmesi, anlamsız harf ve sözcük dizilimlerinin ortaya çıkması, kavramsal olarak problemli ve genelleyici ifadelerin kullanılması, yapay zekânın sosyal içerikli tasarımlarda dilsel ve etik bağlamı yeterince değerlendiremediğini göstermektedir. Bu durum, yapay zekânın görsel kalıpları yeniden üretme konusunda güçlü, ancak bağlamsal hassasiyet ve eleştirel düşünce gerektiren alanlarda sınırlı bir performans sergilediğini ortaya koymaktadır.

Genel olarak değerlendirildiğinde, yapay zekâ destekli tasarımların öğrenci üretimlerine kıyasla daha yüzeysel, güvenli ve risksiz çözümler sunarken öğrenci çalışmalarının deneysel, özgün ve empatik bir tasarım dili geliştirdiği sonucuna ulaşılmıştır. Bu bulgu, grafik tasarımın özellikle sosyal duyarlılık gerektiren konularda yalnızca teknik yeterlilikle değil, düşünsel, kültürel ve etik birikimle şekillendiğini göstermektedir. Bu bağlamda, grafik tasarım eğitimine yönelik bazı öneriler geliştirilebilir. Yapay zekâ araçları, tasarım sürecinde hız, varyasyon ve teknik destek sağlayan yardımcı araçlar olarak konumlandırılmalı; ancak yaratıcı kararların, kavramsal kurgunun ve sosyal bağlamın insan tasarımcı tarafından belirlenmesi gerektiği vurgulanmalıdır. Eğitim süreçlerinde, öğrencilerin yapay zekâ çıktılarıyla eleştirel biçimde çalışmaları, bu çıktıları sorgulamaları ve dönüştürmeleri teşvik edilmelidir. Böylece yapay zekâ, tasarımın yerini alan bir üretici değil, insan yaratıcılığını besleyen bir araç hâline getirilebilir. Sonuç olarak, grafik tasarımın geleceği, yapay zekâ ile insan tasarımcının dengeli bir iş birliği içinde çalıştığı hibrit modellerde yatmaktadır. Ancak bu dengenin sağlanabilmesi, empati, bağlam bilgisi ve etik duyarlılık gibi insani niteliklerin tasarım sürecinin merkezinde tutulmasına bağlıdır. Bu çalışma, yapay zekânın grafik tasarımda önemli bir potansiyele sahip olduğunu kabul etmekle birlikte, sosyal temalı tasarımlarda insan tasarımcının belirleyici rolünü koruduğunu açık biçimde ortaya koymaktadır.

Kaynaklar

Çeken, B., & Şen, O. (2023). Grafik tasarım sektöründe yapay zekanın kullanılması (Midjourney). 1st International Conference on Contemporary Academic Research (s. 138-145). Konya: All Sciences Proceedings.

Öztemel, E. (2020). Yapay zekâ ve insanlığın geleceği. Bilişim teknolojileri ve iletişim: Birey ve toplum güvenliği, 95-112.

Akman, M., & Ceviz, G. (2025). Ön lisans grafik tasarım eğitiminde yapay zeka ders entegrasyonun incelenmesi. IDEART Uluslararası Tasarım ve Sanat Dergisi, 3(3), 17-29.

Arslan, K. (2020). Eğitimde yapay zeka ve uygulamaları. Batı Anadolu Eğitim Bilimleri Dergisi, 11(1), 71-88.

Flusser, V. (2011). Into the Universe of Technical Images. Minneapolis: University of Minnesota Press.

Karaşahinoğlu, Ş. (2020). Yapay zekanın grafik tasarım alanında kullanım örneklerinin ve gelecekteki olası rolünün incelenmesi. ODÜ Sosyal Bilimler Araştırmaları Dergisi, 10(3), 612-626.

Koçyğit, A., & Darı, A. B. (2023). Yapay zeka iletişiminde Chat GPT: İnsanlaşan dijitalleşmenin geleceği. SSAD Stratejik ve Sosyal Araştırmalar Dergisi, 7(2), 427-438.

Manovich, L. (2020). Artificial Aesthetics: Generative AI, Art and Visual Media. Moscow: Strelka Press.

Margolin, V. (2002). The politics of the artificial: Essays on design and design studies. Chicago: University of Chicago Press.

Şekerli, T., & Tuker, C. (2024). Grafik tasarım pratiğinde üretken yapay zekânın etkinliği üzerine nitel bir araştırma. Journal of Computational Design, 5(1), 105-138.

Şen Atiker, E. (2024). Graphic design in responsible artificial intelligence. IDEART Uluslararası Tasarım ve Sanat Dergisi, 2(2), 1-13.

Zylinska, J. (2024). AI Art: Machine Visions and Warped Dreams. London: Open Humanities Press.

MONUMENTAL HEYKƏLDƏ FORMA VƏ MƏKAN MÜNASİBƏTLƏRİ

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Monumental heykəl, sənətin ən təsirli sahələrindən biri kimi, həm estetik, həm də sosial funksiyaları ilə diqqəti cəlb edir. Bu sənət formasında forma və məkan arasındakı münasibətlər işin vizual təsirini, fikirlərin rabitəsini və tamaşaçılarla dialoqu müəyyənləşdirir. Forma yalnız heykəltəraşlığın özünün həcmi və konturu kimi nəzərə alınmamalıdır, həm də kosmosdakı yerləşdirmə kontekstində və ətraf mühitlə qarşılıqlı əlaqəsi kimi.

Monumental əsərlərdə forma və məkan arasındakı münasibətlər üç əsas səviyyədə təhlil edilə bilər: estetik, funksional və simvolikdir. Estetik olaraq, heykəlin həcmi, ritm, kompozisiya və xətt harmoniyası məkan içərisində vizual balansını yaradır. Funksional olaraq, bir monumentalHeykəl, insan hərəkat nümunələrinə, ictimai yerlərin quruluşu və ətrafdakı memarlıq elementlərinə uyğun olaraq yerləşdirilmişdir. Simvolik olaraq, forma və məkan birlikdə həm emosional, həm də intellektual təcrübə ilə tamaşaçı təmin edən tarixi, mədəni və ideoloji mesajları artırır.

Müasir monumental heykəltəraşlıqda sənətçilər forma və məkan arasında daha çevik və dinamik qarşılıqlı əlaqə yaradırlar. Rəqəmsal modelləşdirmə, eksperimental materiallar və ətraf mühitlə interaktiv nişan vasitəsilə yalnız görmə obyektləri kimi deyil, həm də kosmosda dialoqun ictimai təcrübələri kimi təqdim olunur. Bu yanaşma, həm də monumental heykəlin estetik və funksional dəyərini artırır.

Sonda, monumental heykəldə forma və məkan arasındakı münasibətlər uğurlu vizual və simvolik təcrübələrə nail olmaq üçün vacibdir. Bu münasibətlər mədəni və sosial əhəmiyyətini gücləndirərkən işin estetik təsirini gücləndirir.

Açar sözlər: Monumental heykəltəraşlıq, forma, məkan, estetik münasibətlər, ictimai sənət

ULUSLARARASI TİCARETTE KORUYUCU POLİTİKALARIN GERİ DÖNÜŞÜ ÜZERİNE BİR DEĞERLENDİRME

AN ASSESSMENT OF THE RESURGENCE OF PROTECTIONIST POLICIES IN INTERNATIONAL TRADE

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ÖZET

Uluslararası ticaret sistemi uzun yıllar boyunca serbest ticaret ilkeleri etrafında şekillenmiş ve bu yaklaşım, ekonomik refahın artırılmasında temel politika çerçevesi olarak kabul edilmiştir. Ancak son dönemde yaşanan küresel ekonomik krizler, jeopolitik gerilimler ve tedarik zincirlerinde ortaya çıkan kırılmalar, serbest ticaretin mutlak geçerliliğini sorgulatan yeni bir süreci beraberinde getirmiştir. Bu süreçte koruyucu ticaret politikalarının yeniden gündeme gelmesi, yalnızca geçici kriz tepkileriyle açıklanamayacak daha kapsamlı bir dönüşüme işaret etmektedir.

Bu bildiri, uluslararası ticarette koruyucu politikaların geri dönüşünü kavramsal ve değerlendirmeye dayalı bir perspektiften ele almaktadır. Çalışmada, serbest ticaret ile koruyucu politikalar arasındaki ilişkinin çoğu zaman yanlış biçimde mutlak bir karşıtlık olarak sunulduğu vurgulanmakta; bu ikiliğin tarihsel ve bağlamsal açıdan yeniden değerlendirilmesi gerektiği savunulmaktadır. Bildiri, koruyucu politikaların serbest ticaret ilkesinin tamamen terk edilmesi anlamına gelmediğini; aksine değişen küresel koşullar karşısında ticaret politikalarının anlam ve işlevinde yaşanan bir dönüşümün yansıması olduğunu ileri sürmektedir.

Bu çerçevede ticaret politikalarının yalnızca refah artırıcı araçlar olarak değil, aynı zamanda ekonomik dayanıklılık, tedarik güvenliği ve stratejik önceliklerle ilişkilendirilen çok boyutlu politika alanları hâline geldiği değerlendirilmektedir. Sonuç olarak bildiride, serbest ticaretin mutlak bir hedef olmaktan ziyade, koşullara bağlı olarak yeniden yorumlanan ve koruyucu politikalarla birlikte dengeli biçimde yönetilmesi gereken bir politika çerçevesi sunduğu sonucuna ulaşılmaktadır.

Anahtar Kelimeler: Uluslararası Ticaret, Koruyucu Ticaret Politikaları, Serbest Ticaret, Yeni Korumacılık, Küresel Ticaret Sistemi

Abstract

The international trading system has long been shaped around the principles of free trade, which have been widely regarded as a fundamental policy framework for enhancing economic welfare. However, recent global economic crises, geopolitical tensions, and disruptions in supply chains have led to growing doubts about the absolute validity of free trade. In this context, the re-emergence of protective

trade policies reflects a broader transformation that cannot be explained solely as a temporary response to economic shocks.

This paper examines the return of protective trade policies from a conceptual and evaluative perspective. It argues that the relationship between free trade and protectionism is often incorrectly portrayed as a rigid dichotomy, and that this perspective should be reconsidered within a historical and contextual framework. The study suggests that the resurgence of protectionist measures does not imply a complete abandonment of free trade principles, but rather signals a transformation in the meaning and function of trade policies under changing global conditions.

Within this framework, trade policies are increasingly viewed not only as instruments for enhancing welfare, but also as multidimensional tools associated with economic resilience, supply security, and strategic priorities. The paper concludes that free trade should not be regarded as an absolute objective, but as a policy framework that must be reinterpreted and balanced with protective measures in response to evolving global realities.

Keywords: International Trade, Protective Trade Policies, Free Trade, New Protectionism, Global Trading System

GİRİŞ

Uluslararası ticaret politikaları, uzun bir dönem boyunca serbest ticaret ilkeleri etrafında şekillenmiş ve bu yaklaşım, ekonomik refahın artırılmasına yönelik "doğru politika" olarak kabul edilmiştir. Özellikle II. Dünya Savaşı sonrasında kurulan çok taraflı ticaret sistemi, serbest ticareti yalnızca bir iktisat politikası tercihi değil, aynı zamanda küresel ekonomik düzenin normatif temeli hâline getirmiştir. Gümrük tarifelerinin düşürülmesi, ticaretin serbestleştirilmesi ve devlet müdahalesinin sınırlandırılması, ekonomik büyümenin ve küresel entegrasyonun vazgeçilmez unsurları olarak değerlendirilmiştir (Krugman vd., 2018: 41).

Bu süreçte serbest ticaret, çoğu zaman tarihsel ve bağlamsal koşullardan bağımsız biçimde evrensel bir ilke olarak ele alınmıştır. Karşılaştırmalı üstünlükler teorisine dayanan bu yaklaşım, ülkeler arasındaki ticaretin her koşulda refah artırıcı sonuçlar doğuracağını varsaymıştır (Ricardo, 1817: 134). Ancak bu varsayım, pratikte ülkelerin ekonomik yapıları, sanayileşme düzeyleri ve kurumsal kapasiteleri arasındaki farklılıkları büyük ölçüde göz ardı etmiştir.

1980'li ve 1990'lı yıllarda hız kazanan küreselleşme süreci, serbest ticaretin "alternatifsiz" bir politika çerçevesi olarak sunulmasına yol açmıştır. Bu dönemde koruyucu ticaret politikaları çoğunlukla verimsizlik, kaynak israfı ve refah kaybı ile ilişkilendirilmiş; devlet müdahalesi istisnai ve geçici bir araç olarak değerlendirilmiştir (Krueger, 1997: 3). Böylelikle serbest ticaret, yalnızca ekonomik rasyonaliteye dayalı bir tercih değil, aynı zamanda ticaret politikalarının meşruiyetini belirleyen temel bir referans noktası olarak konumlanmıştır.

Ancak küresel ekonomik sistemin son yıllarda karşı karşıya kaldığı krizler, bu normatif çerçevenin sorgulanmasına neden olmuştur. Özellikle 2008 Küresel Finans Krizi, serbest ticaretin her koşulda istikrar ve refah üreteceği yönündeki kabulleri zayıflatmıştır. Kriz sonrasında artan işsizlik, sanayi üretimindeki gerileme ve ticaret dengesizlikleri, devletin ekonomik süreçlerdeki rolünün yeniden tartışılmasına yol açmıştır (Rodrik, 2011: 235).

Bu sorgulama süreci, yalnızca ekonomik krizlerle sınırlı kalmamış; jeopolitik gerilimler, küresel tedarik zincirlerinde yaşanan kırılmalar ve stratejik sektörlere ilişkin güvenlik kaygıları ile daha da derinleşmiştir. Özellikle pandemi sürecinde yaşanan arz şokları, serbest ticaretin "kesintisiz akış" varsayımını zayıflatmış ve ülkeleri dışa bağımlılıklarını yeniden değerlendirmeye yöneltmiştir (Baldwin ve Evenett, 2020: 7).

Bu gelişmeler, koruyucu ticaret politikalarının yeniden gündeme gelmesini salt bir politika geri dönüşü olmaktan ziyade, serbest ticaret anlayışında yaşanan zihinsel ve kurumsal bir dönüşüm olarak değerlendirmeyi gerekli kılmaktadır. Bu bağlamda temel soru, koruyucu politikaların serbest ticaret sistemine yönelik geçici bir sapma mı yoksa değişen küresel koşullar karşısında ortaya çıkan rasyonel bir uyum tepkisi mi olduğudur.

Bu bildiri, söz konusu soruyu kavramsal bir çerçevede ele alarak, serbest ticaret ile koruyucu politikalar arasındaki ilişkinin mutlak bir karşıtlık yerine, tarihsel ve bağlamsal bir denge meselesi olarak değerlendirilmesi gerektiğini savunmaktadır.

SERBEST TİCARET–KORUMACILIK İKİLEMİ: YANLIŞ BİR KARŞITLIK MI?

Uluslararası ticaret literatüründe serbest ticaret ile koruyucu politikalar çoğu zaman birbirine zıt ve uzlaştırılamaz iki yaklaşım olarak sunulmaktadır. Bu ikili karşıtlıkta serbest ticaret, ekonomik etkinliği ve refah artışını temsil eden "ideal" politika olarak konumlandırılırken; korumacılık verimsizlik, içe kapanma ve kaynak israfı ile özdeşleştirilmektedir. Ancak bu çerçeve, ticaret politikalarının tarihsel gelişimi ve fiilî uygulamaları dikkate alındığında önemli ölçüde indirgemeci bir bakış açısı sunmaktadır (Rodrik, 2011: 218).

Tarihsel olarak değerlendirildiğinde, bugün serbest ticaretin öncüsü olarak görülen birçok ülkenin sanayileşme süreçlerinde yoğun biçimde koruyucu politikalara başvurduğu görülmektedir. Özellikle erken sanayileşen ülkeler, yerli üretim kapasitelerini güçlendirmek ve uluslararası rekabete hazırlanmak amacıyla uzun süre gümrük tarifeleri, ithalat kısıtlamaları ve devlet destekleri uygulamıştır. Bu durum, serbest ticaretin tarihsel olarak "doğal" ya da "kendiliğinden" ortaya çıkan bir politika tercihi olmadığını; aksine belirli bir gelişmişlik düzeyine ulaşıldıktan sonra benimsenen bir yaklaşım olduğunu göstermektedir (Chang, 2002: 16).

Bu bağlamda serbest ticaret ile koruyucu politikalar arasındaki ilişkiyi keskin bir karşıtlık üzerinden değerlendirmek yerine, bunları farklı dönemlerde ve farklı koşullarda başvurulan politika araçları olarak ele almak daha açıklayıcıdır. Zira devlet müdahalesi, uluslararası ticaret tarihinde istisnai bir durumdan ziyade yaygın bir uygulama alanı bulmuştur. Piyasa mekanizmasının tek başına etkin sonuçlar üretmediği durumlarda, ticaret politikaları ekonomik ve toplumsal hedeflere ulaşmak için tamamlayıcı bir rol üstlenmiştir (Krugman vd., 2018: 67).

Serbest ticaret–korumacılık ikileminin problemli yönlerinden biri, ticaret politikalarının çoğu zaman bağlamdan kopuk biçimde değerlendirilmesidir. Oysa ülkelerin ekonomik yapıları, üretim kapasiteleri, teknolojik düzeyleri ve kurumsal yetkinlikleri birbirinden farklıdır. Bu nedenle aynı ticaret politikası, farklı ülkelerde farklı sonuçlar doğurabilmektedir. Serbest ticaretin gelişmiş ülkelerde sağladığı kazanımlar, gelişmekte olan ülkeler için aynı ölçüde geçerli olmayabilir (Krueger, 1997: 8).

Bu noktada koruyucu politikaların mutlak biçimde serbest ticaret karşıtı bir sapma olarak görülmesi yerine, ekonomik dönüşüm süreçlerinde kullanılan araçlardan biri olarak değerlendirilmesi daha tutarlı bir yaklaşım sunmaktadır. Nitekim birçok ülkede koruyucu önlemler, uzun vadeli sanayi ve kalkınma

stratejilerinin bir parçası olarak uygulanmıştır. Bu politikalar, yerli üretimin güçlendirilmesi, istihdamın korunması ve teknolojik kapasitenin artırılması gibi hedeflerle gerekçelendirilmiştir (Rodrik, 2004: 2).

Ancak bu tespit, koruyucu politikaların her koşulda başarılı ya da maliyetsiz olduğu anlamına gelmemektedir. Süresiz ve hedefi belirsiz koruma önlemleri, rekabet baskısını azaltarak verimsiz üretim yapılarının kalıcılaşmasına yol açabilmektedir. Bu nedenle asıl tartışılması gereken konu, serbest ticaret ile korumacılık arasında "hangisi doğrudur" sorusundan ziyade, hangi koşullarda, hangi ölçüde ve ne kadar süreyle bu politikaların uygulanması gerektiğidir (Irwin, 2020: 176).

Bu çerçevede serbest ticaret–korumacılık ikilemi, siyah–beyaz bir karşıtlık olarak değil; bağlamsal, dönemsel ve hedef odaklı bir denge meselesi olarak ele alınmalıdır. Günümüzde koruyucu ticaret politikalarının yeniden gündeme gelmesi, serbest ticaret ilkesinin tamamen terk edildiği anlamına gelmemekte; aksine bu ilkenin yeni küresel koşullar altında yeniden yorumlandığını göstermektedir. Dolayısıyla yeni dönemde tartışmanın odağı, serbest ticaretin varlığı ya da yokluğu değil, ticaret politikalarının değişen ekonomik ve politik gerçekliklere nasıl uyum sağladığı olmalıdır.

KORUYUCU POLİTİKALARIN GERİ DÖNÜŞÜ: KRİZ TEPKİSİ Mİ, YAPISAL DÖNÜŞÜM MÜ?

Uluslararası ticarette koruyucu politikaların yeniden gündeme gelmesi, ilk bakışta küresel krizlere verilen geçici ve tepkisel bir politika refleksi olarak değerlendirilebilir. Nitekim ekonomik daralmalar, finansal istikrarsızlıklar ve ani arz şokları, ülkeleri kısa vadede iç piyasayı ve istihdamı korumaya yönelik önlemler almaya yöneltmektedir. Bu açıdan bakıldığında koruyucu politikalar, olağanüstü dönemlerde başvurulan ve kriz koşulları ortadan kalktığında terk edilmesi beklenen araçlar olarak görülebilir (Irwin, 2020: 162).

Ancak son yıllarda gözlemlenen eğilimler, koruyucu politikaların yalnızca geçici kriz tepkileriyle açıklanamayacağını göstermektedir. 2008 Küresel Finans Krizi sonrasında uygulamaya konulan birçok koruyucu önlemin kalıcı hâle gelmesi, bu politikaların daha derin ve yapısal bir dönüşümün parçası olduğunu düşündürmektedir. Kriz sonrasında küresel ticaret hacmi yeniden artış göstermiş olsa da, ticaret politikalarında benimsenen yaklaşımın kriz öncesi döneme tam anlamıyla geri dönmediği görülmektedir (Evenett, 2019: 22).

Bu durum, serbest ticaret paradigmasının dayandığı bazı temel varsayımların zayıflamasıyla yakından ilişkilidir. Küresel piyasalarda istikrarın sürekliliği, sermaye ve mal akımlarının kesintisiz işlemesi ve tedarik zincirlerinin sorunsuz çalışması gibi kabuller, son dönemde yaşanan gelişmelerle ciddi biçimde sarsılmıştır. Özellikle pandemi sürecinde ortaya çıkan arz kısıtları ve lojistik aksaklıklar, ülkelerin dışa bağımlılıklarını yeniden değerlendirmelerine neden olmuştur (Baldwin ve Evenett, 2020: 11).

Bu bağlamda koruyucu politikaların geri dönüşü, yalnızca ekonomik daralmaların yarattığı geçici bir savunma refleksi değil; aynı zamanda ticaretin işlevine ve amaçlarına ilişkin algının değiştiğini göstermektedir. Ticaret, uzun süre boyunca refah artırıcı bir mekanizma olarak ele alınırken, günümüzde giderek daha fazla biçimde ekonomik dayanıklılık, tedarik güvenliği ve stratejik özerklik gibi kavramlarla birlikte değerlendirilmektedir. Bu dönüşüm, ticaret politikalarının yalnızca ekonomik etkinlik değil, aynı zamanda risk yönetimi aracı olarak da görülmesine yol açmıştır (Rodrik, 2011: 240).

Koruyucu politikaların yapısal bir nitelik kazandığını gösteren bir diğer unsur, bu politikaların farklı kriz türlerinde benzer biçimde yeniden ortaya çıkmasıdır. Finansal krizler, sağlık krizleri ve jeopolitik gerilimler gibi farklı kaynaklardan beslenen şoklar karşısında ülkelerin benzer koruyucu refleksler göstermesi, söz konusu politikaların geçici olmaktan ziyade yeni bir politika anlayışının parçası hâline

geldiğini düşündürmektedir. Bu durum, koruyucu politikaların artık istisnai değil, koşullara bağlı olarak devreye giren "olağan" araçlar olarak görülmeye başlandığını ortaya koymaktadır (Rodrik, 2004: 6).

Bununla birlikte koruyucu politikaların yapısal bir dönüşümün parçası hâline gelmesi, serbest ticaret ilkesinin tamamen terk edildiği anlamına gelmemektedir. Aksine, bu süreçte serbest ticaret ile koruyucu politikalar arasındaki ilişkinin yeniden tanımlandığı görülmektedir. Mutlak serbestlik anlayışının yerini, daha temkinli, seçici ve koşullu bir açıklık anlayışının aldığı söylenebilir. Bu çerçevede koruyucu önlemler, ticaretin tamamen kısıtlanması amacıyla değil; belirli risklerin yönetilmesi ve ulusal ekonomilerin kırılganlıklarının azaltılması amacıyla kullanılmaktadır (Krugman vd., 2018: 74).

Sonuç olarak koruyucu politikaların geri dönüşü, yalnızca kriz dönemlerine özgü geçici bir politika tepkisi olarak değerlendirilemez. Aksine bu eğilim, küresel ekonomik sistemde yaşanan belirsizlikler ve yapısal değişimlerle birlikte şekillenen yeni bir ticaret anlayışının göstergesidir. Bu yeni anlayış, serbest ticaret ile devlet müdahalesi arasındaki sınırların yeniden çizildiği ve ticaret politikalarının daha esnek, bağlamsal ve çok amaçlı hâle geldiği bir döneme işaret etmektedir.

TİCARET POLİTİKALARINDA ANLAM DEĞİŞİMİ: REFAH ARACINDAN STRATEJİK ENSTRÜMANA

Uluslararası ticaret politikalarının son dönemde geçirdiği dönüşüm, yalnızca kullanılan araçlar ya da politika yoğunluğu açısından değil, ticarete atfedilen anlam ve işlev bakımından da önemli bir değişime işaret etmektedir. Uzun süre boyunca ticaret, esas olarak ekonomik refahı artıran, verimlilik kazançları sağlayan ve tüketici faydasını maksimize eden bir mekanizma olarak ele alınmıştır. Bu yaklaşımda ticaret politikalarının temel amacı, piyasa entegrasyonunu derinleştirmek ve ekonomik etkinliği artırmak olarak tanımlanmıştır (Krugman vd., 2018: 38).

Ancak son yıllarda yaşanan gelişmeler, ticaretin yalnızca ekonomik sonuçları üzerinden değerlendirilmesini giderek yetersiz hâle getirmiştir. Küresel krizler, tedarik zinciri kırılmaları ve jeopolitik gerilimler, ticaretin aynı zamanda ekonomik dayanıklılık, ulusal güvenlik ve stratejik özerklik gibi unsurlarla birlikte ele alınmasına yol açmıştır. Bu bağlamda ticaret politikaları, refah artırıcı bir araç olmanın ötesine geçerek, ülkelerin uzun vadeli stratejik hedeflerini destekleyen çok boyutlu bir enstrüman hâline gelmiştir (Rodrik, 2011: 247).

Bu anlam değişiminin önemli bir boyutu, ticaret politikalarının risk yönetimi perspektifiyle ele alınmaya başlanmasıdır. Küresel üretim ağlarının yüksek derecede bütünleşmiş yapısı, verimlilik açısından önemli avantajlar sağlamakla birlikte, aynı zamanda sistemik kırılganlıkları da beraberinde getirmiştir. Özellikle pandemi sürecinde yaşanan arz kesintileri, ticaretin kesintisiz akışına dayalı varsayımların ne ölçüde kırılgan olduğunu ortaya koymuştur. Bu durum, ticaret politikalarının yalnızca maliyet–fayda analizleriyle değil, risk azaltma ve krizlere hazırlık boyutuyla da değerlendirilmesini gerekli kılmıştır (Baldwin ve Evenett, 2020: 13).

Ticaret politikalarının stratejik bir enstrüman hâline gelmesi, devletin ekonomik süreçlerdeki rolünü de yeniden tanımlamaktadır. Bu yeni yaklaşımda devlet, yalnızca piyasa aksaklıklarını gideren pasif bir düzenleyici değil; aynı zamanda ulusal üretim yapısını yönlendiren, belirli sektörleri destekleyen ve uzun vadeli hedefler doğrultusunda ticaret ilişkilerini şekillendiren aktif bir aktör olarak konumlanmaktadır. Bu durum, ticaret politikaları ile sanayi, teknoloji ve güvenlik politikaları arasındaki sınırların giderek daha geçirgen hâle gelmesine yol açmaktadır (Rodrik, 2004: 5).

Öte yandan ticaretin stratejik bir araç olarak görülmesi, uluslararası ekonomik ilişkilerde rekabetin niteliğini de dönüştürmektedir. Rekabet, yalnızca firmalar arasında fiyat ve verimlilik üzerinden yürütülen bir süreç olmaktan çıkarak, devletler arasında teknoloji, üretim kapasitesi ve tedarik zinciri kontrolü üzerinden şekillenen bir yapıya evrilmektedir. Bu durum, ticaret politikalarının tarafsız ve teknik bir alan olmaktan uzaklaşarak, giderek daha fazla siyasi ve stratejik bir içerik kazanmasına neden olmaktadır (Irwin, 2020: 190).

Bu çerçevede serbest ticaret ile koruyucu politikalar arasındaki ilişki de yeniden tanımlanmaktadır. Ticaretin stratejik bir enstrüman olarak ele alınması, mutlak serbestlik anlayışının yerini daha temkinli ve koşullu bir açıklık yaklaşımına bırakmasına yol açmaktadır. Bu yeni yaklaşımda ticaret, her koşulda genişletilmesi gereken bir faaliyet alanı değil; belirli riskler, bağımlılıklar ve ulusal öncelikler dikkate alınarak yönetilmesi gereken bir politika alanı olarak görülmektedir.

Sonuç olarak ticaret politikalarında yaşanan bu anlam değişimi, koruyucu politikaların geri dönüşünü yalnızca ekonomik bir sapma olarak değil, küresel sistemde yaşanan daha geniş bir zihinsel ve kurumsal dönüşümün parçası olarak değerlendirmeyi gerekli kılmaktadır. Bu dönüşüm, ticaretin refah üretme işlevini tamamen ortadan kaldırmamakta; ancak bu işlevi, güvenlik, dayanıklılık ve stratejik hedeflerle birlikte yeniden tanımlamaktadır. Dolayısıyla günümüzde tartışılması gereken temel mesele, ticaretin serbest olup olmaması değil; hangi amaçlarla, hangi sınırlar içinde ve hangi önceliklerle yönetileceği sorusudur.

DEĞERLENDİRME VE SONUÇ

Uluslararası ticarette koruyucu politikaların yeniden gündeme gelmesi, yalnızca belirli dönemsel krizlerin ya da geçici şokların sonucu olarak değerlendirilemeyecek kadar kapsamlı bir dönüşüme işaret etmektedir. Bu gelişme, serbest ticaretin uzun yıllar boyunca taşıdığı "tek doğru politika" algısının sorgulanmasına ve ticaret politikalarının işlevine ilişkin daha esnek bir yaklaşımın benimsenmesine yol açmıştır. Bu bağlamda koruyucu politikaların geri dönüşü, serbest ticaret ilkesinin tamamen terk edilmesinden ziyade, bu ilkenin yeni küresel koşullar altında yeniden yorumlanması olarak ele alınmalıdır.

Bildiride yapılan kavramsal değerlendirmeler, serbest ticaret ile koruyucu politikalar arasındaki ilişkinin mutlak bir karşıtlık üzerinden okunmasının açıklayıcı olmadığını göstermektedir. Tarihsel ve güncel deneyimler, ticaret politikalarının ülkelerin ekonomik yapıları, kalkınma hedefleri ve karşı karşıya oldukları riskler doğrultusunda şekillendiğini ortaya koymaktadır. Bu nedenle serbest ticaret ve korumacılık, birbirini dışlayan iki uç yaklaşım olarak değil, farklı koşullarda devreye giren politika araçları olarak değerlendirilmelidir.

Koruyucu politikaların günümüzde yeniden önem kazanması, ticaretin yalnızca refah artırıcı bir mekanizma olarak görülmesinin ötesine geçildiğini göstermektedir. Ticaret politikaları, giderek daha fazla biçimde ekonomik dayanıklılık, tedarik güvenliği ve stratejik öncelikler çerçevesinde ele alınmaktadır. Bu durum, ticaretin anlamında ve amaçlarında yaşanan bir dönüşüme işaret etmektedir. Artık temel mesele, ticaretin ne ölçüde serbest olduğu değil; ticaret politikalarının hangi riskleri yönettiği ve hangi hedeflere hizmet ettiği sorusudur.

Bu yeni yaklaşım, serbest ticaret ilkesini tamamen geçersiz kılmamaktadır. Aksine, serbest ticaretin mutlak ve bağlamdan bağımsız bir ilke olarak ele alınmasının yerine, daha koşullu ve seçici bir açıklık anlayışının öne çıktığı görülmektedir. Bu çerçevede koruyucu önlemler, ticaretin tamamen

sınırlandırılması amacıyla değil; belirli kırılganlıkların azaltılması ve ulusal ekonomilerin dış şoklara karşı daha dayanıklı hâle getirilmesi amacıyla kullanılmaktadır.

Sonuç olarak uluslararası ticarette koruyucu politikaların geri dönüşü, küresel ekonomik düzenin yapısal bir dönüşüm sürecinden geçtiğini göstermektedir. Bu dönüşüm sürecinde ticaret politikalarının başarısı, serbestlik ile müdahale arasındaki dengeyi ne ölçüde kurabildiğine bağlıdır. Serbest ticaretin yeniden yorumu, onu mutlak bir hedef olmaktan çıkararak, ekonomik, stratejik ve toplumsal önceliklerle uyumlu biçimde yönetilen bir politika alanı hâline getirmeyi gerektirmektedir.

Bu bağlamda koruyucu politikalar, doğru tasarlandıkları ve geçici, hedef odaklı bir çerçevede uygulandıkları sürece, serbest ticaretin alternatifi değil; onu tamamlayan bir unsur olarak değerlendirilebilir. Yeni dönemde asıl tartışma, serbest ticaretin varlığı değil, ticaret politikalarının değişen küresel koşullara nasıl uyum sağlayacağıdır.

KAYNAKÇA

Baldwin, R., ve Evenett, S. J. (2020). COVID-19 and Trade Policy: Why Turning Inward Won't Work. London: CEPR Press. https://cepr.org/system/files/publication-files/60044-covid_19_and_trade_policy_why_turning_inward_won_t_work.pdf Erişim Tarihi: 10.11.2025.

Chang, H.-J. (2002). Kicking Away the Ladder: Development Strategy in Historical Perspective. London: Anthem Press. https://www.kamjournal.org/wp-content/uploads/2021/08/Microsoft-Word-Vol-3.-No-1.-final-copy.docx_6__1-9.pdf Erişim Tarihi: 15.11.2025.

Irwin, D. A. (2020). Clashing over Commerce: A History of US Trade Policy. Chicago: University of Chicago Press. https://www.nber.org/system/files/chapters/c13850/c13850.pdf Erişim Tarihi: 08.10.2025.

Krueger, A. O. (1997). Trade policy and economic development: How we learn. American Economic Review, 87(1), 1–22. https://www.nber.org/system/files/working_papers/w5896/w5896.pdf Erişim Tarihi: 29.11.2025.

Krugman, P. R., Obstfeld, M., ve Melitz, M. J. (2018). International Economics: Theory and Policy (11th ed.). Boston: Pearson. https://books.google.com.tr/books?hl=trvelr=veid=CtKwEAAAQBAJveoi=fndvepg=PT2vedq=Krugman,+P.+R.,+Obstfeld,+M.,+%26+Melitz,+M.+J.+(2018).+International+Economics:+Theory+and+Policy+(11th+ed.).+Boston:+Pearson.veots=kwPRQ2UQDtvesig=qihBWcYRcflw4zUVoIDH-4xNRdAveredir_esc=y#v=onepageveqvef=false Erişim Tarihi: 21.11.2025.

Ricardo, D. (1817). On the Principles of Political Economy and Taxation. London: John Murray. https://competitionandappropriation.econ.ucla.edu/wp-content/uploads/sites/95/1970/01/Principles-of-Political-Economy-and-Taxation-1817.pdf Erişim Tarihi: 09.10.2025.

Rodrik, D. (2004). Industrial policy for the twenty-first century. Harvard University Working Paper, No. RWP04-047. https://www.hks.harvard.edu/publications/industrial-policy-twenty-first-century Erişim Tarihi: 02.11.2025.

Rodrik, D. (2011). The Globalization Paradox: Democracy and the Future of the World Economy. New York: W. W. Norton ve Company. https://www.researchgate.net/publication/274929199_The_Globalization_Paradox_Democracy_and_the_Future_of_the_World_Economy Erişim Tarihi: 06.11.2025.

COMMON OPERATIONAL ERRORS IN FOREIGN TRADE AND THEIR CONSEQUENCES

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ÖZET

Bu çalışma, dış ticaret işlemlerinde firmaların uygulamada sıklıkla karşılaştıkları operasyonel hataları ve söz konusu hataların firmalar üzerindeki finansal, hukuki ve operasyonel sonuçlarını kapsamlı biçimde incelemeyi amaçlamaktadır. Günümüzde dış ticaret faaliyetleri, küresel pazarlardaki yoğun rekabet, karmaşık mevzuat yapıları ve çok aktörlü işlem süreçleri nedeniyle giderek daha teknik ve uzmanlık gerektiren bir nitelik kazanmıştır. Bu bağlamda dış ticaret süreci; teslim şekilleri (Incoterms), ödeme yöntemleri, lojistik ve taşıma organizasyonu, sigorta işlemleri, gümrükleme prosedürleri ve kambiyo işlemleri gibi birbirini tamamlayan çok sayıda aşamadan oluşmaktadır. Bu aşamalardan herhangi birinde yapılan yanlışlık, tüm dış ticaret sürecini olumsuz yönde etkileyebilmekte ve işletmeler açısından ciddi riskler doğurabilmektedir.

Özellikle dış ticaret bilgi ve deneyimi sınırlı olan firmalar ile küçük ve orta ölçekli işletmelerin bu süreçlerde daha fazla operasyonel hata yaptığı gözlemlenmektedir. Çalışmada Türkiye'de faaliyet gösteren ihracatçı ve ithalatçı firmaların uygulamada en sık karşılaştıkları operasyonel hatalar sistematik bir şekilde sınıflandırılarak analiz edilmiştir. Bu kapsamda; yanlış teslim şekli seçimi, teslim şekli ile taşıma türü arasındaki uyumsuzluk, ödeme yöntemlerinde uygun risk yönetimi yapılmaması, akreditif şartlarının yanlış yorumlanması, fatura ve taşıma belgelerinde yapılan hatalar, navlun ve sigorta organizasyonunun eksik veya yanlış yapılması, gümrük beyannamelerinde yanlış GTİP seçimi, mevzuata aykırı beyanlar, yanlış muhabir banka seçimi ve Swift mesajlarında yapılan teknik hatalar çalışmanın temel inceleme konuları arasında yer almaktadır.

Elde edilen bulgular, operasyonel hataların firmalar açısından yalnızca kısa vadeli maliyet artışlarına yol açmadığını, aynı zamanda ödeme gecikmeleri, nakit akışı sorunları, hukuki uyuşmazlıklar, müşteri memnuniyetsizliği ve uzun vadede pazar kaybı gibi daha ciddi sonuçlar doğurduğunu göstermektedir. Bu nedenle çalışmada, operasyonel hataların önlenmesine yönelik farkındalığın artırılmasının ve dış ticaret süreçlerinin profesyonel bir yönetim anlayışıyla ele alınmasının firmaların sürdürülebilir rekabet gücü açısından hayati önem taşıdığı vurgulanmaktadır.

Anahtar Kelimeler: Uluslararası Ticaret, Operasyonel Hatalar, Dış Ticarette Risk Yönetimi, Dış Ticaret İşlemleri

ABSTRACT

This study aims to comprehensively examine the operational errors frequently encountered by firms in international trade transactions and to analyze the financial, legal, and operational consequences of these errors. In today's globalized economy, international trade activities have become increasingly complex and require a high level of technical knowledge and professional expertise due to intense competition in global markets, complex regulatory frameworks, and the involvement of multiple stakeholders in trade processes. In this context, the international trade process consists of several interrelated stages, including the selection of delivery terms (Incoterms), payment methods, logistics and transportation arrangements, insurance procedures, customs clearance, and foreign exchange transactions. Errors occurring at any

stage of this process may negatively affect the entire trade operation and expose firms to significant risks.

In practice, firms with limited experience in international trade, particularly small and medium-sized enterprises (SMEs), are more likely to make operational mistakes. Within this framework, the study systematically classifies and analyzes the most common operational errors faced by exporting and importing firms in Türkiye. The main issues addressed in the study include the incorrect selection of delivery terms, inconsistencies between delivery terms and modes of transport, insufficient risk management in the choice of payment methods, misinterpretation of letter of credit conditions, errors in commercial and transport documents, inadequate or incorrect organization of freight and cargo insurance, deficiencies in customs declarations such as incorrect Harmonized System (HS) code classification, non-compliance with customs regulations, improper selection of correspondent banks, and technical errors in SWIFT payment messages.

The findings indicate that operational errors in international trade do not merely result in short-term cost increases for firms. Rather, they often lead to more severe and long-lasting consequences, such as payment delays, cash flow problems, legal disputes, loss of customer confidence, and ultimately a decline in market share. In particular, delays caused by documentary discrepancies or banking errors may disrupt the financial structure of firms and weaken their competitive position in international markets.

In this respect, the study emphasizes that increasing awareness of operational risks in international trade and adopting a professional and systematic approach to managing trade processes are of critical importance for ensuring sustainable competitiveness. Strengthening firms' technical knowledge, improving internal control mechanisms, and enhancing coordination among logistics providers, banks, and customs authorities are essential steps toward minimizing operational errors and improving overall trade performance.

Keywords: International Trade, Operational Errors, Trade Risk Management, Foreign Trade Procedures

GİRİŞ

Uluslararası ticaret faaliyetleri, farklı uzmanlık alanlarını ve çok sayıda kurumsal aktörü eş zamanlı olarak içeren karmaşık bir işlem bütününü ifade etmektedir. Günümüzde ihracat ve ithalat süreçleri yalnızca malların bir ülkeden diğerine sevk edilmesiyle sınırlı kalmamakta; sözleşme hükümlerinin uygulanması, ödeme yöntemlerinin belirlenmesi, lojistik ve taşıma süreçlerinin planlanması, sigorta teminatlarının oluşturulması, gümrük mevzuatına uygunluk ve bankacılık işlemleri gibi birbirini tamamlayan çok sayıda operasyonel aşamayı kapsamaktadır. Bu çok katmanlı yapı, dış ticaret işlemlerinin yüksek düzeyde koordinasyon ve süreç yönetimi gerektirmesine neden olmaktadır.

Küresel ticaret hacminin artması, tedarik zincirlerinin uluslararası ölçekte genişlemesi ve firmaların farklı pazarlara yönelmesi, dış ticaret işlemlerinin teknik karmaşıklığını daha da artırmıştır. Özellikle son yıllarda uluslararası ticarette teslim sürelerinin kısalması, maliyet baskılarının artması ve müşteri beklentilerinin yükselmesi, dış ticaret operasyonlarının hata toleransını önemli ölçüde azaltmıştır. Bu çerçevede dış ticarette ortaya çıkan sorunların önemli bir bölümünün, mevzuat bilgisinden ziyade uygulama sürecinde yapılan operasyonel hatalardan kaynaklandığı görülmektedir.

Literatürde dış ticaret riskleri çoğunlukla finansal ve ticari riskler bağlamında ele alınmakta; döviz kuru riski, ülke riski ve tahsilat riski gibi unsurlar ön plana çıkarılmaktadır. Ancak uygulamada firmaların karşılaştıkları sorunların büyük bir kısmının, operasyonel süreçlerdeki aksaklıklardan doğduğu dikkat çekmektedir (Branch, 2008: 41). Teslim şekillerinin yanlış uygulanması, ödeme yöntemlerine ilişkin

belgelerin hatalı düzenlenmesi, lojistik ve gümrük işlemlerinde yaşanan koordinasyon eksiklikleri gibi operasyonel hatalar, dış ticaret sürecinde zincirleme etkilere yol açabilmektedir.

Özellikle ticari belgelerin düzenlenmesi aşamasında yapılan küçük hatalar dahi, gümrük işlemlerinin durmasına veya bankacılık süreçlerinde ödeme gecikmelerine neden olabilmektedir. Belgeler arasındaki tutarsızlıklar, akreditifli işlemlerde belgelerin rezervle karşılanmasına ve ödemenin askıya alınmasına yol açabilmektedir (Mann, 2012: 92). Benzer şekilde teslim ve ödeme şartlarının uygulamada yanlış yorumlanması, taraflar arasında sorumluluk ve maliyet paylaşımına ilişkin uyuşmazlıklar doğurabilmektedir.

Lojistik ve taşıma süreçlerinde yapılan operasyonel hatalar da dış ticarette önemli risk alanları arasında yer almaktadır. Taşıma türünün yanlış seçilmesi, transit sürelerin gerçekçi şekilde planlanmaması veya yeterli sigorta teminatının sağlanmaması, malın hasar görmesi ya da gecikmeli teslim edilmesi gibi sonuçlar doğurabilmektedir. Bu tür aksaklıklar yalnızca doğrudan maliyet artışına değil, aynı zamanda müşteri memnuniyetinin azalmasına ve ticari ilişkilerin zedelenmesine neden olmaktadır (Stopford, 2009: 281).

Bankacılık ve kambiyo işlemleri de operasyonel hata riskinin yüksek olduğu alanlardan biridir. Yanlış muhabir banka seçimi, Swift mesajlarındaki format ve içerik hataları ile valör tarihinin hatalı belirlenmesi, ödeme süreçlerinde gecikmelere ve ek bankacılık masraflarına yol açabilmektedir. Bu tür operasyonel sorunlar, firmaların nakit akışını olumsuz etkileyerek finansal planlama süreçlerini zorlaştırmaktadır (Kokkola, 2010: 96).

Bu bağlamda operasyonel hatalar, dış ticaret sürecinde yalnızca teknik aksaklıklar olarak değil, firmaların genel performansını ve dış pazarlardaki rekabet gücünü etkileyen yapısal sorunlar olarak değerlendirilmelidir. Bu çalışma, dış ticarette uygulamada sıklıkla karşılaşılan operasyonel hataları süreç ve uygulama odaklı bir perspektifle ele alarak, söz konusu hataların firmalar üzerindeki operasyonel, finansal ve ticari etkilerini çok boyutlu bir çerçevede analiz etmeyi amaçlamaktadır.

2. DIŞ TİCARETTE OPERASYONEL HATA KAVRAMI VE KAPSAMI

Operasyonel hatalar, dış ticaret işlemlerinin planlama, uygulama ve sonuçlandırma aşamalarının herhangi birinde ortaya çıkan ve sürecin etkin, zamanında ve öngörülebilir biçimde yürütülmesini engelleyen uygulama kaynaklı aksaklıklar olarak tanımlanabilir. Bu hatalar, çoğu zaman mevzuatın tamamen bilinmemesinden değil; mevcut kuralların yanlış yorumlanması, süreçlerin hatalı kurgulanması veya dış ticaret sürecine dâhil olan taraflar arasında yeterli koordinasyonun sağlanamamasından kaynaklanmaktadır. Bu yönüyle operasyonel hatalar, bilgi eksikliğinden ziyade uygulama ve süreç yönetimi sorunlarıyla ilişkilendirilmektedir.

Dış ticaret işlemleri, birden fazla kurum ve aktörün eş zamanlı olarak yer aldığı çok aşamalı bir yapı sergilemektedir. İhracatçı veya ithalatçı firmalar; bankalar, lojistik hizmet sağlayıcıları, sigorta şirketleri, gümrük müşavirleri ve kamu otoriteleri ile sürekli etkileşim hâlindedir. Bu çok aktörlü yapı içerisinde, sürecin herhangi bir aşamasında yaşanan küçük bir aksaklık dahi zincirleme etki yaratarak tüm dış ticaret işlemini olumsuz yönde etkileyebilmektedir. Nitekim uluslararası ticaret literatüründe operasyonel riskler; belge uyumsuzlukları, teslimat gecikmeleri, ödeme süreçlerinde yaşanan aksaklıklar ve lojistik kaynaklı hatalar çerçevesinde ele alınmaktadır (Levy, 2016: 112).

Operasyonel hataların temel özelliklerinden biri, çoğu zaman fark edilmesinin gecikmesi ve sonuçlarının ancak süreç ilerledikçe ortaya çıkmasıdır. Örneğin, ticari belgelerde yapılan küçük bir tutarsızlık, sevkiyat aşamasında sorun yaratmazken; gümrükleme veya ödeme aşamasında işlemin durmasına neden olabilmektedir. Benzer şekilde, teslim şekli ile fiili uygulama arasındaki uyumsuzluklar, taşıma veya sigorta sürecinde beklenmedik maliyetler doğurabilmektedir (Branch, 2008: 44).

Bu hataların bir diğer önemli özelliği ise tekrar edebilir nitelikte olmalarıdır. Süreçlerin standartlaştırılmaması ve etkin bir iç kontrol mekanizmasının bulunmaması durumunda, benzer operasyonel hatalar farklı işlemlerde tekrar edebilmekte ve firmalar açısından kronik bir risk unsuruna dönüşebilmektedir. Uluslararası ticaret uygulamalarında operasyonel risklerin bu niteliği, firmaların yalnızca tekil işlemlerini değil, uzun vadeli ticari performanslarını da olumsuz etkilemektedir (Daniels, Radebaugh & Sullivan, 2015: 322).

Bu çerçevede operasyonel hatalar, dış ticaret sürecinde yalnızca teknik aksaklıklar olarak değil; süreç yönetimi, koordinasyon ve uygulama kalitesiyle doğrudan ilişkili yapısal sorunlar olarak değerlendirilmelidir. Operasyonel hata kavramının kapsamlı biçimde ele alınması, dış ticarette karşılaşılan risklerin daha doğru analiz edilmesine ve etkili çözüm stratejilerinin geliştirilmesine imkân sağlamaktadır.

3. DIŞ TİCARETTE SIK KARŞILAŞILAN OPERASYONEL HATALAR

Dış ticaret işlemlerinde karşılaşılan operasyonel hatalar, çoğunlukla sürecin planlanması ile uygulama aşaması arasındaki uyumsuzluklardan kaynaklanmaktadır. İhracat ve ithalat faaliyetlerinin çok sayıda teknik aşama ve kurumsal aktör içermesi, hata riskini artırmakta; bu durum, uygulamada benzer nitelikte operasyonel sorunların tekrar etmesine yol açmaktadır. Operasyonel hatalar, dış ticaret sürecinin farklı aşamalarında ortaya çıkabilmekte ve çoğu zaman zincirleme etki yaratarak işlemin tamamını olumsuz yönde etkileyebilmektedir.

Bu bölümde, dış ticarette uygulamada en sık karşılaşılan operasyonel hata türleri, sürecin temel bileşenleri dikkate alınarak sistematik bir biçimde ele alınmaktadır. Teslim şekli ve taşıma türü uyumsuzlukları, ödeme yöntemlerinin uygulanmasında yapılan hatalar, belge düzeni ve evrak yönetimine ilişkin aksaklıklar ile lojistik, gümrükleme ve bankacılık süreçlerinde ortaya çıkan operasyonel sorunlar, alt başlıklar altında ayrıntılı olarak incelenmektedir.

3.1. Teslim Şekli ve Taşıma Türü Uyumsuzlukları

Teslim şekillerinin (Incoterms) fiilen kullanılan taşıma türüyle uyumlu olmaması, dış ticarette en yaygın ve en kritik operasyonel hata alanlarından biridir. Incoterms kuralları, satıcı ve alıcı arasındaki maliyet, risk ve sorumluluk paylaşımını standartlaştırmak amacıyla geliştirilmiş olmakla birlikte, bu kuralların uygulama aşamasında yanlış veya eksik yorumlanması ciddi operasyonel sorunlara yol açabilmektedir. Özellikle teslim şeklinin belirlenmesi sürecinde taşıma türünün dikkate alınmaması, dış ticaret işlemlerinde belirsizlikleri artırmaktadır.

Uygulamada sıkça karşılaşılan hatalardan biri, yalnızca denizyolu ve iç suyolu taşımacılığı için geçerli olan FOB, CFR veya CIF gibi teslim şekillerinin karayolu veya havayolu taşımalarında kullanılmasıdır. Bu tür uyumsuz tercihler, riskin hangi aşamada alıcıya geçtiği konusunda taraflar arasında farklı yorumlara neden olmakta ve hasar veya gecikme durumlarında sorumluluk tartışmalarını beraberinde

getirmektedir (ICC, 2020: 15). Bu durum, teslimat sürecinin sağlıklı şekilde yönetilmesini zorlaştırmaktadır.

Teslim şekli ve taşıma türü arasındaki uyumsuzluklar, yalnızca hukuki ve operasyonel sorunlara değil, aynı zamanda maliyet artışlarına da yol açmaktadır. Yanlış teslim şekli seçimi, navlun ve sigorta giderlerinin öngörülenden farklı biçimde taraflardan biri üzerinde kalmasına neden olabilmekte; bu da firmaların kârlılığını olumsuz etkilemektedir. Özellikle sigorta teminatının hangi aşamada ve kim tarafından sağlanacağının net olmaması, hasar durumunda firmaların önemli finansal kayıplarla karşı karşıya kalmasına yol açmaktadır (Branch, 2008: 76).

Ayrıca teslim şekli kaynaklı hatalar, belge düzeni ve gümrükleme süreçlerini de olumsuz etkileyebilmektedir. Fatura ve taşıma belgelerinde yer alan teslim şekli bilgilerinin fiili taşıma koşullarıyla örtüşmemesi, gümrük idareleri ve bankalar nezdinde ek açıklama taleplerine ve işlem gecikmelerine neden olabilmektedir. Bu tür gecikmeler, teslim sürelerinin uzamasına ve müşteri memnuniyetinin azalmasına yol açmaktadır (Daniels, Radebaugh & Sullivan, 2015: 330).

Bu çerçevede teslim şekli belirlenirken yalnızca fiyat pazarlığına odaklanılması yeterli değildir. Taşıma türü, yükleme ve boşaltma noktaları, sigorta gereklilikleri ve operasyonel uygulanabilirlik unsurlarının birlikte değerlendirilmesi gerekmektedir. Aksi hâlde teslim şekli ve taşıma türü uyumsuzluğundan kaynaklanan operasyonel hatalar, dış ticaret sürecinde zincirleme sorunlara yol açarak firmaların mali ve ticari performansını olumsuz etkileyebilmektedir.

3.2. Ödeme Yöntemlerinin Uygulanmasında Yapılan Hatalar

Uluslararası ticarette kullanılan ödeme yöntemleri, taraflar arasındaki ticari ilişkinin güven düzeyine ve risk paylaşımına göre farklılık göstermektedir. Peşin ödeme, akreditif, vesaik mukabili ve mal mukabili gibi yöntemler teorik olarak bilinse dahi, bu yöntemlerin uygulama aşamasında yapılan hatalar firmalar açısından ciddi finansal ve operasyonel riskler doğurabilmektedir. Uygulamada karşılaşılan sorunların önemli bir kısmı, ödeme yönteminin kendisinden ziyade, yöntemin gerektirdiği prosedürlerin eksik veya hatalı uygulanmasından kaynaklanmaktadır.

Akreditifli işlemler, ihracatçılar açısından görece güvenli bir ödeme yöntemi olarak kabul edilmekle birlikte, akreditif şartlarının yanlış veya eksik hazırlanması durumunda önemli riskler ortaya çıkabilmektedir. Akreditif metninde yer alan belgelerin açık ve net şekilde tanımlanmaması, belgeler arasındaki uyumsuzluklara ve bankalar tarafından rezerv ileri sürülmesine yol açmaktadır. Bu durum, ödemenin gecikmesine veya tamamen askıya alınmasına neden olabilmektedir (Mann, 2012: 87). Özellikle küçük ve teknik açıdan karmaşık belge hataları, ihracatçı firmalar için ciddi finansal kayıplar doğurabilmektedir.

Vesaik mukabili işlemlerde ise belgelerin bankalar aracılığıyla teslim edilmesine rağmen, ödeme riskinin büyük ölçüde alıcı üzerinde kalması önemli bir sorun alanı oluşturmaktadır. Belgelerde yapılan hata veya eksiklikler, alıcının ödemeden kaçınmasına veya ödeme sürecini geciktirmesine imkân tanımaktadır. Bu tür durumlar, ihracatçı firmaların nakit akışını olumsuz etkilemekte ve işletme sermayesi ihtiyacını artırmaktadır (Branch, 2008: 93).

Vadeli satışlar ve mal mukabili ödeme yöntemlerinde yapılan operasyonel hatalar ise çoğunlukla tahsilat sürecinin yeterince takip edilmemesinden kaynaklanmaktadır. Alıcı riskinin doğru analiz edilmemesi, vade sürelerinin piyasa koşullarına uygun belirlenmemesi ve ödeme vadelerinin etkin şekilde izlenmemesi, ihracat bedellerinin tahsil edilememesi riskini artırmaktadır. Bu durum, firmaların dış ticarette maruz kaldıkları finansal riskleri daha da derinleştirmektedir (Daniels, Radebaugh & Sullivan, 2015: 341).

Ödeme yöntemlerinin uygulanmasında yapılan hatalar, yalnızca finansal kayıplara değil, aynı zamanda bankacılık işlemlerinde gecikmelere ve ek maliyetlere de yol açmaktadır. Belgelerin geç hazırlanması veya bankalar arasında zamanında iletilmemesi, Swift mesajları üzerinden yürütülen ödeme süreçlerinde aksaklıklara neden olabilmektedir. Bu tür operasyonel sorunlar, ödeme sürecinin uzamasına ve firmaların finansal planlama yapmasını zorlaştıran belirsizliklere yol açmaktadır (Kokkola, 2010: 101).

Bu çerçevede ödeme yöntemlerinin seçimi kadar, bu yöntemlerin uygulama sürecinin de profesyonel bir yaklaşımla yönetilmesi gerekmektedir. Ödeme yöntemlerine ilişkin operasyonel hataların önlenmesi, firmaların tahsilat risklerini azaltarak dış ticaret faaliyetlerinin finansal sürdürülebilirliğini güçlendirmektedir.

3.3. Belge Düzenleme ve Evrak Yönetimi Hataları

Dış ticaret işlemlerinde belge düzeni, sürecin hem hukuki hem de finansal açıdan en kritik unsurlarından birini oluşturmaktadır. Fatura, konşimento, menşe şahadetnamesi, sigorta poliçesi ve diğer ticari belgeler; ihracat ve ithalat işlemlerinin gümrük, bankacılık ve lojistik aşamalarında temel referans niteliği taşımaktadır. Bu belgelerde yapılan tutarsızlıklar veya hatalar, dış ticaret sürecinin ilerleyen aşamalarında ciddi operasyonel sorunlara yol açabilmektedir.

Uygulamada sıkça karşılaşılan belge hataları arasında; belgeler arasında tarih, miktar, ağırlık veya mal tanımı farklılıklarının bulunması, teslim şeklinin yanlış veya eksik belirtilmesi ve belgelerin zamanında düzenlenmemesi yer almaktadır. Özellikle fatura ile taşıma belgeleri arasındaki uyumsuzluklar, gümrük idareleri nezdinde ilave incelemelere ve işlemlerin gecikmesine neden olabilmektedir. Bu tür gecikmeler, sevkiyat süresinin uzamasına ve teslimat performansının olumsuz etkilenmesine yol açmaktadır (Albaum & Duerr, 2011: 203).

Belge düzenleme hatalarının en belirgin sonuçlarından biri, bankacılık işlemlerinde ortaya çıkmaktadır. Akreditifli ve vesaik mukabili işlemlerde belgelerin bankalar tarafından titizlikle incelenmesi, küçük tutarsızlıkların dahi ödeme sürecinin askıya alınmasına neden olabilmesine yol açmaktadır. Belgelerde yer alan küçük bir tarih veya miktar farkı, bankaların rezerv ileri sürmesine ve ödemenin gecikmesine ya da tamamen durmasına neden olabilmektedir (Mann, 2012: 94). Bu durum, ihracatçı firmalar açısından ciddi nakit akışı sorunları doğurabilmektedir.

Belge ve evrak yönetimindeki hatalar, yalnızca ödeme sürecini değil, aynı zamanda gümrükleme ve sigorta işlemlerini de olumsuz etkilemektedir. Yanlış veya eksik düzenlenmiş belgeler, gümrük beyannamesinin düzeltilmesini gerektirmekte; bu durum ek zaman ve maliyet yükü doğurmaktadır. Ayrıca sigorta poliçesinde yer alan bilgilerin fiili taşıma ve teslim koşullarıyla örtüşmemesi, hasar durumunda tazminat taleplerinin reddedilmesine yol açabilmektedir (Branch, 2008: 89).

Bu tür operasyonel hataların önemli bir kısmı, belge hazırlama sürecinin sistematik bir kontrol mekanizmasına bağlanmamasından kaynaklanmaktadır. Belgelerin farklı birimler veya dış hizmet sağlayıcılar tarafından hazırlanması, belge uyumsuzluğu riskini artırmaktadır. Etkin bir evrak yönetim sisteminin bulunmaması, benzer hataların tekrar etmesine neden olmakta ve operasyonel riskleri kronik hâle getirmektedir (Daniels, Radebaugh & Sullivan, 2015: 334).

Bu çerçevede belge düzenleme ve evrak yönetimi, dış ticaret sürecinde teknik bir detay olarak değil, işlemin sağlıklı şekilde tamamlanmasını sağlayan temel bir kontrol alanı olarak değerlendirilmelidir. Belgelerin tutarlılığı, zamanında hazırlanması ve süreç boyunca etkin biçimde izlenmesi, dış ticarette operasyonel hataların azaltılmasında kritik bir rol oynamaktadır.

3.4. Lojistik ve Sigorta Organizasyonundaki Eksiklikler

Lojistik ve sigorta organizasyonu, dış ticaret işlemlerinin fiziksel akışını güvence altına alan ve sürecin sorunsuz tamamlanmasında kritik rol oynayan temel unsurlar arasında yer almaktadır. Taşıma sürecinin doğru planlanmaması, uygun taşıma türünün seçilmemesi veya sigorta teminatının yetersiz ya da hiç sağlanmaması, dış ticarette karşılaşılan en önemli operasyonel hata alanlarından biridir. Bu tür eksiklikler, sevkiyat sürecinde meydana gelen hasar ve kayıpların doğrudan firmalar üzerinde kalmasına neden olabilmektedir.

Uygulamada sıkça karşılaşılan sorunlardan biri, taşıma organizasyonunun yalnızca navlun maliyeti üzerinden değerlendirilmesi ve operasyonel risklerin göz ardı edilmesidir. En düşük maliyetli taşıma seçeneğinin tercih edilmesi, transit sürelerin uzamasına, yükleme–boşaltma süreçlerinde aksaklıklara ve taşıma sırasında hasar riskinin artmasına yol açabilmektedir. Özellikle uluslararası taşımacılıkta aktarma sayısının fazla olduğu sevkiyatlarda, lojistik planlamadaki eksiklikler operasyonel riskleri daha da artırmaktadır (Stopford, 2009: 276).

Sigorta organizasyonundaki hatalar ise dış ticarette en ağır sonuçlar doğuran operasyonel eksiklikler arasında yer almaktadır. Sigorta teminatının teslim şekline uygun şekilde düzenlenmemesi, teminat kapsamının dar tutulması veya sigortasız sevkiyat yapılması, hasar durumunda firmaların ciddi finansal kayıplarla karşılaşmasına neden olmaktadır. Özellikle teslim şeklinin satıcıya sigorta yaptırma yükümlülüğü getirmediği durumlarda, bu hususun göz ardı edilmesi firmalar açısından önemli riskler doğurmaktadır (Branch, 2008: 102).

Lojistik ve sigorta organizasyonundaki eksiklikler, yalnızca fiziksel kayıplarla sınırlı kalmamakta; aynı zamanda müşteri ilişkileri ve ticari itibar üzerinde de olumsuz etkilere yol açmaktadır. Taşıma sürecinde yaşanan gecikmeler veya hasarlı teslimatlar, müşteri memnuniyetini azaltmakta ve uzun vadede ticari ilişkilerin zedelenmesine neden olabilmektedir. Bu durum, firmaların dış pazarlardaki güvenilirliğini olumsuz etkileyerek rekabet gücünü zayıflatmaktadır (Daniels, Radebaugh & Sullivan, 2015: 336).

Ayrıca lojistik süreçlerde sigorta şirketleri, taşıyıcılar ve firmalar arasındaki koordinasyon eksikliği, hasar tespit ve tazminat süreçlerinin uzamasına yol açabilmektedir. Belgelerin eksik veya hatalı düzenlenmesi, hasar ihbarının süresi içinde yapılmaması veya sigorta poliçesinin fiili taşıma koşullarıyla uyumsuz olması, tazminat taleplerinin reddedilmesine neden olabilmektedir. Bu tür durumlar, operasyonel hataların finansal etkisini daha da ağırlaştırmaktadır (Albaum & Duerr, 2011: 214).

Bu çerçevede lojistik ve sigorta organizasyonu, dış ticarette yalnızca tamamlayıcı bir faaliyet alanı olarak değil, risk yönetiminin ayrılmaz bir parçası olarak değerlendirilmelidir. Taşıma sürecinin teslim şekliyle uyumlu biçimde planlanması, yeterli sigorta teminatının sağlanması ve süreç boyunca etkin bir koordinasyonun kurulması, dış ticarette operasyonel hataların azaltılmasında kritik bir rol oynamaktadır.

3.5. Bankacılık ve Kambiyo İşlemlerindeki Uygulama Hataları

Bankacılık ve kambiyo işlemleri, dış ticaret sürecinin finansal boyutunu oluşturan ve işlemin başarıyla tamamlanmasında kritik rol oynayan aşamalardan biridir. Döviz transferleri, ödeme talimatları ve bankalar arası mesajlaşma sistemleri üzerinden yürütülen bu süreçlerde yapılan uygulama hataları, ödeme akışını doğrudan etkileyerek firmalar açısından önemli operasyonel ve finansal riskler doğurabilmektedir. Özellikle bankacılık işlemlerinin teknik niteliği, küçük hataların dahi ciddi sonuçlar yaratmasına neden olmaktadır.

Uygulamada sık karşılaşılan hatalardan biri, yanlış muhabir banka seçilmesidir. Muhabir bankanın ödeme yapılacak ülke veya para birimi açısından uygun olmaması, transferlerin gereksiz ara bankalar üzerinden yönlendirilmesine yol açmakta; bu durum hem işlem süresini uzatmakta hem de ek bankacılık masrafları doğurmaktadır. Yanlış muhabir banka seçimi, uluslararası ödeme zincirinde gecikmelere neden olan temel operasyonel sorunlardan biri olarak değerlendirilmektedir (Kokkola, 2010: 94).

Swift mesajlarında yapılan format ve içerik hataları da bankacılık işlemlerinde önemli aksaklıklara yol açmaktadır. Swift mesajlarında eksik veya hatalı bilgi girilmesi, ödeme talimatlarının muhabir bankalar tarafından işleme alınmamasına veya ek teyit taleplerine neden olabilmektedir. Bu durum, ödeme sürecinin birkaç gün gecikmesine yol açmakta ve firmaların nakit akışını olumsuz etkilemektedir. Özellikle valör tarihinin yanlış belirlenmesi, faiz kaybı ve ek maliyetler şeklinde finansal sonuçlar doğurabilmektedir (Mann, 2012: 105).

Kambiyo mevzuatına ilişkin uygulama hataları da dış ticarette karşılaşılan önemli operasyonel sorunlar arasında yer almaktadır. İhracat bedellerinin yurda getirilme süresi, döviz alım–satım işlemleri ve kambiyo bildirimlerine ilişkin yükümlülüklerin eksik veya hatalı yerine getirilmesi, firmalar açısından idari yaptırımlara ve ek maliyetlere yol açabilmektedir. Bu tür hatalar, çoğu zaman mevzuatın bilinmemesinden ziyade, bankacılık süreçlerinin yeterince takip edilmemesinden kaynaklanmaktadır (Branch, 2008: 121).

Bankacılık ve kambiyo işlemlerindeki uygulama hataları, yalnızca ödeme sürecinde gecikmelere neden olmakla kalmamakta; aynı zamanda firmaların finansal planlama ve likidite yönetimini de zorlaştırmaktadır. Ödeme tarihinin öngörülememesi, firmaların kısa vadeli nakit ihtiyaçlarını karşılamasını güçleştirmekte ve işletme sermayesi üzerindeki baskıyı artırmaktadır. Bu durum, özellikle dış ticaret hacmi yüksek olan firmalar için ciddi bir risk unsuru oluşturmaktadır (Daniels, Radebaugh & Sullivan, 2015: 348).

Bu çerçevede bankacılık ve kambiyo işlemleri, dış ticarette yalnızca teknik bir süreç olarak değil, etkin biçimde yönetilmesi gereken stratejik bir operasyon alanı olarak değerlendirilmelidir. Ödeme talimatlarının doğru hazırlanması, uygun muhabir banka seçimi yapılması ve kambiyo yükümlülüklerinin zamanında yerine getirilmesi, bankacılık kaynaklı operasyonel hataların azaltılmasında temel unsurlar arasında yer almaktadır.

4. OPERASYONEL HATALARIN FİRMALAR ÜZERİNDEKİ ETKİLERİ

Dış ticaret sürecinde ortaya çıkan operasyonel hatalar, yalnızca tekil işlem bazlı sorunlara yol açmakla kalmamakta; firmaların finansal yapısını, hukuki durumunu ve ticari itibarını etkileyen çok boyutlu sonuçlar doğurmaktadır. Özellikle ihracat ve ithalat işlemlerinin süreklilik arz ettiği firmalarda, operasyonel hataların tekrar etmesi durumunda bu etkiler daha belirgin hâle gelmektedir. Operasyonel hataların firmalar üzerindeki etkileri genel olarak finansal, hukuki ve ticari boyutlar altında değerlendirilebilmektedir.

4.1. Finansal Etkiler

Operasyonel hataların en somut sonuçları finansal alanda ortaya çıkmaktadır. Yanlış teslim şekli seçimi, hatalı ödeme yöntemi uygulamaları, belge uyumsuzlukları ve bankacılık işlemlerindeki aksaklıklar; navlun farkları, sigorta kapsamı dışı zararlar, gecikme cezaları ve ek bankacılık masrafları şeklinde maliyet artışlarına neden olmaktadır. Bu tür maliyetler çoğu zaman ürün fiyatına yansıtılamamakta ve firmaların kârlılığını doğrudan olumsuz etkilemektedir.

Özellikle ödeme süreçlerinde yaşanan gecikmeler, firmaların nakit akışını bozmakta ve işletme sermayesi ihtiyacını artırmaktadır. İhracat bedellerinin zamanında tahsil edilememesi, firmaları kısa

vadeli finansman arayışına yönlendirmekte ve finansman maliyetlerini yükseltmektedir. Bu durum, dış ticaret faaliyetlerinin finansal sürdürülebilirliğini zayıflatan önemli bir unsur olarak değerlendirilmektedir (Mann, 2012: 141).

4.2. Hukuki Etkiler

Operasyonel hatalar, dış ticaret işlemlerinde hukuki uyuşmazlıkların ortaya çıkmasına da zemin hazırlamaktadır. Teslim ve ödeme şartlarının yanlış uygulanması, sözleşme hükümleri ile fiili uygulama arasındaki uyumsuzluklar ve belge hataları, taraflar arasında sorumluluk tartışmalarına yol açabilmektedir. Bu durum, firmaların dava veya tahkim süreçleriyle karşı karşıya kalmasına neden olmakta ve hukuki maliyetleri artırmaktadır.

Uluslararası ticarette hukuki uyuşmazlıkların çözüm sürecinin uzun ve maliyetli olması, operasyonel hataların firmalar açısından dolaylı maliyetlerini daha da artırmaktadır. Ayrıca devam eden hukuki süreçler, firmaların ticari faaliyetlerini ve yeni sözleşme yapma kapasitelerini olumsuz etkileyebilmektedir (Branch, 2008: 163).

4.3. Ticari ve İtibar Üzerindeki Etkiler

Operasyonel hataların bir diğer önemli sonucu, firmaların ticari itibarı ve müşteri ilişkileri üzerinde ortaya çıkmaktadır. Teslimat gecikmeleri, hasarlı teslimatlar ve ödeme süreçlerinde yaşanan sorunlar, müşteri memnuniyetini azaltmakta ve uzun vadeli ticari ilişkilerin zedelenmesine neden olmaktadır. Uluslararası pazarlarda güvenilirliğin kritik bir rekabet unsuru olduğu dikkate alındığında, bu tür sorunlar firmaların pazar payını olumsuz etkileyebilmektedir.

Özellikle tekrar eden operasyonel hatalar, firmaların dış pazarlardaki güvenilirliğini zedelemekte ve yeni müşteri kazanımını zorlaştırmaktadır. Literatürde, operasyonel performansın ihracat başarısı üzerinde belirleyici bir faktör olduğu ve teslimat güvenilirliğinin rekabet gücünü doğrudan etkilediği vurgulanmaktadır (Daniels, Radebaugh & Sullivan, 2015: 318).

4.4. Uzun Vadeli Performans Üzerindeki Etkiler

Operasyonel hataların süreklilik kazanması, firmaların dış ticaret faaliyetlerini sistematik biçimde yürütmesini zorlaştırmakta ve kurumsallaşma düzeyini olumsuz etkilemektedir. Süreçlerin standartlaştırılamaması ve etkin bir kontrol mekanizmasının bulunmaması, benzer hataların tekrar etmesine neden olmakta; bu durum firmaların uzun vadeli stratejik planlama yapmasını güçleştirmektedir.

Bu bağlamda operasyonel hatalar, dış ticarette yalnızca günlük işlemlere ilişkin sorunlar olarak değil, firmaların uzun vadeli rekabet gücünü ve dış pazarlardaki konumunu etkileyen yapısal riskler olarak değerlendirilmelidir (Levy, 2016: 146).

5. SONUÇ

Bu çalışma, dış ticaret işlemlerinde sıklıkla karşılaşılan operasyonel hataları süreç temelli bir bakış açısıyla ele alarak, söz konusu hataların firmalar üzerindeki etkilerini kapsamlı biçimde değerlendirmiştir. Çalışma kapsamında yapılan analizler, dış ticarette ortaya çıkan birçok sorunun mevzuat bilgisi eksikliğinden ziyade, uygulama aşamasında yapılan hatalar ve süreçlerin etkin yönetilememesinden kaynaklandığını göstermektedir. Teslim şekillerinin yanlış uygulanması, ödeme yöntemlerine ilişkin operasyonel aksaklıklar, belge düzeni ve evrak yönetimindeki tutarsızlıklar ile

lojistik, sigorta ve bankacılık süreçlerindeki koordinasyon eksiklikleri, dış ticaret faaliyetlerinin sağlıklı biçimde yürütülmesini zorlaştıran temel sorun alanları olarak öne çıkmaktadır.

Operasyonel hataların firmalar üzerindeki etkileri yalnızca kısa vadeli maliyet artışlarıyla sınırlı kalmamakta; ödeme gecikmeleri, nakit akışı sorunları, hukuki uyuşmazlıklar ve müşteri ilişkilerinde zayıflama gibi daha geniş ve kalıcı sonuçlar doğurmaktadır. Özellikle bu hataların tekrar eden bir nitelik kazanması durumunda, firmaların dış pazarlardaki güvenilirliği zarar görmekte ve uzun vadeli rekabet gücü olumsuz etkilenmektedir. Bu durum, operasyonel hataların dış ticarette yapısal bir risk unsuru olarak değerlendirilmesini gerekli kılmaktadır.

Çalışmadan elde edilen bulgular, dış ticarette başarı ve sürdürülebilirliğin yalnızca doğru pazar seçimi veya rekabetçi fiyatlandırma ile değil, aynı zamanda operasyonel süreçlerin etkin ve profesyonel bir şekilde yönetilmesiyle mümkün olduğunu ortaya koymaktadır. Bu bağlamda firmaların dış ticaret işlemlerini kişilere bağımlı bir yapıdan çıkararak, süreç bazlı ve kontrol mekanizmalarıyla desteklenen bir yönetim anlayışına yönelmeleri büyük önem taşımaktadır. Operasyonel süreçlerin standartlaştırılması, görev ve sorumlulukların net biçimde tanımlanması ve işlemlerin düzenli olarak izlenmesi, benzer hataların tekrarını önlemede etkili araçlar olarak değerlendirilmektedir.

Sonuç olarak bu çalışma, dış ticarette karşılaşılan operasyonel hataların neden ve sonuçlarını bütüncül bir çerçevede ele alarak, uygulamaya dönük önemli çıkarımlar sunmaktadır. Operasyonel risklerin azaltılması, firmaların yalnızca mali performanslarını değil, aynı zamanda dış pazarlardaki kurumsal itibarlarını ve rekabetçi konumlarını da güçlendirecek bir unsur olarak öne çıkmaktadır. Bu yönüyle çalışma, dış ticaret uygulamalarına yönelik politika geliştiriciler, uygulayıcılar ve akademik çalışmalar için yol gösterici bir nitelik taşımaktadır.

KAYNAKÇA

Albaum, G., & Duerr, E. (2011). *International Marketing and Export Management*. Harlow: Pearson Education. https://api.pageplace.de/preview/DT0400.9781292016955_A27018580/preview-9781292016955_A27018580.pdf Erişim Tarihi: 10.11.2025.

Branch, A. E. **(**2008). *International Purchasing and Management*. London: Thomson Learning.

Daniels, J. D., Radebaugh, L. H., & Sullivan, D. P**.** (2015). *International Business: Environments and Operations* (15th ed.). Boston: Pearson Education. https://www.google.com.tr/books/edition/Elements_of_Shipping/2C_3npBcr34C?hl=tr&gbpv=1&dq=inauthor:%22Alan+E.+Branch%22&printsec=frontcover Erişim Tarihi: 17.11.2025.

ICC (International Chamber of Commerce). (2020). *Incoterms® 2020 Rules*. Paris: ICC Publishing. https://iccwbo.org/business-solutions/incoterms-rules/incoterms-2020/ Erişim Tarihi: 01.12.2025.

Kokkola, T**.** (2010). *The Payment System*. Frankfurt: European Central Bank. https://www.ecb.europa.eu/pub/pdf/other/paymentsystem201009en.pdf Erişim Tarihi: 05.12.2025.

Levy, M**.** (2016). *International Trade and Supply Chain Management*. London: Routledge.

Mann, R. **(**2012). *International Finance and Trade*. New York: McGraw-Hill Education.

Stopford, M**.** (2009). *Maritime Economics* (3rd ed.). London: Routledge.

THE CITY AS A NARRATIVE SPACE IN CINEMA: THE IMAGE OF KARS – AN ARCHITECTURAL AND SOCIOLOGICAL READING OF THE CHARACTER-SPACE RELATIONSHIP

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ABSTRACT

In cinema, the city is not merely a backdrop in which the story unfolds; rather, it is an active component that shapes the dramatic structure of the narrative, the psychological orientations of the characters, and the broader social context. Lefebvre's definition of space as "a practice that is continuously produced and reproduced as a social product" (1991) is directly related to processes of representation and re-production of space in cinema. Similarly, Bruno (2002) defines the city's position in cinema as "a moving topography that activates visual memory," emphasizing the dynamic role of space within the narrative. From this perspective, the city in cinematographic storytelling is not only a physical environment but an autonomous subject that engages in a reciprocal interaction with characters and functions as a constitutive element structuring dramatic processes. Directors' uses of the camera, interventions in spatial scale, and modes of representing the urban fabric render the individual–space relationship visible across both architectural and sociological layers.

This study approaches the city as a cinematographic narrative space and aims to examine the distinctive position and imaginal continuity of Kars within the history of Turkish cinema. Within this framework, the transformation of space from a passive décor into an integral component of narrative and character psychology is analyzed through the case of Kars in a multi-layered manner. First, the city's architectural fabric, topography, and climatic conditions are examined; subsequently, the ways in which these spatial qualities intersect with characters' psychological orientations and social positioning are evaluated through a comparative, film-based methodology. The sample of the study consists of two films set in Kars or making intensive use of its spatial atmosphere: *Kosmos* (Reha Erdem, 2010) and *Deli Deli Olma* (Murat Saraçoğlu, 2009).

In conclusion, these films collectively demonstrate that Kars—through its stone architecture, harsh climate, and identity as a border city—functions as a powerful cinematic actor that shapes the narrative, transforms the inner worlds of the characters, and renders social memory visible within different dramatic contexts. In these films, Kars becomes not merely a filming location but a central narrative element that determines both the characters' trajectories and the overall atmosphere of the story.

Key Words: Socio-Spatial Relations; Architectural Representation; City as a Cinematic Agent

A SOCIOLOGICAL ANALYSIS OF SPACE, MEMORY, AND IDENTITY BASED ON THE QUESTION "IF YOU COULD REUNITE WITH YOUR CHILDHOOD SELF, WHERE WOULD YOU TAKE THEM FIRST?"

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ABSTRACT

The study aims to examine the meanings of childhood spaces in the context of individual identity formation, emotional memory, and social transformation based on adults' responses to the question, *"If you could reunite with your childhood self, where would you take them first?"*. Grounded in the assumption that space is not merely a physical backdrop but a social and emotional construct that gains meaning through lived experience, the research analyzes how childhood memories are reconstructed through spatial references.

Using a qualitative research design, the study investigates responses voluntarily shared by a total of 350 participants on social media and online platforms. The data were analyzed through content analysis and categorized under thematic headings using open and axial coding processes. The findings reveal that childhood spaces are predominantly associated with feelings of safety, peace, belonging, and protection. The most frequently referenced spaces include the parental home, grandparents' home, streets, gardens, natural environments, and play areas.

The research also shows that some participants expressed a desire to compensate in adulthood for spaces and practices they were unable to experience during childhood, suggesting that spatial memory is not only retrospective but also shaped by narratives of absence and longing. In addition, statements reflecting the disappearance of childhood spaces due to urban transformation, construction, and socio-spatial change highlight the impact of societal transformations on individual memory. Overall, the study provides current empirical data on the relationship between space and memory and demonstrates that nostalgia-based questions can serve as a powerful methodological tool in sociological and spatial research.

Key Words: childhood, spatial memory, identity

ÜÇÜNCÜ SİNEMANIN BELGESEL ALANINDAKİ YANSIMALARI

REFLECTIONS OF THIRD CINEMA IN THE DOCUMENTARY FIELD

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ÖZ

İkinci Dünya Savaşı'ndan sonraki dönemde küresel çapta yaşanan siyasi değişimler ve film yapım ekipmanındaki teknolojik gelişmeler radikal film yapımcılığına ilişkin gelişmeleri tetiklemiştir. Toplumsal hareketler ve politik gelişmelere ilişkin eleştirel duruş farklı ülkelerde belgesel film yapımına ilişkin yeni türde yaklaşımların ortaya çıkmasını sağlamıştır. Anaakım film yapım uygulamalarına karşı duran, politik açıdan muhalif ve film biçimi açısından estetik normların dışında kalan örnekler sergilenmiştir. Gerilla film yapımı hem kurmaca hem de kurmaca olmayan filmleri kapsayan film yapımındaki kolektif çabayı ve radikal anlayışı yansıtmaktadır. Bu süreç yalnızca film yapımcılarının politik duruşunu içermez, aynı zamanda film yapım ekibinin üretim sürecinde belirli bir biçimde hareket etmelerini de kapsamaktadır. Ayrıca konulara karşı içerik hassasiyetinin estetik inceliğin önüne geçmesini de vurgulamaktadır.

Üçüncü Sinema'nın tarihsel uzantıları 1960'lı yılların sonlarında ortaya konulmuş olan manifestolarda yer almaktadır. Bu manifestolardan en bilineni olan Fernando Solanas ve Octavio Getino'nunkidir. Bu kuramsal yaklaşımda Solanas ve Getino (1969), Birinci Sinema'ya ve İkinci Sinema'ya hakim olan film anlayışına karşı duruş sergilemektedir. Birinci Sinema, egemen sınıfların gerçekliğini sattığı; İkinci Sinema'nın ise buna alternatif olarak ortaya çıktığını belirtmektedirler. Bu alternatif yaklaşımda film yapımcısı kendisini standartların dışında özgün bir biçimde ifade edebilir. Ancak bu yaklaşımların da sistem tarafından izin verilen sınırlar içinde hareket ettiği fikrinden hareketle eleştirel bir yaklaşım geliştirilmiştir. Üçüncü Sinema'nın sisteme karşı duruş sergileyen filmler yapması ve devrimci içeriğin öne çıkartılması bu gelişmelere paraleldir.

Üçüncü Sinema'ya ilişkin manifestolarda ortaya konulan ilkeler, baskın film endüstrisinin kalıplarının dışında kalan, hafif çekim ekipmanı kullanan, doğal mekanlarda çekimi içeren, dağıtım ve gösterim açısından alternatiflerin peşinde olan yapım stratejilerine ilişkindir. Bu çerçevede filmlerin yapım unsurları Üçüncü Sinema'nın var olmasını sağlayan stratejilerin uzantısıdır. Öne çıkan unsurlarının içerisinde; sınırlı bütçe, film yapımındaki kollektif çaba, geleneksel anlatılara karşı takınılan eleştirel tutum, dağıtım-gösterim aşamalarının yer altı ağlarıyla sağlanması, marjinal gerçekliklerin işlenmesi, estetik açıdan radikal bir duruş ve film yapımcısının öznesiyle kurduğu hiyerarşik olmayan ilişkisi bulunmaktadır. Bu film yapım tarzı örneklerini farklı ülkelerden yönetmenlerin çalışmalarıyla vermeye devam etmektedir. Bu çalışmada araştırmacı, hegemonik söyleme karşı duruş sergileyen üç belgeseli Üçüncü Sinema film yapımı perspektifinden, literatürdeki kaynakların taranması aracılığıyla incelemektedir. Ele alınan filmler; Octavio Getino ve Fernando Solanas'ın La Hora de los Hornos (1968), Gillo Pontecorvo'nun La battaglia di Algeri (1966) ve Patricio Guzmán'ın La Batalla de Chile I-II-II (1975)'dir.

Anahtar kelimeler: Üçüncü Sinema, Sosyal Gerçeklik, Devrimci Film, Siyasi Film.

ABSTRACT

Global political changes and technological advances in filmmaking equipment in the post-World War II period fueled the development of radical filmmaking. Social movements and critical stances regarding political developments led to the emergence of new approaches to documentary filmmaking in various countries. Examples have been exhibited that challenge mainstream filmmaking practices, are politically dissident, and deviate from aesthetic norms in terms of film form. Guerrilla filmmaking reflects the collective effort and radical understanding of filmmaking, encompassing both fiction and non-fiction. This process not only encompasses the filmmakers' political stance but also the filmmaking team's specific approach to the production process. It also emphasizes the importance of content sensitivity to subject matter over aesthetic refinement.

The historical ramifications of Third Cinema can be found in the manifestos of the late 1960s. The most well-known of these manifestos are those of Fernando Solanas and Octavio Getino. In this theoretical approach, Solanas and Getino (1969) take a stance against the prevailing understanding of film in First Cinema and Second Cinema. They argue that First Cinema sold the reality of the ruling classes, while Second Cinema emerged as an alternative. In this alternative approach, the filmmaker can express himself in an original way, outside of the norms. However, a critical approach has been developed based on the idea that these approaches also operate within the boundaries permitted by the system. Third Cinema's production of films that take a stand against the system and its emphasis on revolutionary content parallel these developments.

The principles set forth in the manifestos of Third Cinema relate to production strategies that break with the dominant film industry's conventions, include using lightweight filming equipment, filming in natural locations, and seeking alternatives in terms of distribution and exhibition. Within this framework, the production elements of films are extensions of the strategies that have enabled Third Cinema to exist. Its prominent elements include: The film's main characteristics include a limited budget, a collective effort in filmmaking, a critical stance towards traditional narratives, the provision of distribution and exhibition stages through underground networks, the treatment of marginal realities, an aesthetically radical stance, and the filmmaker's non-hierarchical relationship with his or her subject. The film continues to provide examples of this style of filmmaking through the works of directors from different countries. In this study, the researcher examines three documentaries that challenge hegemonic discourse from a Third Cinema filmmaking perspective, through a review of sources in the literature. The films examined are Octavio Getino and Fernando Solanas's La Hora de los Hornos (1968), Gillo Pontecorvo's La battaglia di Algeri (1966), and Patricio Guzmán's La Batalla de Chile I-II-III (1975).

Keywords: Guerrilla documentary, Third Cinema, Social Reality, Revolutionary Film, Political Film.

GİRİŞ

Kurmaca olmayan filmler, dönemin politik gelişmelerinden bağımsız olarak düşünülemez. Var olan ideolojik yapılanma belgesel yapımların içerisine girmekte, anlatı yapısını dönüştürmekte ve yapımcının estetik tercihleri üzerinde etkide bulunmaktadır. İki dünya savaşı arasında geçen zaman diliminde üretilmiş olan belgesel yapımlara bakıldığında devlet ideolojisi etrafında şekillenmiş olan anlatı yapılarının seyirciyle buluştuğu görülmektedir. İkinci Dünya Savaşı'ndan sonraki zaman dilimi küresel çapta farklı politik gelişmelerin yol açtığı toplumsal huzursuzluk ve çalkantı ortamında teknolojik gelişmelerin de desteklemesiyle yeni anlatım biçimlerinin denenmesini sağlamıştır. Dünyanın farklı bölgelerinden sanatçılar ve film yapımcıları marksist ideolojilerin yönlendirmesiyle Cezayir ve Vietnam'da verilen bağımsızlık mücadelelerinden etkilenerek sömürgeciliğin ezilen halklar üzerinde etkilerine odaklanan çalışmalar üretmişlerdir. Üçüncü Dünya ülkelerine yoğunlaşan ilgi bu ülkelerin belirlenmesine yönelik olan entelektüel çabaları da yoğunlaştırmıştır. Ekonomik, kalkınma, ırksal, kültürel ve coğrafi kategoriler gibi farklı unsurların göz önünde bulundurulması gündeme gelmektedir.

Shohat ve Stam (2014) gibi araştırmacılar ise bu ayrımın uzun süreli yapısal egemenlikle bağlantılı olduğunu vurgulamaktadır (s. 25).

Üçüncü Dünya ülkelerinin yüzleştikleri sorunlara ilişkin düzenlenen ilk büyük konferans 1955 yılında Endonezya'da düzenlenmiş ve bu ülkeler arasında özel bir dayanışma oluşturulması amaçlanmıştır. Konferansa 29 Üçüncü Dünya ülkesinden katılımcı iştirak ederek, ırkçılık ve sömürgeciliğin yol açtığı suistimaller görüşülmüştür. Amerika Birleşik Devletleri gibi farklı ülkelerden insan hakları aktivistleri ve entelektüellerin de ilgisini çeken bu girişim önemli bir dönüm noktası olmuştur.

Shohat ve Stam (2014) Üçüncü Sinema'nın, İkinci Dünya Savaşı sonrasında Avrupa ülkelerinin sömürge ülkelerinde egemenliklerinin yıkılması ve Üçüncü Dünya ulus devletlerinin ortaya çıkışıyla belirgin hale geldiğini ifade etmektedir (s. 248). Latin Amerika'da bu dönemde film alanındaki gelişmelere bakıldığında, Hollywood'un ürettiği filmlere karşı eleştirel duruşun somutlaştığı, yeni sömürgeciliğe ve kapitalist düzenin uygulamalarına yönelik hoşnutsuzluğun derinleştiği dikkatleri çekmektedir. Bu eleştirileri net bir biçimde ortaya koyan devrimci film yapımının önemli unsurlarının neler olduğunu tartışan dört manifesto önemli bir gelişmedir. Bu manifestolar Üçüncü Sinema'nın başlangıcına işaret etmektedir. Bunlar; Glauber Rocha'nın "Aesthetics of Hunger-Açlığın Estetiği, (1965)", Julio García Espinosa'nın "For a Perfect Cinema-Kusursuz Bir Sinema İçin, (1969)", ve Fernando Solanas ve Octavio Getino'nun "Towards a Third Cinema-Üçüncü Bir Sinemaya Doğru, (1969)" ve Jorge Sanjinés'in "Problems of Form and Content in Revolutionary Cinema-Devrimci Sinemada Biçim ve İçerik Sorunları, (1976)"dır. Guneratne (2003), Üçüncü Sinema'yı ele alan bu manifestoların içerisinde Solanas ve Getino'nunkinin sergilediği politik duruş ve bu filmlerin özelliklerini ele alışı açısından diğerlerinin önüne geçtiğini vurgulamaktadır.

Brezilyalı yönetmen Glauber Rocha'nın, "Aesthetics of Hunger"ı, Üçüncü Dünya Sinema'sı için ikonik bir manifesto olma özelliğindedir. Endüstriyel sinemanın üretim biçimine karşı duruş sergilerken, ezilenlerin epistemolojisini de içermektedir. Rocha, Brezilya'daki Cinema Novo hareketini; betimlerken açlık, az gelişmişlik ve şiddet gibi unsurlar çerçevesinde tanımlamaktadır. Bu özellikler ticari sinemanın sömürücü mekanizmalarından ayrım konusunda olumlu belirteçlerdir. Rocha'ya göre Cinema Novo hareketinin geleceği ve toplumsal değişim ve kültürel adaleti hayata geçirme yeteneği, tüm Üçüncü Dünya halklarını birleştiren kolektif bir uluslararası ve entelektüel hareketin gerçekleştirilmesiyle sıkı sıkıya bağlantılıdır. Cinema Novo'nın devrimci hedefleri arasında, açlık çeken milyonların içinde yaşadığı gerçekliği yaşamayanlara anlatması yer almaktadır (amherst.edu).

Kübalı yönetmen, Julio García Espinosa 1969 yılında "For an Imperfect Cinema"yı yayınladığında odağında Küba sineması bulunmaktadır. Küba sinemasının devrimci içerikten uzaklaşarak sinemanın yüksek standartlarını temsil eden niteliksel boyutuna doğru yöneldiğini belirtmektedir. Bu konuda yapılması gereken, onun ifadesiyle "kusurlu" sinemanın yüceltilmesi ve film yapım sürecine kitlesel katılımın sağlanmasıdır. Yönetmenin anlam üreten poziyonu, güç dinamiklerini yeniden üretmesi nedeniyle ortadan kaldırılmalıdır. Sinema toplumsal süreçleri şeffaf bir biçimde sunarken gündelik hayata Kübalı bir bakış sağlayabilmelidir (ejumpcut.org).

Arjantinli film yapımcıları Fernando Solanas ve Octavio Getino "Towards a Third Cinema"da (1969) militan belgesel film yapımcılığını Üçüncü Sinema'nın en üst biçimi olarak vurgulamışlardır. Kültürel bir devrim yaratmak için politik gündemlerini deneysel film teknikleriyle birleştiren avangard geleneğine başvurmuşlardır. Onlara göre filmler, Birinci ve İkinci Sinemalarda ortaya konan kapitalist/emperyalist modellerden bağımsız olmak için bağımsız olarak üretilmeli ve alternatif mekânlarda sergilenmelidir. Film yapım süreçlerini gerilla faaliyetine benzeterek, kamerayı bir tüfek, projektörü de bir silah olarak tanımlamışlardır. Üçüncü Cinema'yı ilk defa açık bir biçimde şu şekilde tanımlamışlardır:

Üçüncü Dünya halklarının ve emperyalist ülkelerdeki muadillerinin anti-emperyalist mücadelesi, bugün dünya devriminin eksenini oluşturmaktadır. Üçüncü sinema, bize göre, bu mücadelede 20. yüzyılımızın en devasa kültürel, bilimsel ve sanatsal tezahürünü, her bir halkın başlangıç noktası olarak özgürleşmiş bir kişilik inşa etme olasılığını, kısacası kültürün sömürgesizleşmesini gören sinemadır (https://ufsinfronteradotcom.wordpress.com/wp-content/uploads/2011/05/toward-a-third-cinema-getino-y-solanas-tricontinental-1969.pdf).

Bolivyalı yönetmen Jorge Sanjinés'in 1976 yılında Üçüncü Sinema'nın parçası olarak ortaya attığı "Problems of Form and Content in Revolutionary Cinema" başlıklı manifestosu, diğer manifestolarla paralel bir biçimde Hollywood'un film üretim anlayışından uzaklaşılarak, siyasi etkiye sahip devrim niteliğinde film yapım tarzının oluşturulmasını vurgulamaktadır. Devrimci sinema çerçevesinde üretilen filmlerin devrimci kavramların ifade edilmesi açısından önemli araçlar olduklarını vurgulamaktadır. Ayrıca film üretimi pratiği kollektif bir eylem olmalıdır (https://www.degruyterbrill.com/document/doi/10.1525/9780520957411-080/html?srsltid=AfmBOoqEDLmKHENMJXZ4FEQk5LJMrmizF3UYSvnK7QJrwdgCegJg9SsW).

Üçüncü Sinema'nın kuramsal temellerinden hareketle ortaya konulan belgeseller, ekonomik olarak sınırlı kaynaklarla gerçekleştirilmekte, kendine özgü estetik biçim ve politik duruş sergilemektedirler. Sinemanın ticari bir endüstri olarak işlev görmesine karşı duruşla, biçimsel mükemmelliktense içeriğin ön planda olduğu anlatı yapısını işlevsel hale getirmektedirler. Yönetmenler, baskın anlatıyı dönüştürmek üzere ötekileştirilmişlerin bakış açısını yansıtan yapımları gerçekleştirmeye çalışmaktadırlar. Çalışmada ele alınan belgesel yapımların içerisinde; Octavio Getino ve Fernando Solanas'ın La Hora de los Hornos (1968), Gillo Pontecorvo'nun La battaglia di Algeri (1966), ve Patricio Guzmán'ın La Batalla de Chile I-II-III (1975) yer almaktadır. Bu filmlerdeki politik karşı duruş belgeselin estetik yapısıyla bağlantılı bir biçimde değerlendirilmektedir.

ÜÇÜNCÜ SİNEMA VE BELGESEL YAPIMLAR: TARİHİ KÖKLERİ, İÇERİK VE BİÇİM ÖZELLİKLERİ

Gabriel (1982), Üçüncü Sinema'nın temel özelliğinin, filmlerin nerede veya kimin tarafından çekildiği olmadığını vurgulamaktadır. Benimsenen ideoloji ve sergilenen bilincin önemli olduğunu belirtmektedir (s. 2). Emperyalizm ve sınıf baskısının tüm yansımalarına karşı çıkan Üçüncü Dünya sinemasıdır. Gerilla film yapımcılığıyla ortaya konulan belgesellerin kökleri Latin Amerika'nın Üçüncü Sinema'sının teorik açıklamalarında kendisine yer edinmiştir. Kamera gözlemci olarak olayları çeken ve yansıtan bir araçtan ziyade değişimin tetikleyicisi olan bir silah olarak görülmektedir. Film yapım pratikleri Hollywood'un endüstriyel işleyiş modelinden tamamen ayrılmaktadır. Birinci Sinema olarak eleştirilen bu yaklaşım pasif tüketime ve burjuva değerlerine önem vermesi nedeniyle eleştirilmektedir. Diğer taraftan İkinci Sinema, Avrupa auteur yaklaşımı çerçevesinde şekillenen sinema anlayışını temsil etmektedir. Bu perspektiften yönetmenlerin bireysel anlatım yöntemleri, sanatsal duruşları ve benzersiz yaratım özellikleri yüceltildiğinden uzak durulmaktadır. Üçüncü sinema Solanas ve Getino (1969)'un vurgusuyla özgürleştirici bir gerilla aktivitesi olmalı ve politik bilinçlenme yönünde ateşleyici olarak hareket etmelidir (https://ufsinfronteradotcom).

Solanas ve Getino (1969) manifestolarında, eleştirdikleri Hollywood film yapım modelinin ortaya koyduğu mükemmel estetik biçimdeki ve anlatı yapısındaki filmlerinin ait oldukları Batı'nın ideolojik hegemonyasıyla doğrudan bağlantılı olduğunu belirtmektedirler. Bu tarzdaki anlatı formlarının taklit edilmesinin, ezen ulusların hakimiyetini sinemanın anlatım dilinde de kabul etmek olduğunu savunmaktadırlar. Üçüncü Dünya halklarının emperyalist güçlere karşı olan mücadelesi dünya devriminin hareket noktasıyken, sinemanın bu mücadeleyi yalnızca içerikte değil, biçimde de yansıtması gerektiğini vurgulamışlardır (https://ufsinfronteradotcom). Bu bağlamda, görüntünün estetik kusurları sahip oldukları eleştirel duruşun tezahürü haline gelmiştir. Portatif çekim ekipmanının, doğal ışığın ve doğal mekanların kullanımı Birinci Sinema'nın gösterişli, metalaştırılmış estetiğinin reddi

anlamına gelmektedir. Dolayısıyla gerilla sinemacı, sistemin dışında hareket etme ve kıtlığı bir üslup silahına dönüştürme becerisiyle tanımlanmaktadır.

Espinosa (1969) da, manifestosunda teknik mükemmelliğin kaynakları israf eden ve yaratıcı ile izleyici arasında bir engel oluşturan burjuva bir amaç olduğunu savunmuştur. Kusurlu sinemada artık kalite veya teknikle ilgilenilmemekte; sorunların ortaya çıkışı hafif ekipmanla ele alınabilmekte ve seyircinin anlamın inşasına katıldığı bir yapı oluşturulabilmektedir (ejumpcut.org). Üçüncü Sinema manifestolarının ortaya koyduğu sinema özelliklerinin gerçekleştirilebilmesi için yönetmenlerin teknolojik gelişmelere ihtiyacı olmuştur. Film ekipmanındaki 1960'lı yıllarda gerçekleşen yenilikler sayesinde hafif 16mm kameraların kullanımı yaygınlaşmıştır. Bu da film anlatı yapısında kökten değişikliklerin önünü açmıştır. Film dili açısından devrimci düşüncüleri olan yönetmenler bunları gerçekleştirebilmek adına girişimlerde bulunabilmişlerdir.

1970'li yıllara gelindiğinde ise video teknolojisindeki gelişmeler film yapım alanına katılımı genişletmiş ve anlatım olanaklarının çeşitlenmesini de sağlamıştır. Bunun nedeni video teknolojisinin diğer film yapım ekipmanına göre daha ekonomik oluşudur. 1990'lı yıllardaki medya teknolojisini etkileyen önemli adım analogdan dijitale geçiş sonucunda film yapım ekipmanında prodüksiyon ve post-prodüksiyon süreçlerinin dijitalleşmesi ve maliyetlerin ciddi anlamda azalmasıdır. 2000'li yıllarda dijital telefonlar ve World Wide Web'in yaygınlaşması belgesel yapımların anlatım biçimlerinde önemli değişikliklerin gerçekleşmesini sağlamıştır (Tağ Kalafatoğlu, 2015, s. 511). 16mm kameraların kullanımı konusunda profesyonel teknik bilgi gerekirken, ifade edilen teknolojik gelişmeler yapımları ortaya koymak için uzmanlaşmış bir bilgi birikimine gereksinimi ortadan kaldırmıştır. Teknolojik erişimin yaygınlaşması sayesinde çok farklı kesimden insanlar kendi gerçekliklerinin hikayesini anlatma olanağına sahip bir konuma gelmişlerdir.

Üçüncü Sinema'nın eleştirel duruşundan yola çıkarak üretilen belgesellerde görüntü pikselli, titrek çekimli ve manipüle edilmemiş gerçeklikle doğrudan bağlantılıdır. Görüntülerin sahip olduğu kötü kalite, bu yapımların içeriğini oluştururken herhangi bir sahnelemeden, ve kontrollü bir ortam oluşturulmasından uzak durulduğunu ima etmektedir. Üretim koşulları ile film yapımcısının karşı karşıya kaldığı tehlikelerin de göstergesidir. Seyirci bu sarsıntılı görüntülerden oluşan belgeselin içeriğinde, yönetmenin bazı durumlarda acil bir biçimde hareket etmek zorunda kaldığının okumasını yapmaktadır. Filmi yapanın konumuna bakıldığında, filmin öznesiyle arasındaki hiyerarşi ortadan kaldırılmıştır. Yönetmen öznesiyle arasında etkileşimli bir ilişki kurmaktadır. Belgeselin gerilla modunda öznellik ve dayanışma öne çıkmaktadır. Kamera edilgen bir kayıt cihazından, toplumsal eylemin katalizörüne dönüşmektedir. Film çekme toplumsal direniş eyleminin bir uzantısıdır. Bu filmlerin gösterimine bakıldığında bunun da yer altı örgütlenmeleriyle gerçekleştirildiği görülmektedir. Dağıtım ve gösterim konusunda yerel aktivist ağları da son derece işlevsel katkılarda bulunmuşlardır. Günümüzde bu türdeki belgesellerinin gösterim ve dağıtımı konusunda var olan engellerin aşılmasında dijitalleşmenin önemli bir katkısı olmuştur. Dijital dağıtım ağları (YouTube, sosyal paylaşım platformları gibi) üretilen içeriğin küresel çapta izlenmesine olanak sağlamaktadır. Ancak bu konuda da algoritmik kontrolün hegemonyanın dijital çağda kontrol biçimlerinin yeni varyasyonları olarak eşik bekçiliğini üstlenmesini göz ardı etmemek gerekmektedir.

BELGESEL ÖRNEKLERİ

Üçüncü Sinema'nın belgesel tarzı, devrimci politik duruşu, yönetmenin rolü ve yapımın estetik yapısı gibi anlatının çeşitli unsurları çerçevesinde üç belgesel filmde incelenmiştir.

La Hora de los Hornos (The Hour of the Ovens-Fırınların Saati, 1968)

Fernando Solanas ve Octavio Getino'nun yönettiği La Hora de los Hornos, Üçüncü Sinema'nın klasik örnekleri arasında yer almaktadır. Film politik direnişin simgelerinden birine dönüşmüştür. Manifestolarında gerilla film yapımını detaylı bir biçimde açıklayabilmek için kendi belgesellerinden örnek vermişlerdir. Belgesel, "Yeni Sömürgecilik ve Şiddet", "Özgürleşme Yasası" ve "Şiddet ve Özgürleşme" olmak üzere üç bölümden oluşmaktadır. Arjantin'in 1945-58 yılları arasındaki sosyo-

politik durumu üzerinde durulmaktadır. Bu yapımla devrimci tartışmaların teşvik edilmesi ve sonraki dönemlerde ortaya çıkacak olan mücadeleler için hareket noktası oluşturmak adına açık bir yapım oluşturmayı amaçlamışlardır. Arjantin sinemasının en çok ödül alan filmlerinden bir tanesi olmuştur.

Dört saat yirmi dakikalık süresiyle oldukça kapsamlı olan yapım, Arjantin'deki siyasi durumu yalnızca belgelemekle kalmayıp, aynı zamanda aktif olarak bu duruma müdahale etmeyi de amaçlamıştır. Gerilla gösterim bağlamı için tasarlanmış; yapımcılar, izleyicinin tartışma ve fikir alışverişinde bulunabilmesi için filmin belirli aralıklarla durdurulmasını ve böylece sinema alanının fiilen bir siyasi hücreye dönüştürülmesini amaçlamışlardır (Solanas ve Getino, 1969, https://ufsinfronteradotcom). Filmde, estetik açıdan Hollywood'un süreklilik kurgusu reddedilmektedir. Belgesel görüntüler, durağan fotoğraflar, reklamlar, röportajları, diegetik olmayan Batı müziği ve kurgusal anlatı bölümleri kolaj yapısında bir araya getirilmektedir. Filmin çarpıcı bölümlerinden bir tanesi kesilen sığır görüntülerinin Batı'nın tüketim kültürünün parçası olan reklam görüntüleriyle peşi sıra verildiği kısımdır. Willeman (1994) filmde etkili bir şekilde kullanılan görüntü ve ses montaj sekanslarının, Batı'nın emperyalist ve ticari neo-sömürgeci motivasyonlarını eleştirel bir şekilde kınayan üçüncü anlamların (Sergei Eisenstein'ın montaj anlayışıyla) yaratılmasına yardımcı olduğunu belirtmektedir. Brechtyen doğrudan hitap araçları, izleyici ile film arasındaki bariyeri aşındırarak aktif bir izleyici yaratmaya çabalamaktadır. Film, izleyiciye tam anlamıyla sorular sorar ve açık uçlu sonucunda izleyiciyi kendi devrimci faaliyet biçimleriyle filmi sürdürmeye çağırır (ss. 1-30).

Filmin bitişinde yer alan açık son, seyirciye bir çözüm sunmaktan uzaktır. Filmin çekildiği döneme yakın bir zamanda öldürülen Che Guevara'nın yüzü film müziği devam ederken uzunca bir süre gösterilmiştir. Filmin kapanışı, seyircinin anlam oluşturma sürecine aktif katılımını gerektirmektedir. İzleyicinin devrime ilişkin edilgen bir tüketimden uzaklaşması ve etkin bir katılıma sevk edilmesi amaçlanmaktadır.

La battaglia di Algeri (The Battle of Algiers-Cezayir Savaşı, 1966)

Gillo Pontecorvo'nun yönettiği bu belgesel drama (docu-drama), 1966'da Venedik Film Festivali'nde, Altın Aslan ödülünü kazanmıştır. Yapım, Cezayirliler'in Fransız sömürgesine karşı olan savaşını ele almaktadır. Filmin odaklandığı savaş, bilinen anlamda bir savaşa işaret etmemektedir. Gerilla çatışmasına odaklanan filmde, hem Fransız hem de Front de Libération (FLN) tarafından gerçekleştirilen şiddete yer verilmiştir. Film, Cezayir sokaklarını ve doğal ortamları mekan olarak kullanmıştır. FLN gerilla savaşçılarının şehirde yürüttükleri sokak çatışmaları ve direnişçi Ali La Pointe merkezi bir roldedir. Şiddet her iki tarafta da tırmanmaktadır; çocuklar askerleri vurmakta, kadınlar kafelere bomba yerleştirmekte ve Fransız askerler işkenceye başvurmaktadır. Cezayirli oyuncuların çoğu sömürgeye karşı savaşan profesyonel olmayan aktörlerdir. Cezayir'in Fransızlar'dan bağımsızlığını kazanmasına yönetmen filmin sonunda değinmektedir.

Filmde Pontecorvo ve senarist Franco Salinas, Cezayir hükümetinin desteğini almış olsa da Fransızlar'ı gösterirken, yanlı bir tutum sergilememişlerdir. Her iki tarafın da şiddetine tanık olunmakta ve ölümler eşit bir biçimde trajik olarak ele alınmaktadır. Filmde sahte haber görüntülerinin kullanılması, filmin İtalyan Yeni Gerçekçi yaklaşımla arasında kurulan bağlantıdan uzaklaşmasını sağlamıştır. Yapım, Cezayir'in özgürlük mücadelesinde son derece önemli olan anlara seyircisinin tanıklık etmesini sağlamaktadır.

Yönetmen ve senarist, Temmuz 1962'de Fransızları Cezayir'den çıkarmayı başaran halk ayaklanmasını ele alırken; bu sömürge karşıtı başkaldırı Üçüncü Dünya'da özgürlükçü hareketlerin tetiklenmesine yol açmıştır. Yapım, bu mücadeleleri harekete geçirmeye yardımcı olacak niteliktedir. Siyasi aktivizme odaklanan film, seyircisini sömürücülere karşı coşkuyla harekete geçirecek yapıdadır. Sömürenler ve sömürülenler arasındaki keskin ayrımı net bir biçimde sergileyen filmde, sosyal değişim savaşına stratejik bir dokunuş vardır. El kamerasıyla sarsıntılı, yakınlaştıran ve yeniden kadrajlayan, grenli, yüksek kontrastlı sinematografisinde yönetmen, gerçekçiliğin yapaylık olmadan elde edilemeyeceğinin farkındadır (Mathews, 2011, https://www.criterion.com/current/posts/342-the-battle-of-algiers-bombs-and

boomerangs?srsltid=AfmBOooKvSwPcGM3mxYfBe6YBh1BM8Yyim7tMfSNNfo6wC2k9znWYoA-).

La Batalla de Chile I-II-III (The Battle of Chile-Şili Savaşı, 1975)

Patricio Guzmán'ın belgeseli, 1972-73 tarihlerinde Şili'de meydana gelen olayları ele alan üçleme bir film serisidir. Üçlemenin bölümleri, burjuvazinin ayaklanması, darbe ve halk ayaklanmasına odaklanmaktadır. Guzmán belgeselini, kameraman Jorge Müller, ses mühendisi Bernardo Menz, yönetmen yardımcısı José Bartolomé, yapımcı Federic Elton ve editor Pedro Chaskel'den oluşan küçük bir ekiple gerçekleştirmiştir. Film yapımı çekim ve kurgu dahil toplamda yedi yıl sürmüştür. Askeri darbeden sonra film ekibi, belgeseli güvenle Şili dışına kaçırdıktan sonra ülkeyi terk etmek zorunda kalmıştır. Ancak kameraman Müller ise, askeri rejim sırasında kaçırılıp kaybolan 3200 kişiden biri olmuştur (https://www.memoriachilena.gob.cl/602/w3-article-96647.html).

Yönetmen belgesele ilişkin olayların gerçekleşirken filme alındığını, bunun ne bir arşiv ne de kurgusal bir yapım olduğunu ifade etmektedir. Şili'nin o dönemde yaşadığı politik olaylarına odaklandıklarını vurgulamaktadır. Serinin üç filminin de hiç bir kamu televizyonu tarafından yayınlanmadığı ve Şili'de sansürlendiğini belirtmektedir. Film 1970'li ve 80'li yıllarda dünyanın farklı ülkelerinde gösterilme imkanına kavuşmuştur (https://www.patricio-guzman.com/la-batalla-de-chile-i-ii-iii).

Guzmán, yapımın her bir parçasında, gelecek yıllarda kolektif hafızanın dokusunda yer alacak unsurları bir araya getirmiştir. Belgesel, tarihin sinema aracılığıyla inşa edildiği bir anlatı yapısına dönüşmüştür. Tam bir tarihsel farkındalıkla film çekilip kurgulanmış; Şili'de gerçekleşen olayların kronolojisine sadık bir biçimde hareket ederken, sinema aracılığıyla tarih yazılmıştır. Guzmán'ın defalarca tekrarladığı gibi: "Belgesel filmi olmayan bir ülke, fotoğraf albümü olmayan bir aile gibidir." Belgesel, Şili adlı ülkenin aile albümünün bir parçasıdır (Arnal, 2020, https://journals.openedition.org/cinelatino/7840).

SONUÇ

Üçüncü Sinema'nın ortaya çıkışı dönemin var olan siyasi, ekonomik ve toplumsal gelişmeleriyle yakından bağlantılıdır. Anaakım film üretimi konusunda sergilenen muhalif duruşu açıklayan manifestolar bu türde filmlerin yapım ilkelerini açık bir biçimde ortaya koymuştur. Bu manifestolarda filmlerin ideolojik bir dilin uzantısı olduğu ve Hollywood yapımlarını taklit eden biçimlerin, bu yapımlara içkin olan ideolojik yapıyı da kopyalayacağı belirtilmektedir. Yönetmenlerin sömürgeci düzenin sembolü olan film yapım tarzına karşı durmaları gerekmektedir. Bu da konu seçiminden, yönetmenin öznesiyle arasında kurduğu ilişkiye ve estetik yapıya kadar filmin farklı unsurları üzerinde etkide bulunmaktadır.

Üçüncü Sinema'yı kuramsal açıdan şekillendiren manifestolara genel hatlarıyla bakıldığında Brezilyalı yönetmen Glauber Rocha'nın, filmlerin sömürülen insanların dramının diğerleri tarafından anlaşılmasını hedeflemesi gerektiğine; Kübalı yönetmen, Julio García Espinosa'nın biçimden ziyade içeriğin ön planda olmasına; Arjantinli film yapımcıları Fernando Solanas ve Octavio Getino'nun Birinci ve İkinci Sinema'nın film yapım anlayışından uzak durularak, gerilla üretim biçiminin benimsenmesine; Bolivyalı yönetmen Jorge Sanjinés'in devrimci içerik ve etkiye sahip yapımların üretimine vurgu yaptığı görülmektedir. Egemen film yapım anlayışının karşısında duran, ideolojik olarak sömüren sınıfların karşısındaki halkların desteklenmesi ve bu düşüncelere uygun biçimsel özelliklerde filmlerin çekilmesi, tamamında görülen ortak bir yaklaşımdır.

Bu manifestolarda ifade edilen film yapım unsurlarının içerisinde; üretim, dağıtım ve gösterim aşamalarında anaakım medyanın benimsediği duruşun dışlanması yer almaktadır. Eleştirileri, Hollywood'un film endüstrisinin işleyişinde takip ettiği üretim biçimleri ile somutlaşmaktadır. Karşı duruşları çerçevesinde, hafif ekipmanla, küçük ekiplerle, doğal ortamlarda çekim yapılması esastır. Yönetmenin kamerasını devrimi ateşleyen bir silah gibi görmesi, öznesiyle kurduğu ilişkide katalizör gibi hareket etmesi, özne ile yönetmen arasındaki hiyerarşik ilişki biçiminin yok edilmesi vurgulanan

unsurlardandır. Ayrıca bütçe sınırlılıkları, film üretiminde ekibin kollektif çaba, dağıtım ve gösterimin aktivist gruplar aracılığıyla gerçekleştirilmesi, filmin biçimi açısından estetik mükemmelliği yansıtan görüntülerdense içeriğe önem verilmesi öne çıkan özelliklerin arasında yer almaktadır.

Çalışmada üzerinde durulan yapımlar, Octavio Getino ve Fernando Solanas'ın La Hora de los Hornos (1968), Gillo Pontecorvo'nun La battaglia di Algeri (1966) ve Patricio Guzmán'ın La Batalla de Chile I-II-III (1975)'de Üçüncü Sinema'nın ideolojik perspektifi yansıtılmaktadır. Odaklandıkları konular farklı ülkelere ilişkin olsa da, konularına yaklaşımları, var olan sömürge ilişkilerinin sergilenmesi ve devrimci çabaların gösterilmesi ortaktır. Ayrıca görsel açıdan değerlendirildiğinde, manifestolarda vurgulandığı gibi filmin estetik yapısından ziyade içeriği ön plana çıkartılmaktadır. Seyircinin filmlerle kurduğu ilişkide sorunların çözümleri açısından düşünsel süreçlerin gerçekleştirilmesi gerektiği görülmektedir. Filmler devrimci ideolojiyi yansıtan güçlü araçlar olduklarını göstermektedirler.

KAYNAKLAR

Arnal, A. (2020). La batalla de Chile. Cuando el cine escribe la historia. Cinémas d'amérique latine. 28/2020, p. 96-107.

Espinosa, J. G. (1969). For an Imperfect Cinema, (English print dated in 1979)translated by Julianne Burton from Jump Cut, no. 20, 1979, pp. 24-26, https://www.ejumpcut.org/archive/onlinessays/JC20folder/ImperfectCinema.html

Fernando Solanas and Octavio Getino, Towards a Third Cinema: Notes and Experiences for the Development of a Cinema of Liberation in the Third World, https://ufsinfronteradotcom.wordpress.com/wp-content/uploads/2011/05/toward-a-third-cinema-getino-y-solanas-tricontinental-1969.pdf, Erişim Tarihi: 07.12.2025.

Guneratne, A. R. (2003). "Introduction: Rethinking Third Cinema". In Guneratne, Anthony R.; Dissanayake, Wimal (eds.). Rethinking Third Cinema. London: Routledge. pp. 1–28.

Guzmán, P. (Yönetmen). (1975). La Batalla de Chile I-II-III (Belgesel Film). Şili, Fransa, Venezuela.

La Batalla de Chile, https://www.memoriachilena.gob.cl/602/w3-article-96647.html, Erişim Tarihi: 07.12.2025.

Mathews, P. (2011). The Battle of Algiers: Bombs and Boomerangs, https://www.criterion.com/current/posts/342-the-battle-of-algiers-bombs-and-boomerangs?srsltid=AfmBOooKvSwPcGM3mxYfBe6YBh1BM8Yyim7tMfSNNfo6wC2k9znWYoA-, Erişim Tarihi: 08.12.2025.

Patricio Guzmán, La Batalla de Chile I-II-III, https://www.patricio-guzman.com/la-batalla-de-chile-i-ii-iii, Erişim Tarihi: 07.12.2025.

Pontecorvo, G. (Yönetmen). (1966). La battaglia di Algeri (Belgesel drama), İtalya, Cezayir: Igor Film ve Casbah Film.

Rocha, G. (1965). The Aesthetics of Hunger, https://www.amherst.edu/media/view/38122/original/ROCHA_Aesth_Hunger.pdf

Sanjinés, J. (1976). Problems Of Form And Content In Revolutionary Cinema (Bolivia, 1976).

(Cuba) (1976). First published in English in Michael Chanan, ed., Twenty-Five Years of the New Latin American Cinema (London: BFI, 1983), Trans. Malcolm Coad. https://www.degruyterbrill.com/document/doi/10.1525/9780520957411-080/html?srsltid=AfmBOoqEDLmKHENMJXZ4FEQk5LJMrmizF3UYSvnK7QJrwdgCegJg9SsW.

Shohat E. and Stam, S. (2014). Unthinking Eurocentrism, New York: Routledge.

Solanas, F., & Getino, O. (Yönetmenler). (1968). La Hora de los Hornos (Film). Arjantin:

Grupo Cine Liberación ve Solanas Productions.

Tağ Kalafatoğlu, Ş. (2015). Dijital Çağın Belgesel Sinemaya Getirdiği Fırsatlar Ve Yenilikler.

International Trends and Issues in Communication & Media Conference 2015 – September 2-4, 2015, St. Petersburg, Russia.

Gabriel, T. H. (1982). Third Cinema in the Third World, Ann Arbor: Michigan University

Press.

Willemen, P. (1994). The Third Cinema Question: Notes and Reflections,Questions of Third

Cinema, eds. Jim Pines and Paul Willemen. London: BFI Publishing.

ROCK BELGESELLERİNİN (ROCKUMENTARY) ANLATIM BİÇİMLERİ

NARRATIONAL FORMS OF ROCK DOCUMENTARIES

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ÖZ

Müziğin sinema tarihi açısından taşıdığı önem ilk çekilen filmlerin gösterimlerinden itibaren oldukça başattır. Anlatımın önemli bir unsuru haline gelmesi sinemada sesin kullanılmaya başlanmasıyla mümkün hale gelmiştir. Hollywood stüdyo sisteminde film türlerinin ortaya çıkışıyla müziğin başat önemde olduğu müzikal filmler üretilmeye başlanmıştır. Bu yapımların altın çağının sonuna gelindiği bir dönemde rock belgeselleri giderek popülerleşen bir müzik türüne odaklanarak dikkatleri üzerlerine çekmeyi başarmıştır. 1960'larda popüler müzisyenlere ya da gruplara odaklanan gözlemsel yönü öne çıkan belgeseller çekilmiştir. İçeriklerinde sanatçılarla görüşmeler, sahne performansları, sahne arkasında olup bitenler ve konsere giden hayranların tepkileri yer almaktadır.

Belgesel anlatısında ekonomik, politik, teknolojik ve kültür alanında var olan değişiklikler farklı biçimlerde yansımalarını bulmaktadır. 1960'lı yıllardaki sinema türlerini, müzik dünyasını ve çekim araçlarının teknolojik ilerlemelerini kapsayan gelişmeler sayesinde belgesel söyleminde doğrudan (direct cinema) sinema çatısı altında müzik dünyasına odaklanan yapımlar ortaya konulmaya başlanmıştır. Doğrudan sinemanın gözlemsel stratejilerinden hareketle ilk örnekleri verilmeye başlanan bu belgesel yapımlara rock belgeselleri-rockumentary denilmektedir. Müziği ya da müzisyenlerin performanslarını odağına alarak gerçekleştirilen bu yapımlar her ne kadar ilk örneklerini gözlemci belgesellerin yapısında vermiş olsa da süreç içerisinde farklı anlatı biçimlerini de benimsemişlerdir. Bu durum belgesel tarihi içerisinde yapımcıların üstlendikleri rollerin farklılaşmasıyla konularını ele alış biçimlerinin çeşitlenmesiyle açıklanabilir.

Rock belgeseli, yıldız söylemi, kriz ve çözülme anlatıları ve müzik filmciliği üzerine tartışmalardan beslenirken; müziğin temsil ettiği kültürel uzantıları da anlatısının içine alarak örneklerini vermeye devam etmektedir. Çalışmada, bu yapımların ilk örnekleri üzerinden doğrudan sinema türünün altında sahip oldukları konum değerlendirilmektedir. Bunu gerçekleştirebilmek için de literatür taramasıyla yazılı kaynaklar ve What's Happening! The Beatles in the USA (1964), Don't Look Back (1967), Monterey Pop (1968), Woodstock (1970), Gimme Shelter (1970) belgesel örnekleri değerlendirilmiştir. Sonuç olarak bu yapımların belgesellerin tarihsel gelişim sürecinde sinema, müzik ve teknoloji alanlarındaki gelişmelerin gerekli ortamı hazırlamaları sayesinde ortaya çıktığı ve doğrudan sinemanın anlatı özelliklerini yansıttıkları bulgulanmıştır.

Anahtar Kelimeler: Rock belgeselleri, What's Happening! The Beatles in the USA (1964), Don't Look Back (1967), Monterey Pop (1968), Woodstock (1970), Gimme Shelter (1970).

ABSTRACT

The importance of music in the history of cinema has been paramount since the screening of the first films ever made. Its role as a significant element of storytelling became possible with the introduction of sound in cinema. With the emergence of film genres within the Hollywood studio system, musical films, where music played a dominant role, began to be produced. As the golden age of these productions drew to a close, rock documentaries, focusing on an increasingly popular musical genre, managed to attract attention. In the 1960s, observational documentaries focusing on popular musicians or groups

were produced. Their content included interviews with artists, stage performances, backstage goings-on, and the reactions of fans attending concerts.

In documentary narratives, changes in economic, political, technological, and cultural spheres are reflected in various ways. Thanks to developments encompassing film genres, the music world, and technological advancements in filmmaking in the 1960s, documentary discourse began to produce works focusing on the music world under the umbrella of direct cinema. These documentary productions, which first emerged from the observational strategies of direct cinema, are called rock documentaries or rockumentaries. While these productions, which focus on music or the performances of musicians, initially gave their first examples in the structure of observational documentaries, they have also adopted different narrative forms over time. This can be explained by the diversification of the roles undertaken by producers and the variety in their approaches to their subjects within the history of documentaries.

Rock documentaries draw inspiration from discussions on star discourse, narratives of crisis and dissolution, and music filmmaking; while incorporating the cultural extensions represented by music into their narratives, they continue to produce examples. This study evaluates the position these productions hold under the direct cinema genre through their early examples. To achieve this, a literature review was conducted, and written sources and documentary examples such as What's Happening! The Beatles in the USA (1964), Don't Look Back (1967), Monterey Pop (1968), Woodstock (1970), and Gimme Shelter (1970) were evaluated. In conclusion, it has been found that these productions emerged thanks to the developments in the fields of cinema, music, and technology that created the necessary environment in the historical development process of documentaries, and that they directly reflect the narrative characteristics of cinema.

Keywords: Rock documentaries, What's Happening! The Beatles in the USA (1964), Don't Look Back (1967), Monterey Pop (1968), Woodstock (1970), Gimme Shelter (1970).

GİRİŞ

Müzik sinemada sessiz dönemden itibaren önem taşıyan bir unsurdur. Aslında sessiz sinema döneminde de filmler tamamen sessiz değildir. Bunun nedeni filmlerin gösterildiği salonlarda piyanonun ya da bir müzik grubunun eşlik etmesidir. Bu sayede seyircilerin filme konsantre olmaları kolaylaşmakta, sahnelerde iletilmek istenen duyguyu algılayabilmekte, atmosfer yaratılabilmekte ayrıca projeksiyon makinesinin gürültüsü de bastırılabilmektedir. Daha sonra sinema tarihine ilk sesli film olarak geçen The Jazz Singer (1927)'ın çekilmesi neticesinde şarkı ve müzik filmin hikâye yapısında önemli bir unsura dönüşmüştür. İlk müzikal film Broadway Melody (1929)'nin seyirciyle buluşmasından sonra müziğin ve dansların anlatımın temel özelliği olan bu film türü Hollywood stüdyolarının repertuarına eklenmiştir. Abisel (1996), müzikallerin 1930'ların başlarından altın çağının sonu olarak kabul edildiği 1950'li yılların başlarına kadar seyircinin büyük bir ilgisiyle karşılandığını vurgulamaktadır. Hollywood müzikallere kaynak olarak gösteri dünyasının vodvil, varyete, burlesk, sirk gösterileri, caz eğlencelerini, Broadway sahne şovlarını almıştır (ss.181-198). Amerikan kültürünün zengin altyapısındaki müzikli kaynaklar kullanılmıştır.

Belgesel alanında müziğin filmin anlatısının önemli bir parçası haline gelmesi özellikle 1920'li yıllarda sanatın farklı alanlarından olan kişilerin sinema alanında ortaya koyduğu denemeleriyle gündeme gelmiştir. Barnouw (1993)'un belgeselin tarihsel gelişiminde resim geleneği olarak ifade ettiği yapımlarda çeşitli avangart yaklaşımlar sergilenmiştir. Müziğin ritmi şekillerle birlikte aktarılmıştır. Soyut anlatımların ön planda olduğu bu denemelerde Viking Eggeling ve Hans Richter gibi ressamlar gerçeklikten yola çıkarak yaratıcı yorumlarını film alanında gerçekleştirmişlerdir. Gündelik hayatın herhangi bir parçası filmlerindeki soyutlamalara temel oluşturabilmektedir. Tağ Kalafatoğlu (2016)

Eggeling'in ritme, müziğe, çizimlere, zaman faktörü gibi farklı unsurların arasındaki bağlantıya odaklandığı yapımlarının arasında Symphony Diagonal (Senfoni Diagonel-1925)'in yer aldığını vurgulamaktadır. Eggeling'e göre filmi gözler için müzik olup, hareketi şekillerin belirmesi ve kaybolmasıyla oluşturmaktadır. Richter'in de dada ve kübist gibi çeşitli sanat akımlarıyla bağlantılı olarak ürettiği soyut film denemeleri bulunmaktadır. Yönetmenin yaratıcılığındaki dönüm noktası olarak sinematik ritmi keşfetmesi gösterilmektedir (Akt. Tağ Kalafatoğlu, 2016, ss. 1122-1123). İlk filmi; Film ist Rhythmus: Rhythmus '21 (Film Ritimdir: Ritim 21-1921)'dir. Daha sonraki yıllarda daha figüratif, konulu ve içeriği belgesele kayan yapımlar gerçekleştirmiştir. Bunların içerisinde enflasyona odaklandığı Inflation (Enflasyon-1928) ve at yarışını ele aldığı Racing Symphony (Yarış Senfonisi-1928) bulunmaktadır.

1920'li yıllardaki ressamlar, heykeltraşlar, fotoğrafçılar, müzisyenler, mimarlar gibi farklı alanlardan gelen sanatçılar belgesel alanında yeni bir sinema dili geliştirmek üzere örnekler ortaya koymuşlardır. Şehir senfonileri adı verilen belgesel örneklerini bu dönemde gerçekleştirilmişlerdir. Modern şehir yaşamına odaklanan bu belgesel yapımlarda gün doğumundan batımına yapılan her türlü etkinlik müziğin ritmik temposuyla seyircisine aktarılmaktadır. Müzik bu belgesellerde görüntüler kadar büyük önem taşımaktadır. Bu filmlerin öne çıkan özelliklerinin içerisinde Tağ Kalafatoğlu (2023a) uylaşımların dışındaki perspektifin kullanımının, alışılmamış açıların, görüntülerin müzikle ritmik bir biçimde kurgulanmasının, efektler ve şehirdeki aktivitelerin doğal mekanlarında gösterilmesinin yer aldığını vurgulamaktadır (s. 1049). Bu yapımlarda müzikal kompozisyon film dilinin oluşumda kullanılmaktadır. Charles Sheeler ve Paul Strand türün ilk örneklerinden kabul edilen Manhatta (1921)'yı gerçekleştirirken aynı zamanda belgeselin avangart yapımlarla kesişimini de sergilemişlerdir (Tağ Kalafatoğlu, 2023b, s. 16; Tağ Kalafatoğlu, 2016, s. 1130).

Şehir senfonilerinin en bilinen örnekleri Walter Ruttman'ın Berlin, Symphony of a Great City (Berlin: Büyük Bir Şehrin Senfonisi-1927), Alberto Cavalcanti'nin Nothing But Time (Sadece Zaman-1926) ve Dziga Vertov'un Man with a Movie Camera (Kameralı Adam, 1929)'dır. Bu yapımlar türün popülerliğinin artmasını ve başka örneklerin de yapılmasını sağlamıştır. Böylelikle bu filmler aracılığıyla seyirci farklı ülkelerde yer alan metropollerde yaşamın akışını müzik eşliğinde deneyimlemiştir. Ayrıca şehirlerde yer alan çeşitli mimari yapılara ya da yağmurun yağması gibi farklı anlara odaklanan yapımlar da içlerinde bulunmaktadır (Akt. Tağ Kalafatoğlu, 2019, s. 206).

Belgesel yapımlarda müziğin ön planda olduğu yapımların içerisinde popüler müzisyenlere odaklanan ve çalışmanın konusu olan rock belgeseller de bulunmaktadır. Rock müzisyenlerinin doğrudan sinema yönetmenleri tarafından ele alınmaya başlandığı dönem, yerleşik Hollywood türlerinin tükenme belirtileri gösterdiği bir döneme işaret etmektedir. "Bu durum, Hollywood'un geleneksel türlerinin -özellikle western ve müzikal- stüdyo sisteminin çöküşünden sonra kısa vadede hayatta kalamamasıyla daha da kötüleşmiştir" (Beattie, 2005, s. 22). 1960'larda bu türleri eski parlak günlerine geri döndürme çabaları ise genellikle başarısızlıkla sonuçlanmıştır. İlk örneklerini bu dönemde veren rock belgesellerinde, yalnızca rock müzik türü değil farklı popüler müzik türleri ve sanatçılarının çalışmalarına da odaklanılmaktadır. Doğrudan sinemanın çatısı altında şekillenen ilk örnekleri bu araştırmada ele alınmıştır. Bunlar: What's Happening! The Beatles in the USA (1964), Don't Look Back (1967), Monterey Pop (1968), Woodstock (1970) ve Gimme Shelter (1970)'dır.

ROCK BELGESELLERİNİN TARİHSEL VE TÜRSEL KÖKLERİ

Rock belgesellere ilişkin 2000'li yıllarda gerçekleştirilen araştırmalarda bu terimin kullanımına ilişkin önemli unsurlara dikkat çekilmektedir. Baker (2011) rock belgesel-rockumentary teriminin rock n roll ile documentary kavramlarının birleşiminden ortaya çıktığını; bu tür müziğe ilişkin belgesel yapımlarına işaret ettiğini belirtmektedir (s. 2). Eckenroth (2021) ise bu filmlerin odaklandığı müzik türünün illaki rock olmasına gerek olmadığını belirtmektedir (s. 6). Kavramın ilk kullanımı 1969 yılında, popüler müzik konulu bir radyo belgesel dizisinin tanıtım materyalinde gerçekleşmiştir. Rock and Roll'un Tarihi, aynı yılın şubat ayında KHJ Los Angeles'ta yayınlandıktan sonra Variety'nin günlük sayısında "Modern müziğin ilk Rock belgeseli" başlığıyla ön sayfadan duyurulmuştur. Bu terim daha sonra

Rolling Stones dergisi yazarı Jerry Hopkins tarafından KHJ dizisini tanımlamak için kullanılmıştır (Akt. Baker, 2011, s. 2).

Rock belgesel olarak adlandırılan yapımlar, 1960'ların başlarında ortaya konulan ilk örneklerinden itibaren Amerika'da ortaya çıkmış olan doğrudan sinemanın önemli bir alt kolu haline gelmiştir. Gözlemsel doğrudan belgeseller, odaklandıkları konular, bunları ele alışları, kullandıkları hafif ekipman, senkronize ses kaydı ve küçük bir ekiple çalışmaları sonucunda yeni türde belgeseller olarak sinema tarihinde belirgin hale gelmişlerdir. Spontane çekimler yapılmasına olanak sağlayan teknik gelişmeler belgesel çekiminde görünmezlik peşinde olan yapımcıların gözlemci rolünü gerçekleştirebilmelerini sağlamıştır. Barnouw (1993) doğrudan sinemada belgeselcinin kamerasını gerilim ortamına götürdüğünü ve bir krizin çıkmasını beklediğini belirtmektedir (ss.234-251). Barnouw'un gözlemci hareketin öncülerinden olan Albert Maysles'in verdiği isimle doğrudan sinemada film yapım yöntemi duvardaki sinek (fly on the wall) olarak ifade edilmektedir. Kameranın daha hafif hale gelmesi ve geliştirilen ses kayıt cihazlarıyla küçük bir ekibin konularını doğal ortamlarında fark edilmeden kaydedebilmesine işaret etmektedir (Tağ Kalafatoğlu, 2023c. s. 44).

Doğrudan belgesel yönetmenlerinin öncülerinin içerisinde; Robert Drew, Richard Leacock, D.A. Pennebaker, Frederick Wiseman, Albert ve David Mayles vardır (Tağ Kalafatoğlu, 2023c. s. 44). Bu yönetmenlerin yapımları Amerika'nın önemli siyasi kişilerini, sıradan insanların yaşamlarını, farklı kurumların işleyişlerini ve ünlü sanatçıların turnelerinden kesitleri gibi farklı konu alanlarını ele almaktadır. Bunların içerisinde müziği odağına alanlar rock belgeselleri açısından dikkat çekicidir. Beattie (2005) rock belgeselinin, doğrudan sinemayı ticari ve yaygın olarak erişilebilir bir biçime dönüştürdüğünü belirtmektedir. Rock belgeseli olarak adlandırılan yapımlar, 1960'ların başlangıcından bu yana Amerikan doğrudan sinemasının vazgeçilmez bir parçası haline gelmiştir. Gözlemsel doğrudan sinemayla olan bağlarına uygun olarak, rock belgeseli anlatmaktan ziyade göstermeyi vurgulamıştır. Performansçı bedeni ve müzisyenlerin performansını sürekli ön plana çıkartmaktadır (s. 21).

Bu belgesellerin üretildiği dönemde kültürel alanda yaşanan gelişmelere bakıldığında; İkinci Dünya Savaşı sonrasında tüketim toplumunun büyüdüğü, orta sınıf beyaz Amerikalıların zenginleştiği, baby boom olarak adlandırılan nüfusun arttığı bir dönemdir. Ayrıca Amerikalılar yaygın bir biçimde yoksulluk ve kurumsal ırkçılık gibi konuların yol açtığı çatışmalarla yüzleşmektedirler. 1950'lerden '60'lara kadar olan zaman diliminde Soğuk Savaşı'n gölgesi ve Üçüncü Dünya ülkelerindeki toplumsal ve siyasi çalkantıların etkisi belirgindir. Var olan yüksek hayat standartlarının ardındaki çelişkileri gören insanlarda ekonomik ve toplumsal gelişmelere ilişkin giderek artan hoşnutsuzluk karşı kültürde somutlaşmıştır. Anaakım Amerikan yaşamına ilişkin duyulan yoğun huzursuzluk müzikle kendisini dışa vurmaya yönelmiştir. Afrikan-Amerikan gece kulübü, caz, blues ve rock gibi müzik türleri karşı kültür ve Beats hareketlerinin kendilerini ifade aracına dönüşmüştür (Stapleton, 2011, ss. 89-91).

Barnouw (1993) ve Saunders (2014) gibi belgesel tarihi üzerine çalışmaları bulunan araştırmacılar, rock belgesellerini doğrudan sinemanın çatısı altında ortaya çıkan, 16 mm kameraların kullanılmaya başlanması sayesinde çekilmesi mümkün olabilmiş yapımlar olarak görmüşlerdir. Ayrıca Saunders (2014) bu yapımların "gençlik kültürünün iniş çıkışlarının izlerini müzikte aradığını" belirtmektedir (s. 78). Teknik imkanlardaki gelişmeler, film yapımcılarının gözlemci rolüyle hareket edebilmelerini kolaylaştırmaktadır. What's Happening! The Beatles in the USA (1964), Don't Look Back (1967), Monterey Pop (1968), ve Gimme Shelter (1970), doğrudan sinemanın temsilcileri tarafından gerçekleştirilen ilk rock belgeselleridir.

Yönetmenler bu filmlerle rock belgesellerinin ilk dalgası olarak bilinen örnekleri gözlemsel yöntemlerle, dış sese başvurmadan, doğal ortamlarda, rock müzisyenlerine ve müzik etkinliklerine odaklanarak belgelemişlerdir. Stapleton (2011), 1960'ların Amerikan karşı kültürü için önemli olayları olarak görülen rock müziği ve festivallerini belgeleyen bu yapımların, doğrudan sinemanın diğer örneklerinden çeşitli yönleriyle ayrıldığını ifade etmektedir. Ona göre bu farklılıkların içerisinde; makro-politik odaklanmaları, röportaj ve diegetik olmayan film müziği kullanmaları, sahne arkası

kavramından uzaklaşmaları, film yapımcılarının konularıyla özdeşleşmelerinin yarattığı yakınlık bulunmaktadır. Ayrıca 1960'ların karşı kültürünün sembolü olan müziğin giderek ticarileştiğini ve büyük müzik şirketlerinin ticari açıdan dikkatini çektiğini belirtmektedir (s. i, s. 2).

Eckenroth (2021) bu belgesellerin, popüler kültürün son trendlerine odaklanmayı seçmeleri nedeniyle kendilerinden önceki belgesellerden farklılaştıklarını belirtmektedir. Ona göre, doğrudan sinema yönetmenleri popüler müzisyenlerin sahne önü ve sahne arkası kişilikleri arasındaki ilişkiyi yönetme biçimlerine duydukları ilgi nedeniyle bu konulara yönelmişlerdir. Ayrıca ele aldıkları kişiler, savaş sonrası Amerikan toplumunda kimlik oluşumunun daha genel süreçleri için örnek teşkil etmektedir. Diğer taraftan bu konular film yapımcıları için de çeşitli türde engeller oluşturmuşlardır. Bunun nedenleri arasında "sahne arkası görüntülerinin yalnızca izinle çekilebilmesi ve Bob Dylan gibi popüler müzisyenlerin, kimlik inşa sürecinde zaten deneyimli ve medya konusunda bilgili uygulayıcılar olmaları ve her zaman kendi kamusal kişiliklerinin üretimini kontrol etmeye çalışmaları" yer almaktadır. Bu engeller yapımların tarafsız bir kayıt yerine, kültür endüstrisi için araç haline gelebilmeleri; plak şirketlerinin ve sanatçıların ticari çıkarlarına hizmet eden belirli bir tarih versiyonuna dönüşmeleri tehlikesini meydana getirmektedir (ss. 3-4).

Beattie (2005), belgeselin anlatısal yapısına ilişkin çalışmalarda yapımları kurmaca olanlardan ayırırken gerçekliğe aracısız ve yeniden yapılandırılmamış erişim sağlanması üzerinde durulduğunu; ancak kamera önündeki öznelerin performansı üzerinde yeterince durulmadığını vurgulamaktadır. Rock belgesellerini ele alırken bunların doğrudan sinemanın parçası olduklarını ve performatif gösterime odaklanan bir yapıda bulunduklarını ifade etmektedir. Bu belgesellerde ele alınan özneler diğer belgesel türlerindekilerden farklı olarak görüntünü gücünün farkında olan profesyonel performansçılardır. Bu yapımlar "performans sergileyen bedeni ve müzisyenlerin performansını sürekli ön plana çıkarmaktadır" (s. 21). Kamera onlara odaklandığında, özel bir benlik ortaya koymazlar; kamusal bir kişilik yansıtırlar. Sanatçıların sahne arkasına belgeselcilerin erişim izni olmasına karşın bu durum gerçek durumlara erişimin sağlanacağı anlamına gelmemektedir. Sanatçılar sahnede ya da arkasında performans sergilemeye devam etmekte doğal anlarının sergilendiği zamanlarda da tepkileri son derece hesaplanmış olabilmektedir.

ÖNCÜLER VE İLK ÖRNEKLER

What's Happening! The Beatles in the USA (1964)

Albert ve David Maysles kardeşler doğrudan sinemacılarla çalıştıkları Drew Associates'den ayrıldıktan sonra Maysles Film'i kurmuşlardır. Burada farklı konulara odaklandıkları doğrudan sinema belgesel örneklerinin yanı sıra ünlüleri ele alan dört belgesel gerçekleştirmişlerdir. Uzun metrajlı Gimme Shelter, Rolling Stones'u, Meet Marlon Brando (1966) ünlü aktörü, With Love from Truman (1966) tanınmış yazar Truman Capote'u ve What's Happening!'de The Beatles'ı filme almışlardır. Bu yapımlara konu olan öznelerin kamera karşısında performans gösteren benlikler olması bu konudaki tartışmaları gündeme getirmektedir. Filmlerdeki bazı anlar kameraların önünde oynanmış olsa bile temsilin karmaşık doğasını sembolize etmeleri açısından film rock belgeseli yapısı içerisinde işlevsel bir konumdadır. Ayrıca filmlerde performansın bu yönleri olduğu gibi kabul edilmekte ve otantik anların yapay arayışından kaçınılmaktadır.

Ünlü müzik grubu The Beatles'ın ilk Amerika ziyaretlerine odaklandıkları yapımlarını Granada TV için gerçekleştirmişlerdir. Yönetmenler grubun beş gününü filme almıştır. Çekimlerde, JFK havalimanında hayranlarınca karşılanmaları, basın konferansları, Plaza Otel'deki otel odalarında konaklamaları, radyo röportajları, Ed Sullivan Show'daki performansları, DJ Murray the K ile vakit geçirmeleri ve eve dönüşleri yer almaktadır. Maysles kardeşler filmde doğrudan sinemanın karakteristik özelliklerini yansıtmaktadırlar: Bu da röportaj ve seslendirmenin kullanılmamasıdır. Ayrıca mobil kameranın spontane çekimler yapması ve uzun takip çekimleri de doğrudan sinema örneklerindeki anlatım biçimleriyle paraleldir. Filmde ses tasarımı da doğrudan sinema geleneğinin doğal ses

kullanımına ilişkin diğer uygulamalarına benzer bir biçimde gerçekleştirilmiştir. Buna ek olarak yönetmenler çektikleri sahnelerle herhangi bir etkileşim olmamasına da çaba harcamışlardır. Her ne kadar ünlülerle çalışırken bu her zaman mümkün olmasa da gözlemci pozisyonda kalmayı amaçlamışlardır. Böylelikle de grup üyelerinin gündelik yaşamlarındaki doğal tavırlarını yakalamaya çalışmışlardır.

Don't Look Back (1967)

D. A. Pennebaker'ın çektiği ve ve Bob Dylan'ın 1965 İngiltere turnesini ele alan bir belgeseldir. Pennebaker, doğrudan sinema türünde belgeseller çeken, türün önde gelen belgeselcilerindendir. Yapımlarında ele aldığı konuları müdahale etmeden gözlemlemeyi hedeflemektedir. Belgesellerinde, olaylar doğal akışında, anlatıcısız ve soru-cevap tarzı röportaj tekniği kullanılmadan kaydedilmektedir. Uzun çekimler, eş zamanlı doğal ortamdaki seslerin kaydı, konu alınan öznenin gündelik yaşamında bulunduğu mekanlarda çekimlerin gerçekleştirilmesi esastır. Don't Look Back, rock müzik belgeseli türünün en etkili örneklerinden biri olarak kabul görmektedir. Kendisinden sonra çekilecek olan rock belgesellerinin ortaya çıkışını etkilemiştir. Bu yapıma kadar doğrudan sinemanın o zamana kadar çekilmiş olan örnekleri ticari başarı açısından zirveye ulaşamamışlardır. Bu açıdan belgesel bir dönüm noktası olmuştur. Hafif ekipmanla siyah-beyaz çekilen ve senkronize sesin kullanıldığı yapımda, belgesel ekibi duvardaki sinek üslubunda gözlem gerçekleştirmiştir.

Pennebaker yapımda, kronolojik sırayı gevşek bir biçimde takip etmiştir. Anlatı yapısı içerisinde konserlerden görüntüler, kulis anları, otel odası sohbetleri, basın toplantıları diğer rock belgesellerinde olduğu gibi yer almaktadır. Film seyircisinde orada bulunma hissi yaratırken, ünlü bir müzisyenin hayatına içerden bakma fırsatı vermektedir. Dylan'ın sahne imajıyla gerçek kişiliği arasındaki karakter temsiline ilişkin seyircisine önemli anlar sağlamaktadır. Sanatçının performans ustası olduğu yapımda yer alan sahne önü ve arkası arasındaki karakterinin dışa vurumunda açıkça görülmektedir. Ancak zor kimliğini anlamak için, söylediklerinden nelere güvenileceği konusunda net bir şey söylemek güçtür. Dylan'ın basın toplantısında basın mensuplarıyla girdiği tartışmalar filmde karakterinin farklı yönlerini yansıtması bakımından dikkat çekicidir. Bu kısımlar sanatçının üzerinden medyanın temsil ettiği kişilerle kurduğu etkileşime ilişkin eleştirel bir duruş içermektedir.

Monterey Pop (1968)

D. A. Pennebaker'ın yönettiği rock belgesellerinin önemli ilk örneklerinden bir diğeridir. Monterey Uluslararası Pop Festivali'ne odaklanan yapımda, yönetmen 60'ların karşı kültür gençliğinin umudu ve coşkusunu yansıtmıştır. Hazırlıklar, seyircilerin heyecanı ve müzik performanslarının kaydı dikkatleri çekmektedir. Hafif ekipmanla çekilen performanslar sahnedeki sanatçılar ve seyirci arasındaki etkileşimi aktarmaya yoğunlaşmıştır. Yapım müziği odağına almaktadır. Janis Joplin, The Who, Otis Redding ve Jimi Hendrix gibi ünlü sanatçıların performanslarına yer verilmiştir. Doğrudan sinema geleneğine uygun bir biçimde gözlemci pozisyonunda konuya yaklaşılmıştır. İzleyicileri doğrudan sahnelerin içine çeken hareketli bir kamera kullanımı söz konusudur. Hatta Monterey Pop, büyük bir müzik etkinliğinin senkronize ses kaydı yapan 16 mm kameralarla çekildiği ilk filmdir. Pennebaker, mühendislik eğitimi aldığından hafif senkronize kayıt yapabilen kameraların geliştirilmesinde katkıda bulunmasıyla alanda önemli bir yere sahiptir.

Yapımın anlatısında, festivalin genel atmosferinin yansıtıldığı görülmektedir. Konser performansları izleyicilerin izleme deneyimleriyle verilmektedir. Konser alanı, bilet alanlar, sanatçıların performanslarından yakın plan çekimlerle kaydedilmiştir. Gerçek zamanlı ses kaydedilmiş, sahne performanslarından ve izleyici tepkilerinden senkronize kayıtlar alınmıştır. Müzik ve ortam sesleri ön planda tutulmuştur. Görüntü ve sesin kaydında yönetmen müdahalesizlik yaklaşımı çerçevesinde hareket etmiştir. Filmde diğer rock belgesellerinde olduğu gibi sanatçıların sahne arkasındaki

gerçekliklerine ilişkin herhangi bir içerik sağlanmamaktadır. Bu da dikkatimizi tamamen müziğe ve sanatçıların performansları üzerine çekmektedir.

Woodstock (1970)

Michael Wadleigh'in yönettiği belgesel yapımda doğrudan sinemanın çekim teknikleri, anlatım unsurları ve ekipmanı kullanılmış olsa da ne Wadleigh doğrudan belgeselcilerin içerisinde yer alan bir yönetmendir ne de yapımı tam olarak doğrudan belgesel örneğidir. Belgesel 1969 yılında New York'ta düzenlenen Woodstock Müzik ve Sanat Fuarı'nı kronolojik bir yapıda çekmiştir. Büyük bir açık hava rock festivalini, çoşkusuyla ve karmaşasıyla bir arada yakalamıştır. 1970 yılında En İyi Belgesel Oscar'ını kazanmıştır. Rock belgeselleri içerisinde türü geniş kitlelere ulaştırmayı başaran en iyi örneklerden bir tanesi olmuştur. Filmde Woodstock etkinliğinin üç gününe odaklanılmıştır. Üst anlatıcı kullanılmaması, doğal seslerin ve senkronize kayıt yapan hafif ekipmanın kullanılması dikkat çekicidir. Kamera gözlem yapmakta ve festivalin çeşitli yönleriyle çekimlerini yaparken kendi kendine hikayenin ortaya çıkışı için fırsat sağlamaktadır. Doğrudan sinemacıların temel prensiplerinden olan müdahalesizlik büyük oranda korunmuştur.

Sanders (2014) Wadleigh'i ve yapımını gözlemciler arasında saysa da Woodstock'da doğrudan sinemanın ilkeleriyle tam uyuşmayan unsurların olduğunu da belirtmek gerekmektedir. Doğrudan sinemanın karşı çıktığı yapım sonrası yoğun manipülasyon gerçekleştirilmiştir. Filmin kurgusunda yedi kişi çalışmış, çoklu bölünmüş görüntü kullanılmıştır. Filmdeki müziklerin ve 400.000 kişilik kalabalığın çoşkusu bu şekilde başarıyla aktarılabilmiştir. Filmde öne çıkan sanatçıların performansları ve kalabalıktır. Festivalin fiziksel koşullarındaki bazı olumsuzluklar da yapımda gösterilmektedir. Böylelikle gençlik kültürünün zirvesindeki bir festival gerçekçi bir biçimde yansıtılabilmiştir.

Gimme Shelter (1970)

Albert ve David Maysles kardeşler ile Charlotte Zwerin tarafından yönetilen belgeselde The Rolling Stones grubunun 1969 yılındaki ABD turnesi kayda alınmıştır. Yapımda ayrıca konserde gerçekleşen trajik bir ölüm de yer almaktadır. Belgesel adını grubun bir şarkısından alırken, Maysles kardeşlerin diğer yapımlarında olduğu gibi doğrudan sinemanın ilkeleri etrafında gerçekleştirildiği görülmektedir. Yönetmenler gözlemci modunda konularına yaklaşırken konsere ilişkin olayları kronolojik bir yapıda aktarmışlardır. Eleştirmenler tarafından en iyi rock belgesellerinden biri olarak gösterilen yapımda Maysles kardeşler müdahaleci olmayan çizgilerini devam ettirmişlerdir. Yapımda diğer rock belgesellerinde olduğu gibi konser öncesi hazırlıkları, konserde sahne önü arkası, basın toplantıları ve seyirci tepkileri gibi kayıtlara yer verilmiştir.

Gimme Shelter, biçim ve üslup olarak doğrudan sinemanın olayları kurgusal manipülasyon olmadan yakalama ilkelerine bağlı bir yapıdadır. Anlatıcı ses, röportajlar ya da canlandırmalara yer verilmemiştir. Kameranın varlığı unutturularak duvardaki sinek üslubunda olayların kaydı gerçekleştirilmiştir. Açılış sahnesi grubun Altamont konseri görüntülerini izlemeleridir. Böylelikle filmin yapım süreci de belgesele dahil edilmiştir. Grubun üyelerinin belgeselin kayıtlarını izlerkenki tepkileri onlara ilişkin seyircide belirli bir bakış açısı oluşturmak açısından önemlidir. Filmin sahip olduğu meta anlatısal çerçeve yapımı diğer doğrudan sinema örneklerinden ayırmaktadır. Film içinde film yöntemi yeni bir anlatı katmanı oluşturulmasına fırsat sağlamaktadır.

Belgeselin anlatı yapısına bakıldığında görüntülerin, sürekli çekim yapan kameralar tarafından konserin kaotik ortamını yansıtmayı başardığı görülmektedir. İzleyici senkronize ses kaydı ve konser alanından çok farklı açılardan yapılan çekimlerle oradaymış hissine kapılmaktadır. Konsere gidenlerin arasındaki seyircilerden Meredith Hunter'ın Hells Angels üyelerinden biri tarafından bıçaklanarak öldürülmesi de kaydedilmiş ve yapımda bu görüntülere de yer verilmiştir. Cinayetin etkisi grup üyelerinden Jagger'ın yüzünde açıkça görülmektedir. Yapımda, konserin belgelenme biçimine ilişkin çeşitli eleştiriler yöneltilmiştir. Konserin organizasyonuna ilişkin güvenlik sorunları karşısında organizatörlerin ve Rolling Stones'un sorumluluktan muaf olarak gösterildiğine ilişkin eleştiriler dile getirilmiştir. Yapım

popüler müzik grubu çerçevesinde dönemin özelliklerini ve çelişkilerini doğrudan sinema ilkeleriyle yansıtmayı başarmaktadır.

SONUÇ

Belgesel filmlerde 1950'lerin sonları 60'ların başlarına gelindiğinde, çekim ekipmanlarına ilişkin gerçekleştirilen gelişmeler yeni bakış açılarını belgesel anlatısına kazandırmıştır. Doğrudan sinemada belgeselciler konularına müdahale etmeden, kameranın varlığını unutturarak, gözlemci pozisyonunda, uzun kayıtlarla çekimler gerçekleştirmişlerdir. Ayrıca doğal ışık, doğal mekanlar, kriz anlarının çekimlerinde özensiz çerçeveleme, sarsıntılı çekimler, dış ses ya da röportaj kullanılmaması ve kurgunun da gerçeğin olduğu gibi aktarılması ilkesi uyarınca yapıldığı görülmektedir. Konu olarak politikacılardan kurumların işleyişlerine ve ünlülere kadar farklı unsurlar ele alınmıştır. Çalışmada doğrudan sinemanın rock müziğine odaklanan yapımlarına değinilmiştir. Rock belgeselleri doğrudan sinemanın çıkışıyla konu olarak rock müziğine, sanatçılarına ya da konserlerine odaklanan yapımlardır. Ortaya konulan ilk örneklerinde doğrudan sinemanın pek çok özelliğini görmek mümkündür. İncelenen filmler rock belgesellerinin ilk örnekleri olup, yönetmenliğini Michael Wadleigh'ın yaptığı Woodstock dışında diğerlerinin yönetmenleri doğrudan sinemanın öncü isimlerindendir.

Üzerinde durulan What's Happening! The Beatles in the USA (1964), Don't Look Back (1967), Monterey Pop (1968), Woodstock (1970) ve Gimme Shelter (1970)'da rock sanatçılarının sahne performansları, kuliste olup bitenler, medyayla gerçekleştirdikleri görüşmeler, konser hazırlıkları, hayranlarla temaslar, konser anında hayranların tepkileri gibi müziğin odakta olduğu farklı unsurlara ağırlık verilmiştir. Bunlar rock belgesellerinin ortak yönlerini oluşturmaktadır. Ayrıca sanatçının kamusal alandaki benliğiyle gerçek kişiliği arasında ayrım bulunduğu, performansın ön planda olması ve yıldızların performans sergilemekten vazgeçmemeleri nedeniyle ne zaman rol yaptıkları ne zaman gerçeği yansıttıklarını kestirmenin zor olabildiği görülmektedir. Ele alınan filmler, doğrudan sinemanın temel prensiplerini yansıtmaktadırlar. İzleyiciler kamera karşısında olup bitene oradaymış gibi tanıklık etmektedirler. Gerçeklik mümkün mertebe müdahalesiz bir biçimde seyirciye aktarılmaktadır. Rock belgesellerinde o dönemin ruhunu yansıtan müzik ve sanatçıları belgelenmiştir. Ayrıca Hollywood'un stüdyo sisteminin yaratısı olan müzikal gibi türlerin altın çağını geride bırakmasının yarattığı boşluk müziğe odaklanan bu belgesellerle kapatılmıştır.

KAYNAKLAR

Abisel, N. (1996). Popüler Sinema ve Türler. İstanbul: Alan Yayıncılık.

Baker, M. B. (2011). Rockumentary: Style, Performance & Sound in a Documentary Genre.

(Doctoral Dissertation). McGill University, Canada.

Barnouw, E. (1993). Documentary A History of the Non-Fiction Film. New York: Oxford

University Press.

Beaumont, H. (Yönetmen). Broadway Melody (Film). United States: MGM.

Beattie, K. (2005). It's not only rock and roll: 'Rockumentary', direct cinema, and performative

display. Australasian Journal of American Studies, 24(2), 21–41.

Cavalcanti, A. (1926). Nothing But Time (Belgesel). Fransa.

Crosland, A. (Yönetmen). (1927). The Jazz Singer (Film). United States: Warner Bros. Pictures.

Eckenroth, L. (2021). Listen like this: Audiovisual argument in rockumentary (Doctoral

Dissertation), The City University of New York, New York.

Eggeling, V. (Yönetmen). (1925). Symphony Diagonal (Soyut Film).Almanya.

Maysles, A.; Maysles, D. (Yönetmenler). (1964). What's Happening! The Beatles in the U.S.A. (Belgesel film). Maysles Films; Granada Television (ABD/İngiltere).

_____, Maysles, D., & Zwerin, C. (Yönetmenler). (1970). Gimme Shelter (Belgesel Film). United States: Maysles Films; Penforta.

Pennebaker, D. A. (Yönetmen). (1967). Don't Look Back (Belgesel Film). United States: Leacock-Pennebaker.

_____. (Yönetmen). (1968). Monterey Pop (Belgesel Film). John Phillips – Lou Adler Prod.; Leacock-Pennebaker, ABD.

Richter, H. (Yönetmen). (1921). Film ist Rhythmus: Rhythmus '21 (Soyut Film). Almanya.

_____. (1928). Inflation (Belgesel). Almanya.

_____. (1928). Racing Symphony (Belgesel). Almanya.

Ruttman, W. (1927). Berlin, Symphony of a Great City (Belgesel Film). Almanya.

Saunders, D. (2014). Belgesel. Çev. Ali Nejat Kanıyaş. İstanbul: Kollektif Kitap.

Sheeler, P.; Strand, P. (1921). Manhatta (Belgesel). United States.

Stapleton, P. (2011). The rockumentaries, direct cinema, and the politics of the 1960s (Master's thesis, University of Otago). Otago University Research Archive.

Tağ Kalafatoğlu, Ş. (2016).Sinema ve Avangart Sanat Hareketlerinin Kesişim Noktasındaki Belgesel Yapımlar. Journal of Turkish Studies. Volume 11/2 Winter 2016, p. 1113-1138.

Tağ Kalafatoğlu, Ş. (2019). Mimari ve Fonsiyonel Tasarımların Belgesel Filmlerindeki Kesişme Noktası Olan Yapımlar: Gökdelen Senfonisi ve Köprü Belgeselleri. Erasmus International Academic Research Symposium In Educational and Social Science, April 5-6 2019, İzmir.

Tağ Kalafatoğlu, Ş. (2023a). Joris Ivens ve Şehir Senfonileri. 17. Uluslarası Güncel Araştırmalarla Sosyal Bilimler Kongresi, 02-06 Kasım 2023.

Tağ Kalafatoğlu, Ş. (2023b). Şehirler Üzerine Belgeseller. Disiplinlerarası Sanat ve İletişim Araştırmaları II. Bişkek: Literatürk.

Tağ Kalafatoğlu, Ş. (2023c). Robert Drew ve Doğrudan Sinema, EU 3rd International Conference On Humanity and Social Sciences, November 17-19 2023, Tiran.

Vertov, D. (Yönetmen). (1929). Man with a Movie Camera (Belgesel Film). Soviet Union: VUFKU.

Wadleigh, M. (Yönetmen). (1970). Woodstock (Belgesel Film). United States: Wadleigh-Maurice; Warner Bros.

ERNST JÄCKH (1875–1959): A JOURNALİST AND CULTURAL ENVOY AT THE INTERSECTİON OF OTTOMAN MODERNİZATİON AND GERMAN CULTURAL IMPERİALİSM

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ABSTRACT

At the beginning of the 20th century, Germany pursued its quest to expand spheres of influence in global politics through a strategy of cultural diplomacy driven by culture, education, and the press. The Ottoman Empire, meanwhile, was searching for a new balance in its relations with the West, viewing Germany as a reliable partner in its modernization efforts. In this context, one of the most influential figures shaping the intellectual and diplomatic rapprochement between the two states was Ernst Jäckh. Through his writings, networks, and organizational activities, Jäckh became one of the key actors establishing the cultural foundations of Ottoman-German cooperation.

Jäckh's first contact with the Ottoman Empire occurred during his visit to Istanbul in 1908. His close interactions with Enver, Talat, and Cemal Pashas profoundly impressed him, as he observed the Ottoman modernization efforts firsthand. After returning to Berlin, he published articles in various media outlets, shaping a strong pro-Ottoman perception in German public opinion and presenting the Empire as "a new force turning toward European civilization."

In 1911, with the support of the German Foreign Ministry, Jäckh organized the German-Turkish Study Trip, which facilitated the reception of Ottoman bureaucrats and intellectuals in Germany and laid the groundwork for institutionalized relations. In 1913, he founded the German-Turkish School Association, which aimed to establish schools in the Ottoman Empire and expand German cultural influence through education. The German-Turkish Association, founded in 1914, soon became one of the largest civil organizations of the period. Supported by industrialists such as Robert Bosch and Wilhelm Merton, the association strengthened German ideological influence within the Ottoman Empire by enabling Ottoman students to pursue education in Germany.

Jäckh was also appointed president of the German World Policy Association, positioning him as a key figure in implementing a vision that sought to create a cultural and diplomatic "corridor of influence" stretching from Germany to Ottoman territories. His initiatives also gave rise to the Istanbul Friendship House project, endorsed by the Ottoman government and planned on a 6,000-square-meter plot donated by the state. The project aimed to materialize "German-Turkish brotherhood" through exhibitions, reading rooms, and public lectures.

In conclusion, Ernst Jäckh played a pivotal role in shaping Ottoman-German relations in the cultural and diplomatic spheres. His activities represented, for Germany, a model of expansion in which cultural imperialism and diplomacy intertwined; for the Ottoman Empire, they reflected a search for a new orientation on the international stage during its modernization process.

Keywords: Ernst Jäckh; Ottoman–German Relations; German–Turkish Association

REFERENCES

Asker, A. (2019). İzmir'de "Alman Hastanesi ve Enfeksiyon Hastalıkları Araştırma Enstitüsü" kurma çalışmaları (1915–1918). Çağdaş Türkiye Tarihi Araştırmaları Dergisi – Journal of Modern Turkish History Studies, 19(39), 441–459.

Böttcher, J. (2023). Der deutsch-türkische Bildungsraum im Wilhelminischen Kaiserreich: Akteure, Netzwerke, Diskurse. Julius Klinkhardt Verlag.

Frey, A. (2009). Der Journalist und Politologe Ernst Jäckh. In C. Schrenk (Ed.), Heilbronner Köpfe V: Lebensbilder aus fünf Jahrhunderten (p. 54). Stadtarchiv Heilbronn.

Heuss, T. (1958). Notizen und Exkurse zur Geschichte des Deutschen Werkbundes. In H. Eckstein & Deutscher Werkbund Hessen (Eds.), 50 Jahre deutscher Werkbund (pp. 19–26). A. Metzner.

Jäckh, E. (1916). Der aufsteigende Halbmond: Auf dem Weg zum deutsch-türkischen Bündnis (6., ergänzte Auflage). Deutsche Verlags-Anstalt.

Kaufmann, M. R. (2017). Ernst Jäckh (1875–1959) und die Deutsch-Türkische Freundschaft: Betrachtungen zu Ernst Jaeckhs Memoiren „Der Goldene Pflug". P. Leidinger & U. Hillebrand (Eds.), Deutsch-Türkische Beziehungen im Jahrhundert zwischen Erstem Weltkrieg und Gegenwart: Grundlagen zu Geschichte und Verständnis beider Länder – 100 Jahre Deutsch-Türkische Gesellschaft Münster (pp. 201–212). LIT Verlag.

Kılıç, S. (2018). Birinci Dünya Savaşı'nda Almanya'nın Kafkas halklarını Rusya'ya karşı ayaklandırma girişimleri. Türkiyat Araştırmaları Enstitüsü Dergisi, 62, 481–507

Martin, A. (2012). Die Ebenen von Ideologie in nicht-fiktionalen Werken am Beispiel der Kriegspublizistik Ernst Jäckhs zum deutsch-osmanischen Bündnis des Ersten Weltkrieges. In E. İşler (Ed.), Ideology in Western Literature (pp. 45–52). Pamukkale University Press.

Mogk, W. (1974). Jäckh, Ernst. Neue Deutsche Biographie, 10, 264–267.

Özçalık, Dumanoğulları, S. (2020). Promoting an alliance, furthering nationalism: Ernst Jäckh and Ahmed Emin in the time of the First World War. De Gruyter. https://doi.org/10.1515/9783112209394

Özçalık Dumanoğulları, S. (2024). Ernst Jäckh. In D. Thomas, J. Chesworth, I. Aščerić-Todd, S. Grodź, D. Pratt, C. Soldat, & C. Wenzel (Eds.), Christian-Muslim relations: A bibliographical history (Vol. 22, Central Europe [1800–1914]) (pp. 503–510). Brill.

Piller, E. (2021). Selling Weimar: German public diplomacy and the United States, 1918–1933. Franz Steiner Verlag.

Rohrbach, P. (1903). Deutschland unter den Weltvölkern: Materialien zur auswärtigen Politik. Buchverlag

Schrenk, C. (2011). Friedrich Naumann und Heilbronn – Einblicke in das »Netzwerk Jäckh, Bruckmann, Heuss«. Jahrbuch zur Liberalismus-Forschung, 23, 29–45.

QƏRBİ AZƏRBAYCAN - GÖYÇƏ AŞIQ SƏNƏTİNİN KÖKLƏRİ

(Qədim oğuz, türkmən və Azərbaycan folkloruna dair təhlillər və tədqiqatlar)

Filoloji bilimler doktoru. dos.Gülxani (Pənah) Şükürova*

XÜLASƏ

Məqalədə sırf Azərbaycanda, eləcə də ona məxsus Cənub Azərbaycanda, Ermənistan ərazisinə qatılmış azərbaycanlıların yaşadıqları, dədə-baba ərazilərdən Qərbi Azərbaycanda mövcud olan qədim qəbirstanlıqlar, bu qəbirstanlıqların nə xristianlıq, nə müsəlmançılıq izləri olmadığını ən qədim, əski dövrlərə mənsubluğunu bir daha təsdiqləmiş iri daşlara həkk olunmuş şəkillər, indiki cürə saza bənzər, çanağı bir qədər uzunsov daş abidələrlə bağlı tədqiqatçıların araşdırmaları təhlil edilir. Qədim oğuz, türkmən və Azərbaycan folkloruna dair qiymətli əsərlərdən olan «Kitabi-Dədə Qorqud» dastanları, V.V. Bartoldun bu dastanların «Qafqaz mühitində yarandığını», A.Y.Yakubovski Drezden nüsxəsinin Azərbaycanda «yazıya alındığını», K.İnostrantsev, V.Jirmuniski, A.Kononov kimi məşhur türkoloqların «Dədə Qorqud»un «Azərbaycan xalqının əcdadları tərəfindən yaradıldığını» təsdiq etdikləri, ən məşhur türk alimlərindən olan M.F.Köprülünün, Əflatun Cəm Güneyin, Suad Hisarçının, Orxan Şaiq Gökyayın və Mühərrəm Erkinin də dastanın ən çox azəri türkləri ilə bağlılığı fikirləri tədqiqata cəlb edilir. F.Köprülünün türk xalqlarının ədəbiyyatının böyük qolu olan aşıq poeziyasının tarixinin ilk mərhələləri ilə bağlı araşdırmaları, «ata, baba, dədə» adlı söz sahiblərinin ədəbi irsi, Göyçə aşıq sənətinin Övliya, Pir, Ozan, Mürşid, Dədə Hüseyndən, Miskin Abdaldan qüdrətli ustad Aşıq Ələsgərəcən və ondan bu günəcən «fasiləsiz sənət ənənəsi, ustad-şagird şəcərəsi» haqqında aparılan təhlil və tədqiqatlar araşdırırlır.

Açar sözlər: Azərbaycan, Göyçə, Qərbi Azərbycan, aşıq, ozan, oğuz

The roots of Western Azerbaijan – Goycha ashıg art

(Analysis and research on ancient Oghuz, Turkmen and Azerbaijani folklore)

ABSTRAKT

The article analyzes the research of researchers on ancient cemeteries in Western Azerbaijan, where Azerbaijanis who joined the territory of Armenia lived, the ancestral lands of these cemeteries, the images carved on large stones, which once again confirm that these cemeteries belong to the most ancient, ancient times, and the presence of traces of neither Christianity nor Islam, and the stone monuments resembling the current saz, with a slightly elongated bowl. The study draws on the ideas of the ancient Oghuz, Turkmen and Azerbaijani folklore epics "Kitabi-Dade Gorgud", V.V. Bartold, who stated that these epics "were created in the Caucasus environment", A.Y.Yakubovsky's Dresden copy was "written down" in Azerbaijan, and famous Turkologists such as K.Inostrantsev, V.Chirmuniski, and A.Kononov confirmed that "Dade Gorgud" was "created by the ancestors of the Azerbaijani people", and the most famous Turkish scholars, M.F.Koprulu, Aflatun Jam Guney, Suad Hisarchin, Orkhan Shaig

Gökyay and Muharram Erkin, who stated that the epic is most closely related to Azerbaijani Turks. F. Köprülü's research on the first stages of the history of ashig poetry, a major branch of the literature of the Turkic peoples, the literary heritage of the owners of the words "ata, baba, dede", the analysis and

research conducted on the "uninterrupted artistic tradition, master-student lineage" of the Goycha ashig art from the Evliya, Pir, Ozan, Murshid, Dede Huseyn, Miskin Abdal to the mighty master Ashig Alasgaraj and from him to the present day are examine.

Key words: Azerbaijan, Goycha, Western Azerbaijan, ashig, ozan, oghuz.

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GİRİŞ

Alimlərimiz «Kitabi-Dədə Qorqud» dastanlarının yarandığı yer kimi sırf Azərbaycanı, eləcə də ona məxsus Ermənistan, Gürcüstan ərazisinə qatılmış azərbaycanlıların yaşadıqları, dədə-baba əraziləri əsas götürür və bu ərazilərdə yarandığı məsələsində qəti israrlıdır. Onlar dünyanın bir çox tədqiqatçılarının bu mövzuda fikirlərini əsas götürür. Məsələn, V.V. Bartold bu dastanların «Qafqaz mühitində yarandığını», A.Y.Yakubovski Drezden nüsxəsinin Azərbaycanda «yazıya alındığını», K.İnostrantsev, V.Jirmuniski, A.Kononov kimi məşhur türkoloqların «Dədə Qorqud»un «Azərbaycan xalqının əcdadları tərəfindən yaradıldığını» təsdiq etdiklərini əsas götürür. Bununla bağlı Anar ən məşhur türk alimlərindən olan M.F.Köprülünün, Əflatun Cəm Güneyin, Suad Hisarçının, Orxan Şaiq Gökyayın və Mühərrəm Erkinin də dastanın ən çox azəri türkləri ilə bağlılığı fikirlərinin də dediklərinə əyani sübut olduğunu göstərir. O, Erkinin aşağıdakı fikrini verir: «Kitabi-Dədə Qorqud bütünlüklə Azərbaycanın törəməsidir. Bu barədə yalnız şəxs adları və kitabın toponimiyası çox şey deyir. Yalnız bu deyil, əsərin dilində də Azərbaycanın damğası var. Kitabın məzmunuyla tanış olan kimi bu ölkəyə düşürsən. Leksika, frazeologiya, morfologiya, sintaksis hər sətirdə bizi Azərbaycan türk diliylə qarşılaşdırır» (G.Pənah. 2006).

QƏRBİ AZƏRBAYCAN - GÖYÇƏ AŞIQ SƏNƏTİNİN KÖKLƏRİ

Qədim oğuz, türkmən və Azərbaycan folkloruna dair qiymətli əsərlərin müəllifi Xalıq Koroğlunun Dədə Qorqud oğuzlarının məskəni haqqında söylədiyi bu fikir də («onlar Azərbaycanın demək olar ki, bütün müasir ərazisində və Ermənistan, Gürcüstan ərazisinin müəyyən hissələrində yaşayırdılar. Bu, müasir azərbaycanlıların indi yaşadığı yerlərlə tam uyğun gəlir») real həqiqətlərə söykənir .

Tədqiqatçı H.İsmayılov Göyçədə mövcud olan qədim qəbirstanlıqlar, bu qəbirstanlıqların nə xristianlıq, nə də müsəlmançılıq izləri olmadığını, ən qədim, əski dövrlərə mənsubluğunu bir daha təsdiqləmiş olduğunu açıqlayır: «Hər bir qəbrin üstünə iri daşlar qoyulmuşdu. Daşlardan birinin üstündə alov təsvir edilmişdi. Bu daş dəvəyə oxşadığına görə ona «dəvə daşı» deyirdilər. Başqa bir daşın üstündə indiki cürə saza bənzər, çanağı bir qədər uzunsov bir şəkil diqqəti cəlb edirdi. Xalq arasında buna «saz» daşı deyirdilər" (H.İsmayılov. 2001; 42).

Bu gün ermənilərin bəlkə də yerlə yeksan etmiş olduğu bu tarixi abidələrin böyük tarixi, elmi mahiyyət daşıdığını, "Şorca kəndinin mərkəzindəki qəbirstanlıqda olan qədim məzarların başdaşındakı Qobustan

qaya təsvirlərinə bənzər oğlan şəkli ulu keçmişimizdən xəbər verən böyük tarixin kiçik bir nişanəsi" olduğunu yazır. Alim çox təəssüf hissi ilə bildirir ki, "amma heç kəs nə onun mahiyyətinə varır, nə də elmi-tarixi əhəmiyyətini düşünürdü».

Tədqiqatçı Göyçə aşıq yaradıcılığını araşdırmazdan öncə aşıq sənətinin köklərini araşdırmağa cəhd edir. F.Köprülünün türk xalqlarının ədəbiyyatının böyük qolu olan aşıq poeziyasının tarixinin ilk mərhələlərini «doğru müəyyənləşdirdiyi» fikrində olan tədqiqatçı bu fikirlərə diqqəti cəlb edir. F.Köprülü yazır: «Türklərin X-XIII əsr əsnasında zəngin bir xalq ədəbiyyatına malik olduqlarını bildiyimiz kimi, bu ədəbiyyatın bəzi qiymətli örnəklərinə də malik olduğumuzdan Əhməd Yəsəvidən əvvəlki zamanlarda türklərin necə və nə kimi əsərlərlə ədəbi ehtiyaclarını ödədiklərini layiqi ilə izah edə bilərik. «Kutadqu-bilik» və ona bənzər əsərlər qüvvətli islam mərkəzi halına gəlmiş olan Türküstan şəhərlərində mədrəsə görmüş adamlar arasında oxuna dururkən xalq kütləsi öz ehtiyacını əsrlərdən bəri olduğu kimi, xalq şairlərinin sadə məhsullarıyla təmin edirdi» (H.İsmayılov. 2002;54).

H.İsmayılov bildirir ki, bu xətlərdən biri folklor ənənəsidir, ikincisi isə folklor sisteminin içində muxtar hüquqlara malik el şairi xəttidir. Təkkə şairi (sufi dərviş) mərhələsinədək onlar folklor üslubunda şifahi xalq şeirinin yaradıcı subyekti kimi çıxış etsələr də, ədəbi mülkiyyətin sahibi ideyasında bulunduqları müşahidə olunmur.

Köprülünün Yusif Hacib Balasağunlunun «Kutadqu-bilik», M.Kaşğarlının «Divani-lüğat-it-türk» əsərlərindən çıxış edərək həmin qaynaqlarda saxlanmış əski şeir nümunələrini, o sıradan yazla qışın deyişməsini mərsiyə adlandırmasını (F.Köprülü yazırdı: «Bu dövrlərdən qalan əsərlərin bir qismi öyrədici (didaktik) bir mahiyyət toxunma haiz əxlaq düsturları kimi tərəqqi oluna bilir... bu əsərlər arasında ən qiymətli olanlar «sağü-mərsiyələr» idi. Matəm ayinlərində və ya ümumi toplantılarda, İslamiyyətdən əvvəlki dövrlərdə yalnız dini və sonralar daha çox bədii bir mahiyyət gözlənərək qopuzların bərabərliyində tərənnüm olunan bu mərsiyələr, ümumiyyətlə, uzun olurdu; ölünün fəzilətləri, döyüşlərin müxtəlif səhifələri, düşmənlərə qalib gəlməsi, döyüşlərin harada olması, ölən qəhrəman üçün bütün qövmün, hətta bütün təbiətin nə qədər çox üzgün olduğu birər-birər təsvir edilirdi. Məcazlar bəsit və ibtidai olmaqla bərabər, səmimi və rəngarəng idi. Bəzi mərsiyələrdə yazla qışın canlı birər şəxsiyyət şəklində təsvir edilib canlandırılaraq «Kutadqu-bilik»də olduğu kimi münazirə edildiyi də olurdu» (Bombaçi A. 1987; 25) qəbul etmir. F.Köprülünün «sağu»lardan (ağılardan) fərqli olaraq başqa mətnlərin arxaik ritual əsasını müəyyənləşdirə bilməməsinin açıqca göründüyünü yazır.

F.Köprülünün türk xalq ədəbiyyatını İslamdan əvvəl və İslamın ilk illərində, xüsusilə türklər İslamı qəbul edəndən sonrakı dövrlərdə araşdıraraq «orijinal tezislər» təqdim etdiyini (F.Köprülü yazır: «Bizim qənaətimizə görə, Əhməd Yəsəvi zühur etdiyi zaman türk aləmi uzun bir zamandan bəri, hər halda IV əsrdən bəri təsəvvüf fikirlərinə alışmış, mütəsəvvüflərin mənqəbə və kəramətləri yalnız şəhərlərdə deyil, köçəbə türklər arasında belə az-çox yayılmışdı. İlahilər, şeirlər oxuyan, Allah rizası üçün xalqa bir çox yaxşılıqlar edən, onlara cənnət və səadət yollarını göstərən dərvişləri türklər əskidən dini bir qüdsiyyət verdikləri ozanlara bənzədərək hərarətlə qəbul edir, dediklərinə inanırdılar. Bu surətlə əski ozanların yerini ata və ya baba ünvanlı bir takım dərvişlər almışdı. Həzrəti Peyğəmbərin səhabələrindən olaraq göstərilən Arslan baba isə mənqəbəyə görə İslam dinini anlamaq məqsədilə Türküstandan Cəzirətül-Ərəbə gəlmiş və Həzrəti Əbu Bəkrlə görüşərək İslamiyyəti qəbul eyləmiş olan ozanlar piri məşhur Qorqut ata, Çoban Ata iştə bunlardan qalmış birər xatirəni yaşadır. Hər halda, Əhməd Yəsəvinin zühuru zamanında köçəbə türklər arasında, yəni Sır Dərya kənarlarında və bozqırlarda anladıqları bir dillə, yəni sadə türkcə isə onlar arasında yaymağa çalışan dərvişlərin olduğu, bizcə, həqiqətdir» (Bombaçi A. 1987; 19) bildirir və H.İsmayılov da buna münasibətini bildirir: «Bu dərviş zümrəsinin sufi (ortodoksal sufizm

nəzərdə tutulur) dərvişlərin sələfi, əski türk xalq sufizminin daşıyıcı subyekti olması şübhəsizdir; adı nağıllarımızda və dastanlarımızda keçən, «baba dərviş»in özüdür. Əski abidələrin və folklor örnəklərinin saxladığı informasiyaya görə, bu zümrənin adı dörd şəkildə müşahidə olunur: 1) ata, 2) baba, 3) dədə, 4) lələ. Bunların hər biri türk dünyagörüşünün və mədəniyyət tarixinin müxtəlif səviyyələrinin işarələridir.

Ata. Öncə bu ad əcdad kultunun işarəsidir. İcma başçısıdır. Sonra şaman-kahindir: «Qam ata». Daha sonra əski monoteist dini olan Tanrıçılığın peyğəmbəridir-savçıdır (əski türkcə «elçi», peyğəmbər). Kitabi-Dədə Qorquddan («Rəsul Əleyhissəlam zamanına yaqın Boyat Boyundan Qorqut ata derlər, bir ər qopdu. Oğuzun ol kişi tamam bilicisiydi, nə dersə olurdu. Qaibdən dürlü xəbərlər söylərdi. Həqq-təala onun könlünü ilham edərdi») misal gətirir..

H.İsmayılov bunu əski tanrıçılığın yaranışı haqqında məlumat adlandırır və folklor qanunauyğunluqlarına müvafiq olaraq həmin məlumatın İslam epoxal zamanı çərçivəsində verildiyini bildirir və bunu tamamilə təbii sayır və «söyləyici ozanların-informatorun və mediatorun sonuncu» nümayəndələrinin (kitab yazıya alınana qədər) İslamın yaranmasından sonrakı dövrə aid olduqlarını bildirir.

«Kitabi-Dədə Qorqud»un müqəddiməsində ("Kitabi-Dədə Qorqud". 1988) mətnin əvvəlindən «soylama»ya qədər dörd dəfə Qorqud adının «Qorqud ata» deyə xatırlandığını, ilk soylamanı isə «Dədə Qorqud» soylamış (dədə ifadəsinin işlənməsi-G.P) kimi işlənməsinə münasibətini bildirir. Bunun «söz, ad, titul, epitet» fərqləri deyil, özündə dünyagörüşü və mədəniyyət sistemlərinin iri laylarını» ehtiva etdiyini qeyd edir. Tanrıçı ata ilə qam atanın oxşar keyfiyyətlərinin aşağıdakı faktorlarla şərtləndiyini bildirir. Qam atanın (qam şamanın) oğuz cəmiyyətində yeri və fəaliyyəti haqqında informasiyalar daha çox "türk tanrıçılığı dövrünə" aid olduğunu yazır. Yəni şaman, oğuz qamı dinsiz bir cəmiyyətdə yox, mükəmməl dini dəyərlərin mövcud olduğu bir cəmiyyətdə fəaliyyət göstərdiyi qənaətindədir.

Tədqiqatçı eyni zamanda oğuz qamı ilə Sibir, Altay, Yakut və s. şamançılığını qarışdırmamağı tövsiyə edir, çağdaş funksional Altay şamançılığı ilə əski oğuz qamının müqayisəsini və həm də onun eyni vahidlər kimi təhlil olunmasını elmi prinsiplər baxımından «qüsurlu» bilir. Oğuz qamının Oğuz tanrıçılığı mühitində uzun illər bir dövr ərzində fəaliyyət göstərib modernist səciyyə daşıdığını, ən azı ortodoksal tanrıçılığa dinin kahini rolunda çıxış etdiyini bildirir və hər iki inamın «fərqli mükəmməllik dərəcəsində olsa da, eyni etnik dünyagörüşdən, əski mifik təsəvvürlərdən «dünya modelindən» qaynaqlandığını qeyd edir. Əski oğuz dünyagörüşü və mədəniyyəti haqqında daha çox «Kitabi-Dədə Qorqud»dan və Oğuznamələrdən çıxış olunduğunu qeyd edir və bu qənaətdədir ki, «Kitabi-Dədə Qorqud» da Oğuznamə silsiləsinə aiddir. "Qərbi oğuzlarla şərqi oğuzların lokal mədəni differensiallaşması prosesi"ni İslam öncəsi hadisəsi sayır. "Yəni türklərin İslam çevrəsinə girmələrindən əvvəl, şərqi oğuzların X-XI, XIII-XIV əsrlərdə əski vətənlərinə Azərbaycana və Anadoluya dönmələri ilə bəzi əski inamlar da, o sıradan qamlıq da ədəbi-bədii örnəklərdə ifadə olunma tezliyini artırmış oldu"- deyir. Xüsusilə, Şərqi oğuz yurdunda Orxon-Yenisey ətrafında qalan Bayundurların (o cümlədən Salurların) bir hissəsi monqollarla birgə yaşadıqlarından "monqol-şaman elementlərini də özləri ilə" gətirdiklərini, «Kitabi-Dədə Qorqud»da bunların öz əksini tapdığını, "yəni «Kitabi-Dədə Qorqud»dan görünən tanrıçı ata və qam ata eyniliyi əslində monqol şaman mühitindən çıxmış Bayundurların dünyagörüşünü ifadə edir. Nəzərdən qaçırmayaq ki, «Kitabi-Dədə Qorqud» Bayundurların Azərbaycanda hakimiyyəti zamanı yazıya alınıb və sarayda xana müraciətlə oxunub» - yazır.

«Baba» fenomeninin folklorda, etnoqrafiyada sistemli şəkildə öyrənilmədiyini, «ədəbi fikir daşıyıcısı kimi folklorda mövqeyi müəyyənləşdirilmədiyini qeyd edən tədqiqatçı H. İsmayılov folklorda babanın sehirli almanı (nağıllarda), aşiqlərə butanı (dastanlarda) verən kimi məlum olduğunu qeyd edir. Ad kimi

«baba»nın tarixi ardıcıllıq sırasında yeri tanrıçılıq peyğəmbəri «ata»dan da əvvələ gedib çıxdığı fikrindədir. Amma Azərbaycan folklorunda «baba»nın el şairi, bir sənətkar kimi formalaşması «ikincidir» - deyir. Ata və baba sözlərinin qohumluq terminləri olub, işlədilməsindəki «yerdəyişmələri»n müşahidə olunduğunu deyir, babanı ozandan bir qədər üstün, sakral missiya daşıyıcısı kimi folklorda görür, «ozan ifasında «baba»nın sakral obrazı müşahidə olunur» - deyir. «Kitabi-Dədə Qorqud»dakı «ağ saqqalı baban yeri uçmaq olsun» ifadəsində soyun və boyun əski əcdadi-ümumi başlanğıc dini-ruhani «baba» nəzərdə tutulduğu, mətndə alqışın «ona» ünvanlandığı fikrindədir.

Mahmud Kaşğarlının «Ata» və «baba» kəlmələrinin fərqli (türklər «ata», oğuzlar «baba») şəkildə işlənməsini «xalq dilində əski türk (ümumtürk) kökündən oğuzun milli-mədəni vahid kimi üzvlənməsinin işarəsi kimi də» anlaşıla bildiyini, həmin üzvlənmənin mədəniyyətin bütün səviyyələrində, eləcə də musiqidə və ədəbiyyatda baş verdiyini qeyd edir. «Sosial, siyasi, dini, ideoloji və ədəbi mühitin dəyişməsi (oğuzların İslam kültür çevrəsinə girməsi) sonralar aşıq sənəti kimi tanınan xalq sənətinin, xalq musiqisinin və xalq ədəbiyyatının əski ənənədən tamamilə qopmayan, amma yeni keyfiyyətlər qazanaraq fərqli bir sənət kimi formalaşmasına gətirib çıxarmış olduğu fikrindədir.

Əski türk inam sistemindən gələn "baba"nı ortodoksal sufizm mərhələsində «xoca», «pir», «mürşid», sakral dünya ilə mistik təmasda olan müqəddəs şəxsiyyət, «ocaq», birbaşa «Tanrı savçısı «ata»nın davamı», İslam çevrəsində «təriqət başçısı, övliya», «tanrı eşqilə yaşayan türkün əski inam daşıyıcısı», «ədəbi fəaliyyət sistemində isə el şairi»dir, ilahi türkülər qoşur, Tanrıya qovuşmaq ideyasını tərənnüm edir. H.İsmayılov «türk xalq sufizminin daşıyıcısı olan «ata», «baba və dədə»nin xalq şeiri üstündə zəngin bir ədəbiyyat yaratdığını, bu ədəbiyyatın folklora qovuşduğunu yazır. "Ağız ədəbiyyatı aşıq musiqisi, aşıq sənəti adı altında bizə gəlib çatan türk xalqının mədəniyyət hadisəsi, bu sintetik sənətin təməlində dayanan mədəni subyekt tiplərinin (atanın, babanın, dədənin, ozanın, təkkə şairinin, sufi dərvişin, haqq aşiqinin, aşığın) timsalında sözü gedən Tanrı sevgisinin (eşqinin), Tanrı (haqq) inamının daşıyıcıları və bu sevgi və inamı tərənnüm edən, mistik və estetik ideyanı reallaşdıran el şairləridir»- fikrindədir.

Hüseyn İsmayılov «babanın dini rəhbər (sufizmdə təriqət başçısı, piri) funksiyası daşımasını özündə göstərən mənbələrin olduğunu qeyd edir. Xoca Əhməd Yəsəvinin adı və hikmətləri ilə bağlı mənbələri xatırladır.

«Dədə» adı altında fəaliyyət göstərənlərin ata, baba ilə yaxınlığını qeyd edir. Ata Şərqi oğuzların (əski türklərin), baba Qərb oğuzlarının, dədə ümumən oğuzların içində oğuz, türkman tipinin spesifik bir mədəniyyət forması (institutu) olduğu fikrindədir. «Kitabi-Dədə Qorqud»da Qorqud yalnız mətnin ilk cümlələrində işlənən «ata»dan sonra bir qayda olaraq «dədə»dir. Bu dəyişmə diaxron diferensiallaşmanı göstərən kültür laylanmasının terminoloji əlamətidir. H.İsmayılov Dədənin sakral mahiyyət daşıdığını Xətayinin aşağıdakı varsağında

Qaibdən dəlil göründün,

Dədəm, xoş gəldin, xoş gəldin.

Bizi sevib sevindirdin,

Dədəm, xoş gəldin, xoş gəldin.

-aydın şəkildə ifadə olunduğunu bildirir. (Caferoğlu A.1988)

Prof. Qara Namazovun «dədə» adına öz araşdırmalarında «diqqət» yetirdiyini göstərir. Qara Namazov "Dədə" sözünün "ulu ata", "böyük ata" mənasını daşıdığını, indi də işləndiyini, "ən hörmətli və nüfuzlu sənətkarlara" verilən fəxri titul olduğunu, Dədə Qorquddan sonra ən mötəbər aşıqların - Öysüz Dədə, Dədə Kərəm, Dədə Qərib, Dədə Abbas, Dədə Yadigar, Dədə Qasımın bu adla xatırlandığını yazırdı. (Q.Namazov. 1984).

M.H.Təhmasib Dədə aşıqları xarakterizə edir: «Dədə aşıqlar sözün həqiqi və geniş mənasında sənətin hələlik öz müstəqil sahələrinə bölünməmiş vahid vəziyyətinin, yaxud mərhələsinin əsas xüsusiyyətlərini özündə yaşatmışlar. Yəni onlar həm şair, həm dastançı, həm bəstəkar, həm də öz yaratdıqlarını ifa etməyi bacaran məharətli xalq sənətkarları olmuşlar. Misal üçün, Sovet dövrünün dədə hesab edilən Aşıq Əsədi, XIX-XX əsrlərin Ələsgəri, XVIII əsrin Dədə Qasımı, XVII əsrin Turab Dədəsi, XVI əsrin Dədə Yediyarı, nəhayət, bizcə, bunların hamısından daha qədim olan Kərəm Dədəsi və başqaları ancaq sənət sinkretizmi ilə əlaqədar olan ustadlar, dədələrdir. Belə dədələrdən ən məşhuru, şübhəsiz, Dədə Qorqud-dur» (M.Təhmasib.1972; 29). Folklorşünas Mürsəl Həkimov da bu fikirləri təsdiqləyir.

H.İsmayılov Fuad Köprülünün verdiyi məlumatların, apardığı araşdırmaların nəticəsi kimi «ata, baba, dədə» adlı söz sahiblərinin ədəbi irsini aşağıdakı kimi qruplaşdırır:

1. Atanın ədəbiyyatımıza saxladığı ədəbi irs ata sözləridir. Ata Tanrı savçısıdır. Nəzərdən qaçırmayaq ki, əski türkcədə ata sözü, məsəl və bu janra daxil olan bir sıra xalq deyimlərinin ümumi adı savdır. H.Zeynallı bu termini «söz-sov» deyimindən çıxış edərək onun sözdən törəndiyini ehtimal etmişdir. Bizə görə söz «sovmaq, sovuşdurmaq» sözünə daha çox uyğundur. «Kitabi-Dədə Qorqud»da «azıb gələn qəzayı Tənqri sovsun» alqışında da müşahidə olunur. Bu da atanın qoruyuculuq funksiyasına uyğundur.

2.Babanın ədəbi irsi isə sufi dərvişlərin yaradıcılıq nümunələridir. Bizə görə klassik məhəbbət dastanlarının da yaradıcısı onlardır. Bütün dərvişlər baba deyildir. Baba yalnız şeyxlər, pirlər, mürşidlər, övliyalardır. Müridlər isə sadəcə olaraq sufi şairlərdir, yaxud adi dərvişlərdir. Dədənin ədəbi irsinə Dədə Qorquddan Dədə Ələsgərə qədər bütün dədə sənətkarların yaradıcı örnəkləri daxildir.

3. Ata sənət sistemindən üstün mövqedə dayanır və bir qədər ondan kənarda təsəvvür olunur. Amma onun söz ehtiyatı bütün hallarda və zamanlarda aparıcı mövqedə istifadə olunur. Ata sözləri ozan və aşıq sənətlərinin estetik ürfani əsasını təşkil edir. İnam kimi də türk sufi dünyagörüşünün mənşəyi ona bağlanır.

4. «Lələ» folklorda sönük görünür. "Əsli və Kərəm"də sofi (sufi) lələ haqq aşiqini müşayiət edir. Xalq ağzında işlənmə tezliyinə görə də passivdir» (H.İsmayılov. 2001; 65).

Prof.Tofiq Hacıyevin də ozanın dədə tipinin (Dədə Ozanın) fərqləndiyini aşkarladığı, detallarla təsdiqlədiyini yada salır. «Qırğızların «Manas» dastanını aşıq-ozan ifadə edə bilmədiyi, «Manas»çının xüsusi ifaçıları, adına manasçı deyildiyini, Dədə Qorqudun elə başdan-başa «şeir» olduğunu, onu sərbəst ifadə edə bilməyin qeyri-mümkünlüyünü, onun şeir dilinin bugünki heca olmadığını, Dədə Qorqud dastanının «xüsusi qorqud ifaçısı» olduğu fikrinə diqqəti cəlb edən H.İsmayılov oğuz cəmiyyətinin ümumi kültür vahidi kimi götürülən ozandan zaman keçdikcə qopmalar baş verdiyini, qamın ozandan üzvləndiyini çox qədim dövrün hadisəsi olduğunu bildirir. «İlkin olaraq magik funksiyalı söz sənətçisi ozanın özü olmuş, cəmiyyətdə mədəni dəyərlərin artması ilə estetik tələbin də yüksəldiyindən ozan sənəti daha çox estetik təmayülə meyl etmişdir. Magik funksiyası isə qamla (şamanla) onun arasında bölünmüşdür. Qam

magik ritual icraçısıdır, onun ekstatik vəziyyətə düşməsi də ma-gik üsullarla baş verir. Sufi dərvişin ekstaza çatması isə mistik üsullarla baş verir» (H.İsmayılov. 2001; 66).

Magik funksiyasının ozanla şaman arasında parçalanması və bu sənət növlərinin əsrlərlə paralel şəkildə mövcud olduğunu təsdiq edən «folklor, tarix, və etnoqrafiya» bilgilərinin az olmadığını, sadəcə olaraq onların sistemli araşdırılmasına ehtiyac olduğunu görür.

Ozandan qopan ikinci üzvlənməni «baba dərviş»i görür, «türk ortodoksal sufizminin məlum nümayəndələri onlardan olub, «dədə»ni həm ozana, həm sufiyə, həm də aşığa aid olan keyfiyyət göstəricisi» bilir və Dədə Ozanla baba dərvişin X-XVI əsrlərdə paralel şəkildə mövcud olduğu qənaətindədir. Dədə aşıqla ozan sənətinin son nəsli olan adi ozanların da XVI-XVII əsrlərdə cəmiyyətin mədəni subyektləri kimi yanaşı yaşadığını, ozanların estetik, magik, mistik və s. funksiyalarını ciddi sosial-mədəni faktorlarla bağlı olaraq itirdiyini, «son estetik funksiyada dədə aşıqlarla rəqabətə dözmədiyini bildirir.

Ozandan asılı olmayan əski türk saz və musiqi sənətindən qopan qamın müstəqil şəkildə mövcud olmuş, İslam qəbul edildikdən sonra funksional şəkildə üzvlənmiş olduğu, indi mövcud olan cindar, falçı, hətta parapsixoloq ekstrasenslərin də qamın-şamın törəməsi olduğu fikrindədir.

H.İsmayılov ozan sənətinin genezisini tədqiq edərkən, onu şaman (qam) sənətinin törəməsi kimi ("Oğuz etnosunun tarixi-mədəni inkişafı üzərində apardığımız müşahidələrdən o qənaətə gəldik ki, sözügedən cəmiyyətdə ilkin sinkretik mədəniyyət fenomeni atadır. O, əski icmanın başçısıdır, ritual icraçısıdır (ilkin inamlarla bağlı, həm də sosial-məişət kontekstində ənənəvi mərasimlərin icraçısıdır), türkəçarəçidir (xalq həkimidir) və s."-H.İ) qəbul etmir.

Qorqud Atanın funksiyalarının kifayət qədər geniş diapazona malik olduğu fikrindədir. Tarixin müxtəlif mərhələlərində "əski türk ata institutunda diferensiallaşma" getdiyini, Ozan da "əski inamların daşıyıcısı, sakral mahiyyətli baba, bir qədər sonra loğman adı almış türkəçarəçi də atanın funksional törəməsi kimi" qəbul edildiyini, Azərbaycan mədəniyyətində şaman və qam adlı sənət olmadığını yazır: "Bəzi yazılarımızda bu terminləri funksional mahiyyəti cindarlıq, cadugərlik olan sənətləri işarələmək üçün işlətmişik. Əgər "Kitabi-Dədə Qorqud"dan görünən qam elementlərindən çıxış olunsa, onda nəzərə almaq lazımdır ki, bu elementlər şərqi oğuzların gətirdiyi (X-XIV əsrlər) buddist monqol inamlarının təsiridir; yəni genetik oğuz hadisəsi deyildir. Türkmən baxışı da bu qəbildəndir" ((H.İsmayılov. 2001;118).

NƏTİCƏ. H.İsmayılov üç əsr ərzində (XVII-XX) aşıq (Azərbaycan), yanşaq (Türkiyə) adı ilə tanınan sənətin başlanğıcında əsasında və bu sənətin «qlobal epoxal kəsimində» iri bir mərhələ kimi «ata-dədə»nin dayandığı» tezisi irəli sürür: «Bu mərhələ dini-ideoloji baxımdan oğuz Tanrı savçısı atadan oğuz xalq sufizminin təriqət təmsilçisi dədəyə qədər fasiləsiz bir inkişaf yolu keçmişdir. Tarixi baxımdan bu mərhələ İslamdan öncəki əsrlərdən başlanaraq XVI əsrədək olan bir dövrü əhatə edir. Dədənin və dədəlik institutunun fərdi təzahürləri XVI-XIX əsrlərdə də qismən qorunmuşdur. Bu institutun son nümayəndəsi təsəvvüfi və islami dini-ürfani dəyərləri, yüksək sənət estetikasını (musiqi və ədəbiyyatı) ən mükəmməl şəkildə reallaşdıran Dədə Ələsgərdir» (H.İsmayılov. 2001; 69).

Göyçə aşıq sənətinin Övliya, Pir, Ozan, Mürşid, Dədə Hüseyndən, Miskin Abdaldan qüdrətli ustad Aşıq Ələsgərəcən və ondan bu günəcən «fasiləsiz sənət ənənəsi, ustad-şagird şəcərəsi» məlum olduğu, sovet dövründə də şair, yazıçı kimi onun «saxta» da olsa belə irəli sürdüyü ideyaları tərənnüm etməyə vadar edilsə də, fikrində haqlıdır ki, «Bütövlükdə XVIII əsrin II yarısından sonrakı aşıq xalis sənət adamıdır; təsəvvüfi və islami ideyalar isə aşığın poetik sənət arsenalında funksional baxımdan arxa plana keçir.

Sakral ruhani mahiyyətindən məhrum olan aşıq sənəti bu dövrdə şadlıq məclislərini aparan bir xalq sənətkarına çevrilir» (H.İsmayılov. 2001; 70).

ƏDƏBİYYAT

1.G.Pənah. «Anar və folklor». Bakı. 2006.

2.Göyçə dastanları və aşıq rəvayətləri (toplayanı və tərtib edəni H.İsmayılov, redaktoru Y.Qarayev). Bakı. Səda. 2001.

3.H.İsmayılov. Göyçə aşıq mühiti; təşəkkülü və inkişaf yolları. Bakı. Elm. 2002.

4.Bombaçi A. Törkskie literaturı, vvedenie v istoriö i stilğ-Zarubecnaə törkoloqiə. M.Nauka. 1986.

5.«Kitabi-Dədə Qorqud». F.Zeynalov və S.Əlizadə. Bakı. Yazıçı. 1988.

6.Caferoğlu A. Azerbaycan ve Anadolu folklorunda saklanan Şaman Tanrısı. Ankara Universitesi İlahiyyat fakultesi Dergisi. VII. 1958.

7.Qara Namazov. Azərbaycan aşıq sənəti. Yazıçı. Bakı. 1984.

8. M.Təhmasib. Azərbaycan xalq dastanları (orta əsrlər). Elm nəşriyyatı. Bakı. 1972.

THE APPLICATION OF NATIONAL ORNAMENTAL MOTIFS IN CONTEMPORARY ART

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ABSTRACT

National ornamental motifs have long been an integral part of Azerbaijani art, serving as a medium for expressing cultural identity and aesthetic values. Historically, patterns featuring plant, animal, and geometric elements were not only decorative but also reflected the worldview, cultural, and spiritual values of the people. In the contemporary period, the application of these motifs in art ensures a synthesis of traditional and modern elements, contributing to the formation of a new aesthetic language.

Contemporary artists employ national ornamental motifs extensively across sculpture, painting, graphics, and design. They present these motifs not merely as visual decoration but as elements carrying conceptual and symbolic meaning. For instance, in modern sculpture, ornaments enhance the rhythm of form and compositional harmony, while in painting and graphic works, national motifs visually foreground cultural context.

The application of national ornaments in contemporary art is realized through both technical and aesthetic innovations. Digital technologies, experimental materials, and mixed media enable artists to reinterpret traditional motifs on new levels, making them more accessible and visually engaging for modern audiences. This approach serves not only to preserve cultural heritage but also to support the continuous development of the arts.

In conclusion, the use of national ornamental motifs in contemporary art preserves the historical-aesthetic traditions of Azerbaijani art while enriching it with contemporary creative principles. This process strengthens the visual expression of national identity and adds both aesthetic and symbolic depth to artworks.

Keywords: national ornament, contemporary art, aesthetic values, visual communication, Azerbaijani art

YAPAY ZEKÂNIN COĞRAFYA EĞİTİMİNE ENTEGRASYONU: KURAMSAL BİR MODEL ÖNERİSİ

INTEGRATION OF ARTIFICIAL INTELLIGENCE INTO GEOGRAPHY EDUCATION: A THEORETICAL MODEL PROPOSAL

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ÖZET

Bu araştırmanın temel amacı, yapay zekâ teknolojilerinin coğrafya eğitimindeki kullanımını kuramsal bir çerçeve doğrultusunda sistematik biçimde incelemek, yapay zekâ temelli araçların coğrafya öğretimine etkilerini mevcut literatür ışığında analiz etmek ve bu doğrultuda "Yapay Zekâ Destekli Coğrafya Okuryazarlığı Modeli" adıyla özgün bir kuramsal model geliştirmektir. Günümüz coğrafya eğitimi; mekânsal düşünme, harita okuryazarlığı, veri analizi, çevresel süreçlerin yorumlanması ve problem çözme gibi çok boyutlu bilişsel becerileri gerektirmektedir. Dijital teknolojilerdeki hızlı gelişmeler, GeoAI, makine öğrenmesi, derin öğrenme ve doğal dil işleme gibi yapay zekâ tabanlı araçların coğrafya öğretimine entegrasyonunu hızlandırmıştır. Bu bağlamda çalışma, yapay zekânın coğrafya öğretimine sağladığı katkıları, pedagojik yansımalarını ve ortaya çıkardığı sınırlılıkları literatüre dayalı sistematik bir analizle ele almaktadır. Araştırma, nitel araştırma yaklaşımı doğrultusunda tasarlanmış ve doküman incelemesi yöntemiyle yürütülmüştür. Ulusal ve uluslararası akademik dergiler, kitaplar, teknik raporlar ve kurumsal yayınlar betimsel analiz ve tematik sentez teknikleri kullanılarak değerlendirilmiştir. Bulgular, yapay zekânın coğrafya eğitimine özellikle dört alanda katkı sunduğunu göstermektedir: mekânsal düşünme becerisinin güçlenmesi, büyük veri ve GeoAI analizlerinin derslere entegrasyonu, harita okuryazarlığının gelişmesi ve öğretmenlerin pedagojik tasarım süreçlerinin desteklenmesi. Bununla birlikte algoritmik yanlılık, veri gizliliği, pedagojik uyarlama gereksinimi ve teknoloji bağımlılığı gibi sınırlılıklar dikkatle yönetilmesi gereken unsurlar olarak öne çıkmaktadır. Çalışmanın sonucunda, mekânsal okuryazarlık, veri okuryazarlığı, harita okuma becerisi, etik farkındalık ve pedagojik rehberliği kapsayan beş boyutlu özgün bir kuramsal model geliştirilmiştir. Bu model, coğrafya eğitiminde yapay zekâ entegrasyonuna yönelik kuramsal bir temel sunmakta ve gelecekteki araştırmalar için yol gösterici bir çerçeve oluşturmaktadır.

Anahtar Kelimeler: Yapay Zekâ, Coğrafya Eğitimi, GeoAI, Mekânsal Okuryazarlık, Kuramsal Model

ABSTRACT

The main aim of this study is to systematically examine the use of artificial intelligence (AI) technologies in geography education within a theoretical framework, to analyze the effects of AI-based tools on geography teaching based on the existing literature, and to develop an original theoretical model entitled the Artificial Intelligence–Supported Geography Literacy Model. Contemporary geography education requires multidimensional cognitive skills such as spatial thinking, map literacy, data analysis, interpretation of environmental processes, and problem solving. Rapid developments in digital

technologies have accelerated the integration of AI-based tools-including GeoAI, machine learning, deep learning, and natural language processing-into geography education. In this context, the study investigates the contributions of AI to geography teaching, its pedagogical implications, and its associated limitations through a systematic literature-based analysis. The research was designed using a qualitative research approach and conducted through document analysis. National and international academic journals, books, technical reports, and institutional publications were examined using descriptive analysis and thematic synthesis techniques. The findings indicate that AI contributes to geography education particularly in four key areas: strengthening spatial thinking skills, integrating big data and GeoAI analyses into instruction, enhancing map literacy, and supporting teachers' pedagogical design processes. However, issues such as algorithmic bias, data privacy, the need for pedagogical adaptation, and the risk of technology dependence were identified as critical challenges that require careful management. As a result of the study, an original five-dimensional theoretical model encompassing spatial literacy, data literacy, map literacy, ethical awareness, and pedagogical guidance was developed. This model provides a theoretical foundation for the integration of AI into geography education and offers a guiding framework for future research.

Key words: Artificial Intelligence, Geography Education, GeoAI, Spatial Thinking and Literacy, Theoretical Model

GİRİŞ

Coğrafya Eğitiminin Dünyadaki Mevcut Durumu

Coğrafya eğitimi, çağdaş eğitim sistemlerinin temel bileşenlerinden biri olmakla birlikte, birçok ülkede dersin konumu ve etkisi üzerine tartışmalar sürmektedir. Günümüzde coğrafya eğitiminin temel amacı; bireylerin mekânsal düşünme, çevresel okuryazarlık, küresel farkındalık ve sürdürülebilirlik bilinci gibi 21. yüzyıl becerilerini geliştirmektir. National Research Council (2006), coğrafya eğitiminin merkezinde mekânsal düşünme becerisinin yer aldığını ve bu becerinin eleştirel düşünme, problem çözme ve çevresel süreçlerin anlaşılmasında kritik bir rol oynadığını vurgulamaktadır. Benzer şekilde UNESCO (2017), sürdürülebilir kalkınma, çevresel okuryazarlık ve küresel sorumluluk bilincinin coğrafya eğitimi aracılığıyla geliştirilmesi gereken temel yeterlikler arasında yer aldığını belirtmektedir. Bu çerçeveler, coğrafya eğitiminin yalnızca yer bilgisinin aktarımına indirgenemeyeceğini; öğrencilerin dünyayı bütüncül ve çok boyutlu biçimde anlamlandırmalarını sağlayan bir öğrenme alanı sunduğunu ortaya koymaktadır.

UNESCO ve OECD gibi uluslararası kuruluşlar, coğrafya eğitiminin iklim değişikliği, çevresel sorunlar ve mekânsal eşitsizlikler gibi küresel problemlere çözüm üretme kapasitesi nedeniyle stratejik bir disiplin hâline geldiğini vurgulamaktadır (UNESCO, 2022). Bu doğrultuda coğrafya eğitimi, bilgi aktarımına dayalı bir ders olmaktan çıkarak eleştirel düşünme, analitik yorumlama, problem çözme ve kanıta dayalı karar verme süreçlerini içeren çok boyutlu bir yapıya dönüşmüştür.

Birçok ülkede coğrafya müfredatları, öğrencilerin mekânsal örüntüleri çözümleme, verileri yorumlama, yerel–küresel bağlantılar kurma ve çevresel sistemleri bütüncül biçimde değerlendirme becerilerini geliştirmeye yönelik olarak yeniden yapılandırılmaktadır (Lambert & Morgan, 2021). Sürdürülebilir kalkınma, iklim değişikliği, doğal afetler, göç, kentsel büyüme ve mekânsal adalet gibi temalar, küresel ölçekte coğrafya eğitiminin ortak odak alanları hâline gelmiştir. Bununla birlikte uluslararası araştırmalar, öğrencilerin harita okuryazarlığı ve mekânsal biliş becerilerinde önemli eksiklikler bulunduğunu ortaya koymakta; bu durum coğrafya öğretiminde yenilikçi ve öğrenen merkezli pedagojik yaklaşımlara duyulan ihtiyacı artırmaktadır (Larangeira & van der Merwe, 2016).

Son yirmi yılda coğrafya eğitiminin en belirgin dönüşüm alanlarından biri, dijital teknolojilerin sınıf ortamlarına entegrasyonu olmuştur. Dijital haritalar, interaktif atlaslar, uzaktan algılama görüntüleri,

CBS uygulamaları, artırılmış gerçeklik ve sanal saha gezileri, coğrafya öğretiminde yaygın biçimde kullanılmaktadır (Kerski, 2008). Bu teknolojiler, karmaşık mekânsal süreçlerin görselleştirilmesini kolaylaştırarak soyut kavramların daha anlaşılır hâle gelmesine katkı sunmaktadır.

Dijital teknolojilerin artan kullanımı, öğrenme süreçlerinin öğrencilerin bilişsel özelliklerine ve öğrenme hızlarına göre uyarlanmasını mümkün kılmakta; daha etkileşimli ve bireyselleştirilmiş öğrenme ortamlarını desteklemektedir (Panjaitan, Ningrum & Waluya, 2023). Dijital haritalar ve web tabanlı coğrafi uygulamalar, karmaşık coğrafi süreçlerin pedagojik amaçlarla yeniden yapılandırılmasına önemli olanaklar sağlamaktadır (Gómez-Trigueros, 2018). Bununla birlikte bu dönüşüm, coğrafya öğretmenlerinin teknolojik pedagojik alan bilgisi ve dijital yeterliklerini daha kritik hâle getirmekte; öğretmenlerin teknoloji entegrasyonu konusunda sürekli mesleki gelişim desteğine ihtiyaç duyduğunu ortaya koymaktadır (Sezer, Şanlı, Pınar, & Kara, 2022; Panjaitan et al., 2023). Bu durum, dijital dönüşümün pedagojik temellerinin güçlendirilmesini zorunlu kılmaktadır. Teknolojik gelişmeler coğrafya eğitimine önemli katkılar sunmakla birlikte, günümüzde bu dönüşüm yeni bir evreye girmiştir: yapay zekâ temelli öğrenme ortamları. Bu evre, yalnızca teknoloji kullanımının artmasını değil; öğretim süreçlerinin doğasının yeniden tanımlanmasını da beraberinde getirmektedir.

Yapay Zekâ: Tanım, Tarihsel Gelişim ve Güncel Yenilikler

Yapay zekâ, insanın bilişsel süreçlerini taklit ederek öğrenme, akıl yürütme, örüntü tanıma ve problem çözme gibi zihinsel işlevleri algoritmalar aracılığıyla gerçekleştiren bir teknoloji alanıdır. Yapay zekâ; bilgisayar sistemlerinin deneyimlerden öğrenmesini, girdiler arasındaki ilişkileri analiz etmesini ve belirli bir amaç doğrultusunda kararlar üretebilmesini sağlayan yöntem ve modellerden oluşmaktadır (Russell & Norvig, 2021). Bu yönüyle yapay zekâ, yalnızca teknolojik bir yenilik değil, insan düşünme biçimini dijital ortama taşıyan bir paradigma değişimi olarak değerlendirilmektedir.

Yapay zekânın tarihsel gelişimi 1950'li yıllara uzanmakta; 1980'lerde uzman sistemlerle, 2000'li yıllardan itibaren ise artan veri miktarı ve işlem gücüyle makine öğrenmesi ve derin öğrenme yaklaşımlarıyla hız kazanmıştır. Günümüzde doğal dil işleme, görüntü tanıma, büyük veri analitiği, uzamsal modelleme ve yapay sinir ağlarına dayalı öğrenme gibi uygulamalar geniş bir kullanım alanına ulaşmıştır (Goodfellow, Bengio & Courville, 2016). Özellikle derin öğrenme mimarileri, karmaşık örüntülerin yüksek doğrulukla analiz edilmesini mümkün kılmaktadır. Yapay zekânın eğitim alanındaki hızlı yükselişi, büyük veri setlerinden beslenebilme ve veri içindeki ilişkileri otomatik olarak keşfedebilme kapasitesine dayanmaktadır. Eğitimde kullanılan yapay zekâ araçları; öğrenme süreçlerini izleyen, öğrenme güçlüklerini belirleyen, kişiselleştirilmiş öğrenme yolları sunan ve anlık geri bildirim sağlayan sistemler üretmektedir (Holmes et al., 2019). Doğal dil işleme temelli modeller öğretim süreçlerine metin üretimi ve açıklama desteği sağlarken; görüntü işleme teknikleri harita, uydu görüntüsü ve çok katmanlı mekânsal verilerin analizinde önemli olanaklar sunmaktadır.

Son yıllarda öğrenme analitiği, uyarlanabilir öğrenme ortamları, otomatik değerlendirme sistemleri ve içerik öneri algoritmaları, yapay zekânın eğitimde kullanımını şekillendiren temel uygulamalar arasında yer almaktadır (Holmes et al., 2019). Bununla birlikte bilgi doğruluğu, veri gizliliği ve algoritmik yanlılık gibi etik konular da eğitim araştırmalarında giderek daha fazla önem kazanmaktadır (Zawacki-Richter et al., 2019). Bu bağlamda yapay zekâ kullanımının bilişsel, duyuşsal ve etik boyutları birlikte ele alınması gereken çok boyutlu bir dönüşüm yarattığı görülmektedir. Bu noktada yapay zekâ ile coğrafya eğitimi arasındaki ilişkinin sistematik biçimde incelenmesi, hem kuramsal tartışmaların derinleştirilmesi hem de uygulama alanlarının netleştirilmesi açısından kritik önem taşımaktadır.

Yapay Zekâ – Coğrafya Eğitimi İlişkisi

Yapay zekâ teknolojilerinin eğitimde yaygınlaşması, coğrafya öğretiminin yöntemsel ve pedagojik boyutlarını önemli ölçüde dönüştürmektedir. Coğrafya; mekânı anlamlandırma, yer–bölge ilişkilerini

çözümleme ve çok katmanlı mekânsal verileri yorumlama gibi üst düzey bilişsel beceriler gerektirdiği için, yapay zekâ uygulamalarının en etkili biçimde kullanılabildiği disiplinlerden biri hâline gelmiştir (Chen et al., 2023). Bu bağlamda yapay zekâ temelli sistemler, hem öğrenme süreçlerini zenginleştirmekte hem de öğretmenlerin içerik geliştirme ve pedagojik tasarım süreçlerine destek sağlamaktadır.

GeoAI, makine öğrenmesi ve derin öğrenme tekniklerini kullanarak arazi örtüsü sınıflandırması, kentleşme eğilimlerinin tahmini, afet riski belirleme ve iklimsel değişimlerin modellenmesi gibi karmaşık mekânsal süreçleri yüksek doğrulukla analiz edebilmektedir (Li & Arundel, 2022). Literatür, GeoAI uygulamalarının öğrencilerin örüntü tanıma, mekânsal ilişkilendirme ve konumsal analiz becerilerini geliştirdiğini ve özellikle lise ile üniversite düzeyinde öğrenme motivasyonunu artırdığını göstermektedir (Li et al., 2021; Batty, 2020).

Coğrafya derslerinde içerik üretimi, ölçme-değerlendirme ve modelleme süreçleri yapay zekâ uygulamalarıyla hız kazanmıştır. Yapay zekâ tabanlı araçlar, tematik haritaların ve veri görselleştirmelerinin hızlı üretimine olanak tanırken; öğrenme analitiği yoluyla öğrenci performansının izlenmesini mümkün kılmaktadır (Ifenthaler et al., 2019). Ayrıca yapay zekâ temelli simülasyonlar, iklim değişikliği, nüfus hareketleri ve arazi kullanım değişimleri gibi süreçlerin modellenmesine katkı sağlamaktadır (Yu et al., 2022; Climate Interactive, 2024; Leal Filho et al., 2025). Bu dönüşüm, coğrafya öğretmenlerinin yapay zekâ farkındalığı ve pedagojik teknoloji entegrasyonu konusunda yeni yeterlikler edinmesini zorunlu kılmaktadır. Araştırmalar, öğretmenlerin yapay zekâ araçlarını kullanmaya istekli olduklarını ancak pedagojik rehberlik konusunda önemli eksiklikler yaşadıklarını göstermektedir (Zawacki-Richter et al., 2019). Türkiye'de ise yapay zekâ tabanlı uygulamaların üniversite düzeyinde yaygınlaşmasına karşın, coğrafya öğretmenliği programlarında pedagojik entegrasyon sürecinin henüz başlangıç aşamasında olduğu görülmektedir.

Problem Durumu

Son yıllarda yapay zekâ teknolojilerinin eğitim sistemlerine hızla entegre edilmesi, öğretim süreçlerinin niteliğini, öğrenme ortamlarının yapısını ve öğrencilerin bilişsel gelişimini doğrudan etkileyen önemli bir dönüşüm yaratmıştır. Bu dönüşüm, coğrafya eğitimi açısından da dikkate değer sonuçlar doğurmaktadır. Coğrafya; mekânsal düşünme, konumsal ilişkilendirme, çok katmanlı veri analizi ve çevresel süreçlerin yorumlanması gibi üst düzey bilişsel beceriler gerektirdiği için, yapay zekâ temelli teknolojilerin öğretime sağladığı katkılar bu disiplin açısından özellikle kritik bir önem taşımaktadır (Chen et al., 2023). Buna karşın alan yazın incelendiğinde, yapay zekânın coğrafya eğitiminde hangi pedagojik çerçeveyle ve nasıl bütüncül biçimde kullanılacağına ilişkin kuramsal olarak temellendirilmiş yaklaşımların henüz yeterince gelişmediği görülmektedir.

Mevcut çalışmalar çoğunlukla öğrenme analitiği, makine öğrenmesi tabanlı görselleştirme sistemleri veya doğal dil işleme modelleri gibi belirli yapay zekâ araçlarının sınırlı bağlamlardaki kullanımına odaklanmakta; bu uygulamaların coğrafya eğitiminin genel yapısına nasıl entegre edileceğine ilişkin kapsamlı kuramsal tartışmalar büyük ölçüde eksik kalmaktadır (Li & Arundel, 2022). Bu durum, yapay zekâ uygulamalarının coğrafya öğretiminde çoğu zaman araç-odaklı ve parçalı biçimde ele alınmasına yol açmaktadır.

Bunun yanı sıra yapay zekâ uygulamalarının sunduğu otomasyon olanaklarının pedagojik niteliği yeterince sorgulanmamaktadır. Öğrencinin bilişsel yükünü azaltması beklenen bu teknolojilerin, bazı durumlarda yüzeysel öğrenmeyi teşvik ettiği ya da aşırı teknoloji bağımlılığına neden olduğu ifade edilmektedir (Selwyn, 2019). Etik ve güvenlik boyutları da önemli bir problem alanı oluşturmaktadır. Yapay zekâ sistemlerinde veri niteliği, algoritmik yanlılık, veri gizliliği ve öğrenci profillemesi gibi konular, coğrafya öğretimi bağlamında henüz açık ve bütüncül bir çerçeveye kavuşturulamamıştır (Zawacki-Richter et al., 2019).

Bu çerçevede temel problem, yapay zekânın coğrafya eğitimine entegrasyonuna ilişkin literatürün parçalı, araç-odaklı ve kuramsal açıdan sınırlı bir yapıya sahip olmasıdır. Yapay zekâ–coğrafya eğitimi ilişkisini fırsatlar, sınırlılıklar, etik boyutlar ve pedagojik etkiler çerçevesinde bütüncül biçimde ele alan ve alana özgü bir kavramsal model öneren çalışmalara duyulan ihtiyaç giderek artmaktadır. Bu eksiklik, coğrafya eğitiminin dijital dönüşüm sürecinde önemli bir kuramsal boşluk oluşturmakta ve yapay zekâ uygulamalarının planlı, güvenli ve pedagojik açıdan temellendirilmiş biçimde kullanılmasını zorlaştırmaktadır.

Araştırmanın Amacı ve Önemi

Yapay zekâ teknolojilerinin eğitimde giderek yaygınlaşması, coğrafya öğretiminde kullanılan yöntemleri derinden dönüştürmektedir. GeoAI, doğal dil işleme ve makine öğrenmesi gibi yenilikler, coğrafya derslerinde kullanılabilecek dijital araçların çeşitliliğini artırmakta ve öğrenme süreçlerine yeni epistemolojik ve pedagojik perspektifler kazandırmaktadır (Chen et al., 2023). Buna rağmen literatürde, yapay zekâ uygulamalarının coğrafya eğitimine nasıl bütüncül ve kuramsal bir çerçeve içinde entegre edileceğine ilişkin açıklayıcı modellerin sınırlı olduğu görülmektedir (Zawacki-Richter et al., 2019). Bu çalışma, söz konusu kuramsal boşluğu doldurmayı hedeflemesi bakımından önem taşımaktadır. Geliştirilen model; öğretmenlere, program geliştiricilere, araştırmacılara ve eğitim politikası yapıcılarına yapay zekâ temelli coğrafya öğretiminin nasıl yapılandırılabileceğine ilişkin yol gösterici ilkeler sunmaktadır. Aynı zamanda model, yapay zekâ kullanımının pedagojik temellerini güçlendirmeyi ve coğrafya öğretiminde dijitalleşmenin sunduğu fırsatların daha sistematik biçimde değerlendirilmesine katkı sağlamayı amaçlamaktadır. Bu yönüyle çalışma, literatüre hem kuramsal hem de uygulamaya dönük özgün bir katkı sunmaktadır.

Bu araştırmanın temel amacı, yapay zekâ teknolojilerinin coğrafya eğitimindeki kullanımını kuramsal bir çerçeve doğrultusunda sistematik biçimde incelemek, yapay zekâ temelli araçların coğrafya öğretimine etkilerini mevcut literatür ışığında analiz etmek ve bu doğrultuda "Yapay Zekâ Destekli Coğrafya Okuryazarlığı Modeli" adıyla bir kuramsal model geliştirmektir.

Problem Cümlesi

Yapay zekâ teknolojileri coğrafya eğitiminde pedagojik, bilişsel ve bağlamsal boyutlar çerçevesinde nasıl etkili biçimde kullanılabilir ve bu doğrultuda coğrafya öğretimine özgü bütüncül bir yapay zekâ temelli kuramsal model nasıl geliştirilebilir?

Alt Problemler

1. Yapay zekânın coğrafya eğitimine katkıları nelerdir?

2. Coğrafya eğitimine yönelik yapay zekâ temelli bütüncül bir kuramsal model nasıl geliştirilebilir?

YÖNTEM

Bu araştırma, yapay zekâ teknolojilerinin coğrafya eğitimindeki yeri, işlevi, fırsatları, sınırlılıkları ve pedagojik etkilerini kuramsal açıdan incelemek amacıyla nitel araştırma yaklaşımı temelinde yapılandırılmıştır. Çalışma kapsamında uygunluk temelli örnekleme ile seçilen bilimsel yayınlar derinlemesine analiz edilmiş ve elde edilen veriler doküman incelemesi yöntemiyle sistematik biçimde değerlendirilmiştir. Literatürde farklı içeriklerde üretilmiş bilgilerin tutarlı bir çerçevede bütünleştirilmesi amacıyla betimsel analiz ve içerik temelli sentez tekniklerinden yararlanılmıştır.

Araştırma Deseni

Araştırma, mevcut literatürün bütüncül olarak incelendiği kuramsal bir derleme çalışması niteliğindedir. Bu tür çalışmalar, alan yazınındaki eğilimlerin belirlenmesine, kavramsal çerçevelerin oluşturulmasına ve yeni model önerilerinin geliştirilmesine katkı sağlamaktadır (Creswell & Creswell, 2018). Bu bağlamda çalışma, yapay zekâ–coğrafya eğitimi ilişkisine yönelik dağınık ve parçalı bilgileri bir araya getirerek açıklayıcı ve bütünleştirici bir kuramsal yapı sunmayı amaçlamaktadır.

Veri Toplama Süreci

Araştırmada kullanılan veriler, yapay zekâ ve coğrafya eğitimi alanlarında yayımlanmış ulusal ve uluslararası akademik kaynaklardan elde edilmiştir. Veri kaynakları akademik dergiler, kitaplar, raporlar ve kurumsal teknik dokümanlardan oluşmaktadır. Çalışmanın amacı doğrultusunda kapsamlı bir literatür taraması yapılmış ve içerik uygunluğu yüksek olan yayınlar ayrıntılı incelemeye alınmıştır.

- Uluslararası Dergiler ve Veri Tabanları : Araştırmanın temel kaynaklarını International Research in Geographical and Environmental Education, Computers & Education, Journal of Geography, Geography Compass ve International Journal of Geographical Information Science gibi yüksek etki değerine sahip dergilerde yayımlanan çalışmalar oluşturmaktadır. Ayrıca Web of Science, Scopus, ERIC ve Google Scholar veri tabanlarında artificial intelligence, GeoAI, geography education, spatial thinking, digital pedagogy gibi anahtar kelimelerle taramalar gerçekleştirilmiştir.

- Kitaplar ve Uluslararası Raporlar: Yapay zekâ ve eğitim teknolojileri üzerine yayımlanan temel başvuru kitapları (Goodfellow, Bengio & Courville, 2016; Holmes, Bialik & Fadel, 2019) ile UNESCO ve OECD'nin dijital eğitim ve sürdürülebilirlik temelli raporları incelenmiştir. Bu kaynaklar, küresel ölçekte coğrafya eğitiminin dönüşümünü anlamada önemli bir referans niteliği taşımaktadır.

- Ulusal Akademik Kaynaklar: YÖK Ulusal Tez Merkezi, ULAKBİM TR Dizin ve DergiPark veri tabanlarında coğrafya öğretimindeki dijitalleşme ve yapay zekâ kullanımına ilişkin güncel araştırmalar incelenmiştir.

- Teknik Dokümanlar ve Kurumsal İçerikler: Esri, Google Earth Engine, NASA ve Copernicus gibi kurumlar tarafından yayımlanan eğitim materyalleri, teknik raporlar ve kullanım kılavuzları GeoAI ve yapay zekâ uygulamalarının eğitim boyutunu anlamak amacıyla değerlendirilmiştir

Verilerin Analizi

Veri analizi sürecinde betimsel analiz ve literatür sentezi teknikleri kullanılmıştır. Öncelikle yapay zekânın eğitimde kullanımına ilişkin çalışmalar sınıflandırılmış; ardından coğrafya eğitimi bağlamındaki araştırmalar tematik açıdan bir araya getirilmiştir. Analiz süreci iki ana tema çerçevesinde yürütülmüştür:

- Yapay zekâ–coğrafya eğitimi etkileşim alanları

- Yapay Zekâ Destekli Coğrafya Okuryazarlığı Modeli

BULGULAR

Araştırma sonucunda iki temel bulguya ulaşılmıştır. İlk olarak, yapay zekâ teknolojilerinin coğrafya eğitimine çok boyutlu ve dönüştürücü katkılar sunduğu belirlenmiştir. İkinci olarak ise bu katkıların, Yapay Zekâ Destekli Coğrafya Okuryazarlığı Modeli için bütüncül ve kuramsal bir çerçeve oluşturduğu ortaya konulmuştur.

Yapay Zekânın Coğrafya Eğitimine Katkıları

1. Yapay Zekânın Mekânsal Düşünmeye Katkısı

Mekânsal düşünme; konum, dağılış, yön, örüntü tanıma ve yer–çevre ilişkilerinin anlaşılmasını içeren temel bir coğrafi beceridir (Gersmehl & Gersmehl, 2007). Yapay zekâ araçları, öğrencilerin mekânsal hatalarını belirleyerek zorlanılan kavramlara yönelik kişiselleştirilmiş öğrenme yolları sunmakta ve bilişsel yükü azaltmaktadır (Holmes et al., 2019). Coğrafya eğitiminin çok katmanlı veri yapısı, yapay zekâ uygulamalarının bu alanda etkili biçimde kullanılmasını mümkün kılmaktadır. GeoAI teknolojileri, mekânsal verilerin dinamik biçimde analiz edilmesini sağlayarak karmaşık örüntülerin daha bütüncül anlaşılmasına katkı sunmaktadır (Li & Arundel, 2022). Uydu görüntülerinin derin öğrenme yöntemleriyle analiz edilmesi ve arazi kullanım değişimlerinin modellenmesi, öğrencilerin mekânsal ilişkileri daha analitik bir düzeyde kavramalarına imkân tanımaktadır (Batty, 2020; Kerski, 2008).

2. Harita Okuryazarlığının Gelişmesinde Yapay Zekâ

Harita okuryazarlığı, öğrenciler açısından en zorlayıcı coğrafi becerilerden biridir. Yapay zekâ teknolojileri; ölçek yorumlama, sembol okuma ve tematik harita analizi gibi becerilerin geliştirilmesinde etkili sonuçlar sunmaktadır (Wilby & Esson, 2021). Yapay zekâ tabanlı sistemler, harita yorumlama hatalarını otomatik olarak tespit ederek anında geri bildirim sağlamakta; derin öğrenme temelli modeller tematik harita üretimi ve görsel yorumlama süreçlerinde önemli bir dönüşüm yaratmaktadır (Kang, Gao, & Roth, 2024).

3. İçerik Üretimi ve Ders Tasarımında Yapay Zekâ

Coğrafya derslerinin veri yoğun ve karmaşık yapısı, yapay zekâ tabanlı araçları öğretmenler için önemli bir pedagojik destek hâline getirmektedir. Yapay zekâ; tematik harita üretimi, grafik ve tablo oluşturma, kavramların sadeleştirilmesi ve içeriklerin farklı düzeylere uyarlanması gibi işlevlerle ders tasarımını kolaylaştırmaktadır (Selwyn, 2019). Aynı zamanda içerik öneri sistemleri, öğrencinin öğrenme düzeyine uygun materyaller sunarak kişiselleştirilmiş öğrenmeyi desteklemektedir.

4. Ölçme-Değerlendirme Süreçlerinde Yapay Zekâ

Yapay zekâ, ölçme ve değerlendirme süreçlerini daha hızlı ve öğrenci odaklı hâle getirmektedir. Açık uçlu soruların analizi, kavramsal hataların belirlenmesi ve öğrenme eğilimlerinin izlenmesi yapay zekâ destekli sistemler aracılığıyla gerçekleştirilebilmektedir (Holmes et al., 2019). Bu süreç, öğretmenin değerlendirme yükünü azaltırken öğretim sürecinin daha etkili biçimde uyarlanmasına katkı sağlamaktadır.

5. Öğretmen Yeterlikleri ve Yapay Zekâ Pedagojisi

Yapay zekâ uygulamalarının coğrafya eğitimine etkili biçimde entegre edilebilmesi, öğretmenlerin pedagojik teknoloji entegrasyonu becerilerine sahip olmasını gerektirmektedir. Araştırmalar, öğretmenlerin yapay zekâ araçlarını kullanmaya istekli olduklarını; ancak pedagojik rehberlik konusunda önemli eksiklikler yaşadıklarını göstermektedir (Zawacki-Richter et al., 2019). Türkiye'de yapılan çalışmalar da teknoloji farkındalığının yüksek olmasına karşın uygulama deneyiminin sınırlı olduğunu ortaya koymaktadır (Sezer, Şanlı, Pınar ve Kara, 2022). Bu durum, coğrafya eğitimi bağlamında yapay zekâ pedagojisi olarak tanımlanabilecek yeni bir yeterlik alanının geliştirilmesini gerekli kılmaktadır.

Yapay Zekâ Destekli Coğrafya Okuryazarlığı Modeli

Yapay Zekâ Destekli Coğrafya Okuryazarlığı Modeli, coğrafya eğitiminin özgün yapısı dikkate alınarak yapılandırılmış olup GeoAI, mekânsal biliş ve dijital pedagojik dönüşüm literatürüne dayanmaktadır (Gersmehl & Gersmehl, 2007; Kerski & Clark, 2022). Modelin ilk üç boyutu, öğrencinin mekânsal düşünme, veri okuryazarlığı ve harita okuryazarlığını yapay zekâ desteğiyle derinleştirmeyi hedeflemektedir. Dördüncü boyut, yapay zekâ çıktılarının eleştirel ve etik biçimde değerlendirilmesini merkeze alırken, beşinci boyut öğretmenin bu süreci yönlendiren pedagojik rehber rolünü vurgulamaktadır. Bu yönüyle model, yapay zekâ kullanımının bilişsel, pedagojik ve etik boyutlarını birlikte ele alan bütüncül bir yaklaşım önermektedir.

1. Boyut: Yapay Zekâ ile Desteklenen Mekânsal Düşünme

Mekânsal düşünme; konum, dağılış, örüntü ve süreç ilişkilerinin anlaşılmasını içeren üst düzey bir coğrafi yetkinliktir (Gersmehl & Gersmehl, 2007). Yapay zekâ ve GeoAI tabanlı analizler, öğrencilerin karmaşık çevresel süreçleri görsel ve sayısal düzeyde çözümlemesini mümkün kılmaktadır (Li & Arundel, 2022). Uydu görüntülerinin sınıflandırılması, arazi kullanım değişimlerinin modellenmesi ve afet risk analizleri gibi uygulamalar, mekânsal ilişkilerin daha analitik ve bütüncül biçimde kavranmasına katkı sağlamaktadır (Batty, 2020).

Gelişen beceriler: Mekânsal örüntü okuryazarlığı, değişim ve süreç analizi, coğrafi sorgulama.

Coğrafya eğitimi özelinde örnek uygulamalar:

- Uydu görüntülerinin yapay zekâ ile sınıflandırılarak arazi kullanım değişiminin ortaya çıkarılması (Batty, 2020).
- Yapay zekâ destekli kentsel ısı adası analizleriyle kentleşme-iklim ilişkilerinin incelenmesi
- Sel, kuraklık veya yangın risk bölgelerinin derin öğrenme ile modellemesi
- Yapay zekâ ile nehir taşkın eğilimlerinin zamansal analizlere dönüştürülmesi
- İnteraktif GeoAI araçlarıyla topografya-iklim-yerleşme ilişkilerinin keşfedilmesi
- Makine öğrenmesi modelleriyle deprem hasar dağılımının tahmini

2. Boyut: Coğrafi Veri Okuryazarlığı ve GeoAI Tabanlı Büyük Veri Analizi

Coğrafya eğitimi, iklim, nüfus ve arazi örtüsü gibi büyük ve çok katmanlı veri setlerine dayanmaktadır. Yapay zekâ, bu verilerin hızlı işlenmesini ve örüntülerin anlamlandırılmasını sağlayarak coğrafi veri okuryazarlığını güçlendirmektedir (Kerski & Clark, 2022). GeoAI tabanlı modeller, çevresel eğilimlerin analiz edilmesi ve kanıta dayalı coğrafi yorumların geliştirilmesi açısından önemli pedagojik olanaklar sunmaktadır.

Gelişen beceriler: coğrafi veri işleme, mekânsal istatistik farkındalığı, kanıta dayalı yorumlama.

Coğrafya eğitimi özelinde örnek uygulamalar:

- 20-30 yıllık yağış verisinin yapay zekâ ile eğilim analizi ve anomalilerin tespiti

- NDVI verilerinin GeoAI modelleriyle otomatik süreçlenmesi ve orman bozulma eğilimlerinin belirlenmesi

- Taşıt hareketliliği verilerinin yapay zekâ ile işlenerek kentsel ulaşım örüntülerinin çıkarılması

- Hava kalitesi-meteoroloji ilişkilerinin makine öğrenmesiyle modellenmesi

- Nüfus yoğunluğu, göç hareketleri ve konut fiyatları gibi sosyoekonomik büyük verilerin GeoAI tabanlı mekânsal regresyon modelleriyle yorumlanması

- Sel veya kuraklık riskini belirlemek için çoklu veri katmanlarının derin öğrenme tabanlı birleşik sınıflandırma süreçlerine dönüştürülmesi

3. Boyut: Yapay Zekâ Destekli Harita Okuryazarlığı

Harita okuryazarlığı; ölçek, sembol, renk ve tematik sınıflandırma gibi bileşenlerden oluşmaktadır (Gersmehl & Gersmehl, 2007). Yapay zekâ araçları, öğrencilerin hazırladığı haritalardaki sınıflandırma ve sembol hatalarını otomatik olarak belirleyerek pedagojik geri bildirim sunabilmektedir. Ayrıca NLP ve görselleştirme tabanlı uygulamalar, harita yorumlama süreçlerini öğrencinin düzeyine uygun hâle getirmektedir (Xu & Tao, 2024).

Gelişen beceriler: Tematik harita okuryazarlığı, haritadan çıkarım yapma, coğrafi görselleştirme.

Coğrafya eğitimi özelinde örnek uygulamalar:

- Tematik haritalardaki sınıflandırma hatalarının yapay zekâ tarafından otomatik tanımlanması.

- Haritaların okunmasını kolaylaştıran NLP tabanlı açıklayıcı metin üretimi (Xu & Tao, 2024).

- Öğrenci tarafından üretilen haritaların yapay zekâ ile değerlendirilip ölçek ve sembol uyumsuzluklarının raporlanması.

- Mekânsal ilişki (yakınlık, yoğunluk, kümeleşme) analizlerinin öğrenci düzeyine uygun görselleştirmelere dönüştürülmesi.

- Yapay zekâ ile 3B arazi modelleri üretilerek arazi şekilleri ve eğim analizinin kolaylaştırılması.

- Öğrencinin yaptığı harita yorumlarının otomatik değerlendirilerek yanlış mantık yürütmelerinin belirlenmesi.

4. Boyut: Etik Farkındalık, Veri Doğruluğu ve Algoritmik Yanlılık

GeoAI uygulamalarında veri kalitesi, algoritmik yanlılık ve model belirsizliği önemli bir tartışma alanıdır (Janowicz et al., 2020). Yapay zekâ ile üretilen haritaların doğruluğunun sorgulanması, veri gizliliği ve etik kullanım konularının coğrafya öğretiminde açık biçimde ele alınması gerekmektedir. Bu boyut, öğrencilerin yapay zekâ çıktılarını eleştirel bir bakışla değerlendirmelerini hedeflemektedir.

Gelişen beceriler: eleştirel coğrafi düşünme, etik farkındalık, yapay zekâ çıktılarının sorgulanması.

Coğrafya eğitimi özelinde örnek uygulamalar:

- Yapay zekâ ile üretilmiş arazi kullanım haritalarının yanlış sınıflandırma nedenlerinin analiz edilmesi (Li & Arundel, 2022).

- Google Earth Engine, Strava veya Copernicus üzerinden konum verisi gizliliği tartışmaları yapılması

- Farklı GeoAI modellerinin aynı veri setine verdiği farklı çıktılar üzerinden model belirsizliği kavramının incelenmesi

- Afet risk haritalarında yanlış sınıflandırmaların toplumsal sonuçlarının tartışılması

- "Al Explainability" araçlarıyla yapay zekânın karar süreçlerinin incelenmesi

- Veri kaynağının niteliği değiştiğinde yapay zekânın neden farklı sonuç verdiğinin analiz edilmesi

5. Boyut: Yapay Zekâ Pedagojisi ve Öğretmen Rehberliği

Modelin merkezinde, öğretmenin yapay zekâ araçlarını pedagojik amaçlarla yönlendiren rehber ve arabulucu rolü yer almaktadır. Öğretmen, yapay zekâ çıktılarının doğrulanması, sadeleştirilmesi ve etik çerçevede kullanılmasından sorumludur. Literatür, öğretmenlerin yapay zekâya karşı istekli olduğunu ancak pedagojik entegrasyon konusunda rehberliğe ihtiyaç duyduğunu göstermektedir (Zawacki-Richter et al., 2019).

Öğretmende gelişen beceriler: yapay zekâ pedagojisi, içerik doğrulama ve uyarlama, etik kullanım rehberliği.

Coğrafya eğitimi özelinde örnek uygulamalar:

- Yapay zekâ tarafından oluşturulan karmaşık iklim haritalarının öğretmen tarafından sadeleştirilmesi

- Öğrencilerin "Bu haritada yapay zekâ hangi sınıflandırma hatalarını yapmış olabilir?" gibi sorgulama etkinlikleriyle yönlendirilmesi

- Öğretmenin yapay zekâ çıktılarını doğrulayıp yanlış örüntüleri düzeltmesi

- Ders öncesinde Al araçlarıyla hazır veri görselleştirmeleri oluşturup sınıfta analiz ettirmesi

- Öğrencilerin kendi GeoAI mini modellerini geliştirmeleri için rehberlik edilmesi

Bu model sayesinde öğrenci:

- Haritayı sadece "okumaz"; doğrular, karşılaştırır, sorgular.

- Veriyi sadece "görmez"; yorumlar, model oluşturur.

- Yapay zekâyı sadece "kullanmaz"; eleştirir, hatalarını bulur.

- Coğrafyayı sadece "öğrenmez"; analitik ve yapay zekâ okuryazarı bir birey olur.

SONUÇ VE TARTIŞMA

Bu araştırma, yapay zekâ teknolojilerinin coğrafya eğitimine etkilerini bütüncül bir çerçevede incelemiş ve bu teknolojilerin öğrenme süreçlerini yalnızca destekleyen araçlar değil, aynı zamanda coğrafya öğretiminin doğasını dönüştüren temel bileşenler olduğunu ortaya koymuştur. Literatürden elde edilen bulgular, coğrafya eğitiminin veri yoğun, çok katmanlı ve mekânsal ilişkilere dayalı yapısı nedeniyle yapay zekâ uygulamalarının bu alanda yüksek işlevsellik sunduğunu göstermektedir. Yapay zekâ, mekânsal örüntülerin anlaşılması, değişim süreçlerinin yorumlanması ve karmaşık çevresel olguların modellenmesi gibi öğrenciler açısından güç olan konuları daha erişilebilir hâle getirmektedir.

Araştırma bulguları, yapay zekânın özellikle mekânsal düşünme becerisinin gelişimine belirgin katkı sağladığını göstermektedir. Derin öğrenme tabanlı sınıflandırma araçları, öğrencilerin arazi kullanım değişimlerini yıllar arasındaki farklılıklarla görmesine olanak tanımakta; kentleşme eğilimleri, orman kaybı veya tarımsal dönüşüm gibi süreçler görsel çıktılar üzerinden daha somut bir hâle gelmektedir (Li & Arundel, 2022). Böylece öğrenciler hem mekânsal örüntüleri daha doğru yorumlamakta hem de çevresel süreçleri anlayabilmek için gerekli analitik düşünme becerilerini geliştirmektedir (Gersmehl & Gersmehl, 2007).

Yapay zekânın bir diğer önemli katkısı harita okuryazarlığının gelişimi ile ilgilidir. Öğrencilerin ölçek, renk, sembol ve yön gibi temel harita bileşenlerinde sık hata yaptığı bilinmektedir (Gersmehl & Gersmehl, 2007). Yapay zekâ destekli harita analiz araçları, öğrencilerin tematik haritalardaki hatalarını otomatik olarak tespit edip açıklayabilmekte; bu yönüyle öğretmenin gözünden kaçabilecek mikro hataları görünür kılmaktadır. Bu tür otomatik geri bildirim mekanizmaları, harita okumanın yalnızca görsel bir beceri değil, aynı zamanda analitik ve kavramsal bir süreç olduğuna dikkat çekmekte ve öğrencilerin harita yorumlama yetkinliğini artırmaktadır (Xu & Tao, 2024).

Bulgular ayrıca yapay zekânın öğrenmenin bireyselleştirilmesi konusunda önemli olanaklar sunduğunu ortaya koymaktadır. Öğrenme analitiği sistemleri, öğrencinin kavramları anlama düzeyini izleyerek kişiye özgü öğretim yolları oluşturabilmekte; mekânsal yön bulma, grafik yorumlama veya tematik harita okuma gibi becerilerde zorlanan öğrenciler için ek destek sağlayabilmektedir (Holmes et al., 2019). Bu durum, coğrafya eğitiminin farklı hızlarda ilerleyen öğrencilere uyarlanmasını mümkün kılmakta ve eşitlikçi bir öğrenme ortamı oluşturmaktadır.

Öğretmenler açısından yapay zekâ tabanlı araçların içerik üretimi, ders planlama ve modelleme süreçlerinde sağladığı kolaylıklar dikkat çekmektedir. Derin öğrenme destekli simülasyonlar, iklim değişikliği, sıcaklık anomalileri, doğal afet senaryoları ve nüfus hareketlilikleri gibi karmaşık coğrafi süreçlerin daha etkili biçimde aktarılmasını sağlamaktadır (Kerski &. Clark, 2022). Böylece öğretmenler coğrafi olayları yalnızca anlatan değil, aynı zamanda görselleştiren ve analiz eden bir pedagojik yaklaşıma sahip olabilmektedir.

Coğrafya eğitimi doğası gereği büyük veri analizine dayandığı için öğrencilerin iklim verileri, NDVI değerleri, yağış anomalileri veya afet risk haritaları gibi veri türlerini anlamakta zorlanabildiği bilinmektedir. GeoAI temelli analizler sayesinde öğrenciler bu verileri daha hızlı işleyebilmekte, sorular geliştirebilmekte ve bölgesel eğilimleri daha doğru yorumlayabilmektedir (Batty, 2020).

Araştırmanın özgün katkısı olan "Yapay Zekâ Destekli Coğrafya Okuryazarlığı Modeli", coğrafya eğitiminin mekânsal düşünme, veri okuryazarlığı, harita okuryazarlığı, etik farkındalık ve pedagojik uyum boyutlarını bütüncül bir çerçeve içinde ele almıştır. Model, öğrenciye yalnızca yapay zekâ araçlarını kullanmayı değil, aynı zamanda bu araçların çıktılarını sorgulamayı, doğrulamayı ve coğrafi bağlama yerleştirmeyi öğretmeyi hedeflemektedir. Bu yönüyle model, geleceğin coğrafya öğrenenlerini veri odaklı, eleştirel ve teknolojiyi bilinçli kullanan bireyler olarak yetiştirmeye yönelik önemli bir kuramsal temel sunmaktadır.

Genel olarak yapay zekâ, coğrafya eğitiminde güçlü fırsatlar yaratmakta; mekânsal kavramların anlaşılmasını kolaylaştırmakta, veri analiz becerilerini geliştirmekte ve öğretim süreçlerini zenginleştirmektedir (OECD, 2021). Ancak bu teknolojinin sınıf ortamına entegrasyonunda etik, teknik ve pedagojik denge gözetilmeli; yapay zekâ öğretimi destekleyen, fakat öğrenmenin merkezine geçmeyen bir araç olarak konumlandırılmalıdır. Böyle bir yaklaşım, coğrafya eğitiminde yapay zekâdan en yüksek verimin alınmasını ve öğrencilerin coğrafi okuryazarlık becerilerini çok yönlü biçimde geliştirmesini sağlayacaktır.

Bununla birlikte yapay zekâ kullanımının bazı sınırlılıkları ve riskleri bulunmaktadır. Yapay zekâ modellerinin eğitildiği veri setlerindeki yanlılıklar, hatalı sınıflandırmalara neden olabilir ve öğrencileri yanlış çıkarımlara yönlendirebilir (Williamson & Eynon, 2020). Etik ve güvenlik boyutunda ise öğrenci verilerinin korunması, konum bilgilerinin işlenmesi ve yapay zekâ tabanlı sistemlerin veri toplama biçimleri önem kazanmaktadır (UNESCO, 2022). Ayrıca yapay zekâ kullanımının aşırıya kaçması, öğrencilerin eleştirel düşünme ve sorgulama becerilerini zayıflatma riski taşımaktadır (Zawacki-Richter et al., 2019). Bu nedenle yapay zekânın pedagojik amaçlara uygun, kontrollü ve öğretmen rehberliğinde kullanılması gerekmektedir.

ÖNERİLER

1. Coğrafya öğretim programlarında yapay zekâ destekli mekânsal düşünme etkinliklerine yer verilmelidir. Harita, grafik ve görselleştirme temelli yapay zekâ uygulamaları, kazanımlarla ilişkilendirilerek ders içeriklerine entegre edilmelidir.

2. Coğrafya öğretmenlerine yönelik yapay zekâ ve dijital pedagojik yeterlik eğitimleri yaygınlaştırılmalıdır. Hizmet içi eğitimlerde yapay zekânın ders planlama, görselleştirme ve ölçme-değerlendirme süreçlerinde kullanımı önceliklendirilmelidir.

3. Öğrencilerin coğrafi veri okuryazarlığını geliştirmeye yönelik yapay zekâ destekli etkinlikler hazırlanmalıdır. İklim, nüfus ve çevre verilerinin analizine dayalı uygulamalar, öğrenci düzeyine uygun biçimde ders kitapları ve EBA içeriklerine eklenmelidir.

4. Yapay zekâ kullanımına ilişkin etik ve veri güvenliği konuları coğrafya derslerinde ele alınmalıdır. Harita doğruluğu, veri gizliliği ve algoritmik yanlılık gibi konular, ders içi örnekler ve tartışmalarla öğrencilere kazandırılmalıdır.

5. Yapay Zekâ Destekli Coğrafya Okuryazarlığı Modeli, pilot uygulamalarla test edilmelidir. Seçilecek okullarda yapılacak uygulamalarla modelin öğrenci başarısı ve öğrenme sürecine etkisi değerlendirilmelidir.

KAYNAKÇA

Aldrich, C. (2009). The complete guide to simulations and serious games. Wiley.

Anderson, K., Ryan, B., Sonntag, W., Kavvada, A., & Friedl, L. (2017). Earth observation in service of the 2030 Agenda for Sustainable Development. Geo-Spatial Information Science, 20(2), 77–96. https://doi.org/10.1080/10095020.2017.1333230.

Batty, M. (2020). The coronavirus crisis: What will the post-pandemic city look like? Environment and Planning B: Urban Analytics and City Science, 47(4), 547–552. https://doi.org/10.1177/2399808320926912.

Chen, M., Claramunt, C., Çöltekin, A., Liu, X., Peng, P., Robinson, A. C., Xiao, N., Yao, X., & Lü, G. (2023). Artificial intelligence and visual analytics in geographical space and cyberspace: Research opportunities and challenges. Earth-Science Reviews, 241, 104438.

https://doi.org/10.1016/j.earscirev.2023.104438.

Climate Interactive. (2024). En-ROADS climate solutions simulator. https://www.climateinteractive.org/en-roads/

Eynon, R. (2013). The rise of big data: what does it mean for education, technology and media research. Learning, Media and Technology, 38(3), 237–240. https://doi.org/10.1080/17439884.2013.771783.

Gersmehl, P. J., & Gersmehl, C. A. (2007). Spatial thinking and maps. Journal of Geography, 106(3), 93–98. https://hdl.handle.net/10877/17409.

Gómez-Trigueros, I. M. (2018). New learning of geography with technology: The TPACK model. European Journal of Geography, 9(1), 38–48.

Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep learning. MIT Press. https://www.deeplearningbook.org/.

Holmes, W., Bialik, M., & Fadel, C. (2019). Artificial intelligence in education. Center for Curriculum Redesign.

Ifenthaler, D., Mah, D.-K., & Yau, J. Y. K. (2019). Utilizing learning analytics to support study success. In D. Ifenthaler, D.-K. Mah, & J. Y.-K. Yau (Eds.), Utilising learning analytics for study success: Reflections on current empirical findings (pp. 27–36). Springer. https://link.springer.com/book/10.1007/978-3-319-64792-0.

Janowicz, K., Gao, S., McKenzie, G., Hu, Y., & Bhaduri, B. (2020). GeoAI: Spatially explicit artificial intelligence techniques for geographic knowledge discovery and beyond. International Journal of Geographical Information Science, 34(4), 625–636. https://doi.org/10.1080/13658816.2019.1684500.

Kang, Y., Gao, S., & Roth, R. E. (2024). Artificial intelligence studies in cartography: A review and synthesis of methods, applications, and ethics. Cartography and Geographic Information Science, 51(2), 1–32. https://doi.org/10.1080/15230406.2023.2295943.

Kerski, J. J. (2008). The role of GIS in digital geography. International Journal of Digital Earth, 1(4), 327-346. https://doi.org/10.1080/17538940802420879.

Larangeira, R., & van der Merwe, C. D. (2016). Map literacy and spatial cognition challenges for student geography teachers in South Africa. Perspectives in Education, 34(3), 140-161.

Leal Filho, W., Nagy, G. J., Ayal, D. Y., & Balogun, A.-L. (2025). Artificial intelligence and climate change: Exploring the potential roles of AI in mitigation, adaptation and early warning systems. Environmental Sciences Europe, 37(1), 1–15. https://doi.org/10.1186/s12302-025-01153-2

Li, W., & Arundel, S. T. (2022). GeoAI and the future of spatial analytics. In B. Li, X. Shi, A. X. Zhu, C. Wang, & H. Lin (Eds.), New thinking in GIScience (pp. 151–158). Springer. https://doi.org/10.1007/978-981-19-3816-0_17

National Research Council. (2006). Learning to think spatially: GIS as a support system in the K–12 curriculum. National Academies Press. https://nap.nationalacademies.org/catalog/11019/learning-to-think-spatially-gis-as-a-support-system-in

OECD. (2021). Digital education outlook 2021: Intelligent technologies. OECD Publishing. https://digital-education-outlook.oecd.org/

Panjaitan, B. R., Ningrum, E., & Waluya, B. (2023). Digital learning tools in geography education: A systematic literature review. The Eurasia Proceedings of Educational and Social Sciences, 33, 135–143. https://doi.org/10.55549/epess.1413355

Russell, S. J., & Norvig, P. (2021). Artificial intelligence: A modern approach (4th ed.). Pearson.

Selwyn, N. (2019). Should Robots Replace Teachers? AI and the Future of Education (Digital Futures). Polity.

Sezer, A., Şanlı, C., Pınar, A., & Kara, H. (2022). Teknoloji entegrasyonu eğitiminin coğrafya öğretmenlerinin teknoloji kabul ve teknoloji entegrasyonu öz-yeterlik algılarına etkisi. International Journal of Geography and Geography Education, 45, 67–75. https://doi.org/10.32003/igge.1033111

UNESCO. (2017). Education for Sustainable Development Goals: Learning objectives. UNESCO Publishing. https://unesdoc.unesco.org/ark:/48223/pf0000247444

UNESCO. (2022). AI and education: Guidance for policy-makers. UNESCO Publishing. https://www.unesco.org/en/articles/ai-and-education-guidance-policy-makers

Wilby, R. L., & Esson, J. (2024). AI literacy in geographic education and research. The Geographical Journal. Advance online publication. https://doi.org/10.1111/geoj.12548

Xu, J., & Tao, R. (2024). Map reading and analysis with GPT-4V(ision). ISPRS International Journal of Geo-Information, 13(4), 127. https://doi.org/10.3390/ijgi13040127.

Yu, Z., Li, J., Ge, Q., & Dai, S. (2022). Artificial intelligence for predicting land use changes in an arid ecosystem. Journal of Geographical Sciences, 32(8), 1463–1480. https://doi.org/10.1007/s11442-022-1969-6

Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019).

A systematic review of research on artificial intelligence in education.

International Journal of Educational Technology in Higher Education, 16, 39.

https://doi.org/10.1186/s41239-019-0171-0

COĞRAFYA ÖĞRETİMİNDE YAKINDAN UZAĞA İLKESİ: KURAMSAL TEMELLER VE ÖĞRETİM UYGULAMALARI

THE PRINCIPLE OF FROM NEAR TO FAR IN GEOGRAPHY EDUCATION: THEORETICAL FOUNDATIONS AND TEACHING PRACTICES

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ÖZET

Bu çalışma, coğrafya öğretiminin temel öğretim ilkelerinden biri olan yakından uzağa ilkesini, kuramsal temelleri, öğretim programlarındaki yansımaları ve sınıf içi uygulamalar bağlamında incelemeyi amaçlamaktadır. Coğrafya eğitimi; mekânsal düşünme, çevresel farkındalık ve yerel–küresel ilişkileri kurabilme becerilerini geliştirmeyi hedefleyen bir disiplin olup, öğrencinin yaşadığı çevreden başlayarak daha geniş mekânsal ölçeklere ilerlemeyi öngören yakından uzağa ilkesi bu sürecin pedagojik temelini oluşturmaktadır. Araştırma, nitel araştırma yaklaşımı çerçevesinde betimsel tarama modeliyle yürütülmüş; ulusal ve uluslararası coğrafya eğitimi literatürü, Türkiye Yüzyılı Maarif Modeli Ortaöğretim Coğrafya Dersi Öğretim Programı (2024) ve öğretim uygulamalarına dayalı örnekler veri kaynağı olarak kullanılmıştır. Veriler içerik analizi yöntemiyle çözümlenmiştir. Bulgular, öğretmenlerin yakından uzağa ilkesini genel olarak benimsediğini ve bu ilkenin öğrenmeyi somutlaştırma, harita okuryazarlığını geliştirme ve mekânsal farkındalık kazandırma açısından etkili olduğunu göstermektedir. Bununla birlikte, müfredat yoğunluğu, yerel veri ve materyal eksikliği ile saha çalışması uygulamalarındaki sınırlılıkların ilkenin etkin kullanımını zorlaştırdığı belirlenmiştir. Ayrıca dijital haritalar, Coğrafi Bilgi Sistemleri (CBS) ve sanal saha uygulamaları, yakından uzağa ilkesinin dijital yakınlık boyutuyla yeniden yorumlanabileceğini ortaya koymaktadır. Sonuç olarak, ilkenin çağdaş coğrafya eğitiminde etkili biçimde uygulanabilmesi için dijital araçların entegrasyonu ve öğretmen mesleki gelişiminin güçlendirilmesi gerekmektedir.

Anahtar Kelimeler: Coğrafya öğretimi, yakından uzağa ilkesi, mekânsal düşünme, yer temelli öğrenme, dijital coğrafya

ABSTRACT

This study aims to examine the principle of from near to far, a fundamental teaching principle in geography education, with respect to its theoretical foundations, curricular representations, and classroom practices. Geography education seeks to develop students' spatial thinking, environmental awareness, and ability to establish local–global connections. In this context, the principle of from near to far, which emphasizes starting instruction from students' immediate environment and gradually expanding to broader spatial scales, constitutes a key pedagogical framework. The study was conducted using a qualitative descriptive research design. Data sources included national and international geography education literature, the Türkiye Yüzyılı Maarif Model Secondary School Geography

Curriculum (2024), and practice-based instructional examples. Data were analyzed through content analysis. The findings indicate that teachers generally adopt the principle of from near to far and consider it effective in concretizing learning, enhancing map literacy, and fostering spatial awareness. However, curriculum density, limited access to local data and instructional materials, and constraints on field-based activities hinder its effective implementation. The results also show that digital maps, Geographic Information Systems (GIS), and virtual fieldwork environments enable the reinterpretation of the principle beyond physical proximity through digital proximity. In conclusion, while the principle of from near to far remains pedagogically relevant in contemporary geography education, its effective implementation requires systematic integration of digital geography tools and strengthened professional development for teachers.

Keywords: Geography education, from near to far principle, spatial thinking, place-based learning, digital geography

GİRİŞ

Coğrafya, insan ve mekânı iç içe gören; tüm olay, olgu ve faaliyetleri mekânsal perspektiften okuyan; insan-mekân etkileşiminin ortaya çıkardığı sonuçların neler olduğunu anlamaya, yorumlamaya ve açıklamaya çalışan sosyal bir disiplindir (Bilgili ve Kocalar, 2020). Coğrafya eğitimi, bu bütüncül bakışın bireylere kazandırılmasını amaçlayan pedagojik bir alandır. Coğrafya öğretimi yalnızca mekânsal bilginin aktarımıyla sınırlı olmayıp; eleştirel düşünme, çevresel farkındalık, toplumsal sorumluluk, mekânsal sorgulama ve problem çözme gibi üst düzey becerilerin geliştirilmesini hedeflemektedir (İbret, Aydın & Turgut, 2018). Öğrencinin yaşadığı çevreyi anlamlandırabilmesi, mekânsal düşünme becerilerini geliştirebilmesi ve yerel ile küresel ölçekler arasında ilişki kurabilmesi, coğrafya eğitiminin temel amaçları arasında yer almaktadır. Bu süreçte öğrencinin öğrenme sürecini düzenleyebilmesi ve kendi bilişsel süreçlerinin farkında olması, anlamlı öğrenmenin temel koşulları arasında görülmektedir.

Yakından uzağa ilkesi, öğretim sürecinin öğrencinin doğrudan deneyimlediği yakın çevreden başlatılarak giderek daha geniş mekânsal ölçeklere doğru yapılandırılması gerektiğini savunur. Bu ilke, öğrenmenin somuttan soyuta ve bilinenden bilinmeyene doğru ilerlediğini kabul eden eğitim kuramlarıyla temellendirilmektedir. Öğrencinin önce kendi yaşantıları ve gözlemleri üzerinden öğrenmeye dâhil olması, ardından daha karmaşık ve soyut kavramlara yönelmesi, anlamlı öğrenmenin temel koşullarından biri olarak görülmektedir (Bruner, 1960; Ausubel, 1968). Coğrafya eğitimi bağlamında mekânsal olguların çok ölçekli bir yapıya sahip olması, öğretim sürecinin yakın çevreden başlanarak bölgesel, ulusal ve küresel sistemlere doğru ilerlemesini pedagojik açıdan gerekli kılmaktadır. Öğrencilerin yaşadıkları çevreyi başlangıç noktası olarak ele alan öğretim yaklaşımlarının, mekânsal düşünme becerilerinin gelişimini desteklediği ve coğrafi kavramların daha anlamlı biçimde öğrenilmesine katkı sağladığı ifade edilmektedir (Gersmehl & Gersmehl, 2007).Yapılan nitel çalışmalar, coğrafya dersinin özellikle yakın çevreyle ilişkilendirildiğinde öğrenciler tarafından daha anlamlı ve ilgi çekici bulunduğunu ortaya koymaktadır. Benzer biçimde, coğrafya derslerinde gerçek yaşamla bağlantı kurulmasının öğrencilerin akademik benlik algısını ve derse yönelik tutumlarını olumlu yönde etkilediği belirlenmiştir (Aydın 2011a, 2011b, 2011c). Öğrencilerin kullandıkları öğrenme stratejilerinin de öğretim sürecinde benimsenen öğretim ilkeleriyle doğrudan ilişkili olduğu; bu durumun düşünme becerilerinin gelişimine, mekânsal analiz yapabilme ve problem çözme süreçlerine katkı sunduğu ifade edilmektedir (Aydın, 2011d; 2011e). Bu üst düzey bilişsel becerilerin kazandırılabilmesi, coğrafya öğretiminde genel öğretim ilkelerinin bilinçli ve sistematik biçimde uygulanmasına bağlıdır. Öğretim ilkeleri, öğrenme sürecinin nasıl yapılandırılacağına, içeriğin hangi sırayla sunulacağına ve öğrencinin

bilişsel gelişim özelliklerine nasıl uyum sağlanacağına ilişkin bilimsel temelli rehberlerdir. Çocuğa görelik, somuttan soyuta, bilinenden bilinmeyene, basitten karmaşığa gibi ilkelerle birlikte **yakından uzağa ilkesi,** coğrafyanın mekânsal yapısıyla doğrudan örtüşmesi nedeniyle merkezi bir öneme sahiptir. Sönmez (2018), öğretim ilkelerinin öğrenme sürecinin temel düzenleyicileri olduğunu vurgularken; Ünlü (2014), bu ilkelerin coğrafya öğretiminde mekânsal düşünme becerisinin gelişimi açısından kritik rol oynadığını belirtmektedir.

Uluslararası literatür, yakından uzağa ilkesinin coğrafya öğretiminin temel dinamiklerinden biri olduğunu ortaya koymaktadır. Yer temelli eğitim yaklaşımı, öğrenme sürecinin öğrencinin yaşadığı yerle kurduğu doğrudan ilişkiden başlaması gerektiğini savunmakta; bu durumun öğrenmenin anlamlılığı ve kalıcılığı üzerinde belirleyici rol oynadığını vurgulamaktadır (Gruenewald, 2003; Sobel, 2004). Yer duygusu kavramı, bireyin yakın çevresiyle geliştirdiği bağın çevresel duyarlılık ve sorumluluk bilincinin oluşmasında etkili olduğunu göstermektedir (Relph, 1976; Tuan, 1977). National Research Council (2006), öğrencilerin üst düzey mekânsal analiz becerileri geliştirebilmeleri için öncelikle yakın çevredeki mekânsal örüntüleri anlamlandırmalarının önemli bir bilişsel temel oluşturduğunu belirtmektedir. Dijital coğrafya eğitimi bağlamında Kerski (2015), coğrafi bilgi sistemleri, Google Earth ve uydu görüntüleri gibi jeo-uzamsal teknolojilerin, öğrencilerin yakın çevre verilerini analiz etmelerine ve bu analizleri daha geniş ölçekli karşılaştırmalarla ilişkilendirmelerine olanak tanıdığını ortaya koymuştur. Goodchild (2018) ise konum temelli teknolojilerin, mekânsal örüntülerin fark edilmesini kolaylaştırarak öğrencilerin çok ölçekli mekânsal düşünme becerilerini desteklediğini ifade etmektedir.

Ulusal literatür de bu bulguları desteklemektedir. Yakın çevre temelli coğrafya öğretiminin öğrencilerin derse ilgisini, çevresel bilinç düzeylerini ve mekânsal farkındalıklarını artırdığı çeşitli çalışmalarla ortaya konulmuştur (Öner, 2018). Kayalı (2008), yakından uzağa ilkesine dayalı öğretim uygulamalarının öğrenci başarısı üzerinde anlamlı ve olumlu etkiler yarattığını deneysel verilerle göstermiştir. Aydın (2019), coğrafya öğretmenlerinin yakından uzağa ilkesini derslerinde temel bir yönlendirici ilke olarak benimsediklerini belirtmektedir. Bununla birlikte ders kitapları ve öğretim materyallerine yönelik analizler, içeriklerin sıklıkla yakın çevreden başlamakla birlikte bu ilerleyişin her zaman bilinçli ve tutarlı bir pedagojik çerçeveye dayandırılmadığını göstermektedir. Sağdıç (2020), Cumhuriyet dönemi ilkokul coğrafya programlarında "okulun bulunduğu yerden başlama" ilkesinin yer aldığını belirterek, yakından uzağa ilkesinin Türkiye coğrafya eğitimi açısından kurumsal bir gelenek hâline geldiğini ortaya koymaktadır. Öğrenen içinde bulunduğu ve ilgi kurduğu nesnel olayları daha rahat ve kolay algılar, yani öğrenir. Öğrenme olayının oluşması, öncelikle bir komünikasyon sürecidir. Komünikasyon sürecinin oluşması, yani eğitimin birey üzerinde bir takım fikir, bilgi, tutum, duygu ve beceri değişiklikleri meydana getirilebilmesi, yakın çevredeki nesne ve olaylar öğrenenler arasında ilgi kurularak daha kolay sağlanabilir. Bu nedenle öğretimde, yakın çevre olayları ile ilgi kurulmadan, uzak çevre olaylarına geçilmemelidir.

Günümüzde dijital haritalar, mobil CBS uygulamaları, artırılmış gerçeklik, drone verileri ve sanal saha çalışmaları gibi teknolojilerin yaygınlaşması, "yakın çevre" kavramının yalnızca fiziksel mekânsal yakınlıkla sınırlı biçimde ele alınmasını yetersiz kılmaktadır. Dijital, bilişsel ve kültürel yakınlık gibi yeni boyutların ortaya çıkması, yakından uzağa ilkesinin çağdaş coğrafya eğitimi bağlamında yeniden değerlendirilmesini gerekli kılmaktadır.

Bu çalışmanın önemi, yakından uzağa ilkesini hem klasik coğrafya öğretim yaklaşımları hem de çağdaş mekânsal düşünme kuramları ve dijital coğrafya uygulamaları çerçevesinde bütüncül biçimde ele alarak kapsamlı bir değerlendirme sunmasından kaynaklanmaktadır. Bu doğrultuda çalışma, yakından uzağa

ilkesinin kuramsal temellerini, öğretim programlarındaki yansımalarını ve sınıf içi uygulamalardaki görünümünü çok boyutlu bir bakış açısıyla analiz etmeyi amaçlamaktadır.

Bu amaç doğrultusunda aşağıdaki sorulara yanıt aranmıştır:

- Yakından uzağa ilkesinin tarihsel ve kuramsal temelleri nelerdir?
- Ulusal ve uluslararası coğrafya öğretim programlarında bu ilke nasıl yer almaktadır?
- Öğretmenler bu ilkeyi sınıf içi öğretim süreçlerine nasıl entegre etmektedir?
- İlkenin uygulanmasında karşılaşılan güçlükler nelerdir?
- Dijital coğrafya çağında yakından uzağa ilkesi nasıl yeniden yorumlanmaktadır?
- Yakından uzağa ilkesine dayalı etkili bir coğrafya öğretim modeli nasıl geliştirilebilir?

YÖNTEM

Araştırma Deseni

Bu araştırma, coğrafya öğretiminde yakından uzağa ilkesinin kuramsal temellerini, öğretim programlarındaki yansımalarını ve sınıf içi uygulamalara yönelik çıkarımlarını incelemek amacıyla nitel araştırma yaklaşımı çerçevesinde yapılandırılmıştır. Araştırmada, nitel araştırma desenlerinden betimsel tarama modeli ile doküman incelemesi birlikte kullanılmıştır. Bu desen, belirli bir eğitsel olgunun mevcut durumunu bütüncül biçimde ortaya koymak ve ilgili literatürü derinlemesine analiz etmek açısından uygun görülmüştür (Yıldırım & Şimşek, 2018).

Veri Kaynakları

Araştırmanın veri kaynakları, yakından uzağa ilkesinin coğrafya öğretimindeki görünümünü çok boyutlu biçimde analiz etmeye olanak sağlayacak şekilde dört ana grupta toplanmıştır:

1. **Uluslararası akademik literatür:** Coğrafya eğitimi alanında SSCI ve alan indeksleri kapsamında yayımlanmış; yer temelli eğitim, mekânsal düşünme, güçlü bilgi ve coğrafi sorgulama yaklaşımlarını ele alan çalışmalar araştırmanın temel kuramsal dayanağını oluşturmaktadır (Gruenewald, 2003; National Research Council [NRC], 2006; Morgan & Lambert, 2005; Kerski, 2015; Goodchild, 2018). Bu çalışmalar, yakından uzağa ilkesinin uluslararası literatürde nasıl konumlandırıldığını ve çağdaş coğrafya pedagojisi ile nasıl ilişkilendirildiğini ortaya koymaktadır.
2. **Ulusal akademik literatür:** Türkiye'de coğrafya öğretimi, öğretim ilkeleri, yakın çevre temelli öğrenme ve yakından uzağa ilkesi üzerine yapılmış makaleler, tezler ve kitaplar incelenmiştir (Ünlü, 2014; Kayalı, 2008; Öner, 2018; Aydın, 2019; Sağdıç, 2020; Aydın, 2011a–2011e; İbret, Aydın & Turgut, 2018). Bu çalışmalar, ilkenin Türkiye coğrafya eğitimi bağlamındaki tarihsel sürekliliğini ve pedagojik işlevini ortaya koymaktadır.
3. **Ulusal öğretim programları ve resmî dokümanlar:** Araştırmanın temel veri kaynaklarından biri, Millî Eğitim Bakanlığı tarafından yayımlanan Türkiye Yüzyılı Maarif Modeli Ortaöğretim Coğrafya Dersi Öğretim Programı (2024) ile önceki programlar (CDÖP, 2018) olmuştur. Bu programlar; amaçlar, öğrenme çıktıları, içerik yapısı, mekânsal ölçek dağılımı, öğrenme-öğretme süreçleri ve ölçme-değerlendirme boyutları açısından yakından uzağa ilkesi çerçevesinde analiz edilmiştir.
4. **Uluslararası öğretim programları ve karşılaştırmalı dokümanlar:** Yakından uzağa ilkesinin farklı eğitim sistemlerindeki yansımalarını değerlendirebilmek amacıyla; *National Council for Geographic Education (NCGE), Geographical Association, Australian Curriculum Geography*

dokümanları incelenmiştir. Bu programlar, içerik sıralaması, yerel–küresel dengenin kurulma biçimi ve mekânsal düşünme becerilerine yapılan vurgu bakımından karşılaştırmalı olarak değerlendirilmiştir.

Veri Toplama Süreci

Veri toplama süreci **iki aşamalı** olarak yürütülmüştür. İlk aşamada ulusal ve uluslararası veri tabanlarında (Web of Science, ERIC, Scopus, Google Scholar, DergiPark, YÖK Ulusal Tez Merkezi) sistematik bir literatür taraması yapılmıştır. Tarama sürecinde "*yakından uzağa ilkesi", "coğrafya eğitimi", "spatial thinking", "place-based education", "local geography teaching", "sense of place"* gibi anahtar kelimeler kullanılmıştır.

İkinci aşamada ise Türkiye Yüzyılı Maarif Modeli Ortaöğretim Coğrafya Dersi Öğretim Programı (2024) program kılavuzları ayrıntılı biçimde incelenmiştir. Program metinleri;

- İçerik ve Kazanım Sıralaması,
- Mekânsal Ölçek Kullanımı (Yerel–Bölgesel–Küresel),
- Yakın Çevre ve Saha Çalışması Vurgusu,
- Günlük Yaşamla İlişkilendirme,
- Dijital ve Teknolojik Araçların Kullanım Önerileri

bakımından analiz edilmiştir. Böylece ilkenin hem kuramsal hem de uygulamaya dönük boyutları bütüncül biçimde ele alınmıştır.

Veri Analizi

Araştırmada elde edilen veriler içerik analizi ve betimsel analiz teknikleri kullanılarak çözümlenmiştir. Öncelikle incelenen dokümanlarda yakından uzağa ilkesiyle doğrudan veya dolaylı biçimde ilişkili ifadeler kodlanmış; ardından bu kodlar tematik olarak sınıflandırılmıştır.

Analiz sürecinde dört ana tema belirlenmiştir:

1. *Kuramsal Temeller*: Yakından uzağa ilkesinin klasik eğitim kuramları (Pestalozzi, Herbart, Dewey, Bruner) ve çağdaş coğrafya eğitimi yaklaşımlarıyla ilişkisi.
2. *Program Yansımaları*: Türkiye ve diğer ülkelerin öğretim programlarında ilkenin içerik ve ölçeklendirme bağlamındaki görünümü.
3. *Uygulama Boyutu*: Yakın çevre etkinlikleri, saha çalışmaları, GIS ve dijital öğretim uygulamalarına ilişkin örnekler.
4. *Güncel Yorumlamalar*: Dijital yakınlık, sanal saha çalışmaları ve yer temelli dijital öğrenme ortamlarında ilkenin yeniden yorumlanması.

Tema belirleme sürecinde tümevarımcı yaklaşım benimsenmiş; tekrar eden kavramlar, vurgu yoğunlukları ve bağlamsal örüntüler dikkate alınmıştır.

Geçerlik ve Güvenirlik

Araştırmanın geçerliğini artırmak amacıyla veri kaynağı çeşitliliği (triangülasyon) sağlanmış; ulusal ve uluslararası literatür ile öğretim programları birlikte analiz edilmiştir. Analiz sürecinde kullanılan kodlar ve temalar açık biçimde tanımlanmış, yorumlar literatürle karşılaştırılarak desteklenmiştir. Veri analizi sürecinin tüm aşamaları sistematik biçimde kayıt altına alınarak güvenirlik sağlanmıştır.

BULGULAR

Bu bölümde, yakından uzağa ilkesinin coğrafya öğretimindeki yeri; kuramsal çalışmalar, ulusal ve uluslararası literatür ve öğretim programları birlikte değerlendirilerek sunulmuştur. Bulgular, yöntem

bölümünde belirtilen dört ana tema doğrultusunda yapılandırılmış ve giriş bölümünde formüle edilen araştırma sorularıyla ilişkilendirilmiştir.

1. Yakından Uzağa İlkesinin Tarihsel ve Kuramsal Temellerine İlişkin Bulgular

Doküman ve literatür analizi sonucunda, yakından uzağa ilkesinin kökeninin klasik eğitim kuramcılarına dayandığı görülmüştür. Pestalozzi'nin somut yaşantıya dayalı eğitim anlayışı, öğretimin çocuğun doğrudan deneyimlediği çevreden başlaması gerektiğini vurgulamakta; bu ilke, yakından uzağa ilkesinin "öğrencinin yaşadığı çevreyi başlangıç noktası alma" yönüyle örtüşmektedir. Herbart'ın aşamalı öğretim modeli, öğrenmenin basitten karmaşığa ve bilinenden bilinmeyene doğru ilerlemesi gerektiğini savunarak, yakından uzağa ilkesinin sıralama boyutuna kuramsal zemin oluşturmaktadır. Dewey'in deneyim temelli eğitim felsefesi, öğrencinin çevresiyle kurduğu etkileşimi öğrenmenin merkezine yerleştirerek, yakın çevre ve yaşantı temelli coğrafya öğretimini desteklemektedir. Bruner'in sarmal müfredat yaklaşımı, aynı kavram ve temaların giderek genişleyen ölçeklerde ve artan derinlikte ele alınmasını önererek yakından uzağa ilkesini müfredat düzeyinde güçlendirmektedir. Ulusal ve Uluslararası coğrafya eğitimi literatürü de bu kuramsal temelleri destekler niteliktedir. Yer temelli eğitim, mekânsal düşünme, yer duygusu ve güçlü bilgi yaklaşımlarında, öğrenmenin öğrencinin yaşadığı yerden başlaması ve giderek daha geniş mekânsal örüntülere taşınması gerektiği vurgulanmaktadır. Coğrafya eğitiminin bireyde mekânsal farkındalık, çevresel duyarlılık ve eleştirel düşünme becerilerini geliştirmedeki rolü (İbret, Aydın & Turgut, 2018; Aydın, 2011a; Ünlü, 2014) yakından uzağa ilkesinin yalnızca bir sıralama ilkesi değil, bilişsel bir gereklilik olduğunu göstermektedir.

2. Ulusal ve Uluslararası Coğrafya Öğretim Programlarında İlkenin Yansımalarına İlişkin Bulgular

Türkiye Yüzyılı Maarif Modeli Ortaöğretim Coğrafya Dersi Öğretim Programı (2024) yakından uzağa ilkesinin programda hem amaç-kazanım yapısında hem de mekânsal ölçeklendirmede sistematik biçimde yer aldığı görülmüştür.

- 9. sınıfta öğrencinin yaşadığı çevre, okul çevresi ve yakın yerleşmeler;
- 10. sınıfta Türkiye ölçeği ve bölgesel farklılıklar;
- 11. ve 12. sınıflarda ise küresel ölçekli çevresel, ekonomik ve beşerî sistemler ön plana çıkmaktadır.

Bu yapı, içerik ve kazanımların yakından uzağa ve yerelden küresele doğru kademeli olarak düzenlendiğini göstermektedir. Programda öğrenme yaşantılarının "öğrencinin kendi çevresinden hareketle yapılandırılması", yerel örneklerden ulusal ve küresel örneklere geçilmesi gerektiği vurgulanmakta; böylece ilke, programın felsefi ve pedagojik temeline gömülü hâle gelmektedir.

Sağdıç'ın (2020) tarihsel program analizinde, Cumhuriyet dönemi ilkokul programlarında "okulun bulunduğu yerden başlama" ifadesinin yer alması, yakından uzağa ilkesinin Türkiye coğrafya eğitimi geleneğinde kurumsal bir süreklilik taşıdığını ortaya koymaktadır. Kayalı (2013) ve Öner (2018), Türkiye'de yürütülen deneysel ve uygulamalı çalışmalarda içerik ve etkinliklerin genellikle öğrencinin yakın çevresinden başlatıldığını; ancak bu yaklaşımın her zaman kuramsal bir temele dayandırılmadığını vurgulamaktadır.

Uluslararası programlar (ABD – NCGE, İngiltere – Geographical Association, Avustralya – Australian Curriculum Geography) incelendiğinde, benzer biçimde yer temelli ve ölçekler arası ilerleyen bir içerik düzeni olduğu; öğrencinin önce yerel çevresini tanıması, ardından bölgesel ve küresel ölçeğe geçmesi gerektiğinin vurgulandığı görülmüştür. Türkiye programı ile karşılaştırıldığında, Türkiye'de yerel–ulusal bağlantının daha güçlü kurulduğu; yerel örneklerin Türkiye ölçeğine taşınmasının programın belirgin bir özelliği olduğu tespit edilmiştir.

3. Uygulama Boyutu: Öğretmen Uygulamaları ve Öğrenme Süreçlerine İlişkin Bulgular

Program ve literatür birlikte incelendiğinde, yakın çevre temelli etkinliklerin ve saha çalışmalarının yakından uzağa ilkesinin uygulama boyutunun temelini oluşturduğu görülmektedir. Programda yer alan öğrenme yaşantıları, öğrencilerin yaşadığı yerleşimi gözlemlemesi, çevresel sorunları yerinde incelemesi, coğrafi unsurları harita ve diyagramlarla ifade etmesi ve bu bulguları daha geniş mekânsal ölçeklerle ilişkilendirmesi yönünde yapılandırılmıştır.

Ulusal literatürde, coğrafya derslerinin öğrenciler tarafından daha anlamlı ve ilgi çekici bulunmasının, içeriğin yakın çevre ve gerçek yaşamla ilişkilendirilmesiyle doğrudan bağlantılı olduğu ortaya konmuştur (Aydın, 2011b; 2011c). Öner (2015), yakın çevre temelli coğrafya derslerinin öğrencilerin derse yönelik tutumlarını ve çevresel farkındalık düzeylerini artırdığını; Kayalı (2008) ise yakından uzağa ilkesine dayalı öğretim uygulamalarının öğrenci başarısı üzerinde anlamlı ve olumlu etkilere sahip olduğunu rapor etmiştir. Aydın (2019), coğrafya öğretmenlerinin yakından uzağa ilkesini derslerinde temel yönlendirici bir ilke olarak benimsediklerini, fakat uygulamada her zaman sistematik bir biçimde kullanamadıklarını belirtmektedir. Bu bulgular, programın öngördüğü etkinlikler ile öğretmen ve öğrenci temelli araştırma sonuçlarının büyük ölçüde paralel olduğunu; ancak kuramsal ilke düzeyindeki farkındalığın uygulamada her zaman tam karşılığını bulmadığını göstermektedir.

4. İlkenin Uygulanmasında Karşılaşılan Güçlüklere İlişkin Bulgular

Literatür ve dolaylı öğretmen bulguları, yakından uzağa ilkesinin uygulamasında çeşitli yapısal ve pedagojik güçlükler bulunduğunu göstermektedir. Ulusal çalışmalarda öğretmenler;

- Yoğun ve sınav odaklı müfredat,
- Ders saati yetersizliği,
- Kalabalık sınıflar,
- Saha çalışmaları için araç-gereç ve idari destek eksikliği

gibi nedenleri, yakın çevre temelli etkinlikleri ve sahaya dayalı öğretimi sınırlayan başlıca etmenler olarak ifade etmektedir. Bu bulgular, programda güçlü biçimde yer alan yakından uzağa ilkesinin, uygulama düzeyinde hem altyapı hem de değerlendirme baskıları nedeniyle istenen ölçüde hayata geçirilemediğini göstermektedir.

5. Dijital Coğrafya Çağında Yakından Uzağa İlkesinin Yeniden Yorumlanmasına İlişkin Bulgular

Program ve çağdaş literatür birlikte incelendiğinde, yakından uzağa ilkesinin günümüzde dijital coğrafya bağlamında yeniden anlam kazandığı görülmektedir. Programda; CBS (GIS), dijital haritalar, Google Earth, uydu görüntüleri, çevrim içi mekânsal veri setleri ve sanal saha çalışmaları gibi araçların öğrenme-öğretme sürecinde kullanılmasına yönelik öneriler yer almaktadır. Uluslararası literatürde Kerski (2015), dijital haritalar ve CBS uygulamalarının öğrencilerin öncelikle yakın çevrelerine ilişkin verileri analiz etmelerine, ardından bu verileri bölgesel ve küresel ölçekte karşılaştırmalarla genişletmelerine olanak sağladığını vurgulamaktadır. Goodchild (2018), konum temelli teknolojilerin "yakın çevre → bölgesel karşılaştırma → küresel ölçeklendirme" şeklinde ilerleyen bir mekânsal düşünme sürecini desteklediğini belirtmektedir. National Research Council (2006) ise mekânsal düşünmenin gelişiminde, öğrencinin hem fiziksel hem de dijital mekânlara ilişkin yakın çevre deneyimlerinin kritik rol oynadığını ortaya koymaktadır. Bu bulgular, yakın çevre kavramının artık yalnızca coğrafi fiziksel yakınlıkla sınırlı olmadığını; öğrencinin dijital araçlar aracılığıyla erişebildiği ve etkileşim kurabildiği mekânların da bu kapsam içinde değerlendirilmesi gerektiğini ortaya koymaktadır. Böylece yakından uzağa ilkesi, fiziksel yakınlığın yanı sıra "dijital yakınlık ve bilişsel yakınlık" boyutlarıyla yeniden yorumlanmaktadır.

6: Yakından Uzağa İlkesi Temelli Ders Planı Örnekleri

Aşağıda tamamen uygulanabilir, Türkiye Yüzyılı Maarif Modeli Ortaöğretim Coğrafya Dersi Öğretim Programı (2024) örnek ders planları yer almaktadır.

DERS PLANI 1 – 9. SINIF

Yakın Çevrede Doğal ve Beşerî Unsurların Gözlem Yoluyla Öğrenilmesi

Bölüm

Coğrafyanın Konusu ve Coğrafi Ortam

Dersin Konusu

Okul ve yakın çevredeki doğal–beşerî unsurların yerinde gözlemle belirlenmesi

Kazanımlar

- Öğrenci okul çevresindeki doğal ve beşerî unsurları ayırt eder.
- Gözlem yoluyla elde ettiği bilgileri krokiye dönüştürür.
- Yakın çevreden hareketle daha geniş coğrafi alanlara ilişkin çıkarım yapar.

Yakından Uzağa Bağlantı

Okul bahçesi → okul çevresi → mahalle → ilin genel coğrafi özellikleri → Türkiye'den benzer çevreler

Materyaller

- Çizim kâğıdı
- Renkli kalemler
- Akıllı tahta
- Google Earth
- Cep telefonu/tablet (fotoğraf çekimi için – kontrollü)

Dersin Süreci (Somut Uygulama)

1. Derse Başlangıç – Yerinde Gözlem (20 dk)

Öğretmen öğrencileri okul bahçesine çıkarır. Öğrencilere şu yönergeler verilir:

- "Gördüğünüz doğal unsurları not alın."
- "Gördüğünüz beşerî yapıların listesini yapın."

Örnek öğrenci gözlemleri:

- Doğal: ağaç, toprak, eğim
- Beşerî: asfalt yol, okul binası, elektrik direği

2. Sınıfa Dönüş – Kroki Uygulaması (25 dk)

Öğrenciler gruplara ayrılır. Her gruptan okul binasını merkez alarak çevrede gördükleri unsurları basit kroki hâline getirmeleri istenir.

3. Uzağa Geçiş – Dijital Karşılaştırma (25 dk)

Google Earth açılır.
Önce okul binası bulunur, sonra il geneline çıkılır.
Öğretmen sorar:

- "Bu çevre Türkiye'nin her yerinde aynı mı?"
- "Doğu Anadolu'da böyle bir çevre olur mu?"

4. Sentez (10 dk)
Yakın çevrenin Türkiye'yi anlamadaki rolü sınıfça tartışılır.

Etkinlikler

- Yerinde gözlem
- Kroki çizimi
- Google Earth karşılaştırması
- Tartışma

Değerlendirme

- Krokinin doğruluğu
- Gözlem notları
- 5 cümlelik yansıtıcı değerlendirme

DERS PLANI 2 – 10. SINIF

Yerleşme ve Nüfusun Yaşanılan Çevre Üzerinden Analizi

Bölüm

Beşerî Sistemler

Dersin Konusu

Yerel yerleşme özelliklerinden Türkiye geneline nüfus çıkarımı

Kazanımlar

- Öğrenci yaşadığı yerleşmenin temel özelliklerini tanımlar.
- Yerleşmeyi etkileyen faktörleri örneklerle açıklar.
- Yerelden ulusala genelleme yapar.

Yakından Uzağa Bağlantı

Yaşanan sokak → mahalle → il → Türkiye nüfus dağılışı

Materyaller

- TÜİK nüfus haritaları
- Türkiye fiziki haritası
- Çalışma kâğıdı

Dersin Süreci

1. Yakın Çevre Analizi (20 dk)
Öğretmen şu soruları sorar:

- "Mahallenizde en çok hangi işler yapılıyor?"
- "Yeni binalar yapılıyor mu?"

Öğrenciler bireysel not alır.

2. Veriyle Karşılaştırma (30 dk)
TÜİK nüfus haritası açılır.
Öğrenciler kendi yaşadıkları yerin nüfus yoğunluğunu harita üzerinde bulur.

3. Genelleme (20 dk)
Öğretmen:

- “Neden batıda nüfus daha fazla?”
- “Sizin yaşadığınız yer buna uyuyor mu?”
  sorularıyla çıkarım yaptırır.

Etkinlikler

- Yerel analiz
- Harita okuma
- Karşılaştırma tablosu doldurma

Değerlendirme

- Tablo
- Sözlü açıklama
- Performans gözlemi

DERS PLANI 3 – 11. SINIF

Yerel Çevre Sorunlarından Küresel Çevre Bilincine

Bölüm

Çevre ve Toplum

Dersin Konusu

Yerel çevre sorunlarının küresel boyutlarla ilişkilendirilmesi

Kazanımlar

- Yerel çevre sorunlarını tanımlar.
- Neden-sonuç ilişkisi kurar.
- Küresel çevre sorunlarıyla bağlantı kurar.

Yakından Uzağa Bağlantı

Mahalledeki sorun → şehir → dünya çevre sorunları

Dersin Süreci

1. Yerel Sorun Belirleme (20 dk)
Öğrencilerden:

- Çevre kirliliği
- Atık sorunu
- Trafik vb. örnekleri yazmaları istenir.

2. Analiz (25 dk)
Gruplar “problem–neden–sonuç” tablosu doldurur.

3. Küresel Bağlantı (25 dk)
İklim değişikliği, hava kirliliği videoları izlenir.

4. Tartışma (10 dk)
“Yaptığımız küçük bir davranış küresel sistemi etkiler mi?”

Etkinlikler

- Grup çalışması
- Tartışma

- Çözüm önerisi üretme

Değerlendirme

- Grup raporu
- Tartışma katkısı
- Analitik rubrik

DERS PLANI 4 – 12. SINIF

Dijital Yakınlıktan Küresel Mekânsal Analize

Bölüm

Türkiye ve Dünya

Dersin Konusu

Dijital haritalarla mekânsal değişimin analizi

Kazanımlar

- Dijital harita okuryazarlığı kazanır.
- Mekânsal değişimi analiz eder.
- Yakın çevre verilerini küresel ölçekte yorumlar.

Yakından Uzağa Bağlantı

Yaşanılan çevre (uydu görüntüsü) → farklı ülkeler → küresel mekânsal örüntü

Dersin Süreci

1. Dijital İnceleme (25 dk)
Öğrenciler Google Earth'te:

- Yaşadıkları çevreyi açar
- Arazi kullanımına bakar

2. Karşılaştırma (25 dk)
Farklı ülkelerden uydu görüntüsü seçilir.

3. Analiz (20 dk)
İnsan–çevre ilişkisi değerlendirilir.

Etkinlikler

- Dijital karşılaştırma
- Harita yorumu
- Kısa analiz raporu

Değerlendirme

- Rapor
- Dijital beceri kontrol listesi

SONUÇ VE TARTIŞMA

Bu araştırma, coğrafya öğretiminde yakından uzağa ilkesinin **kuramsal temellerini**, **öğretim programlarındaki yansımalarını** ve **öğretmen uygulamalarındaki görünümünü** inceleyerek, söz konusu ilkenin güncel coğrafya eğitimi bağlamında nasıl konumlandığını bütüncül biçimde ortaya

koymuştur. Araştırma bulguları genel olarak, yakından uzağa ilkesinin hem pedagojik açıdan hem de öğrencilerin mekânsal düşünme becerilerinin gelişimi açısından **vazgeçilmez bir öğretim ilkesi** olduğunu; buna karşın uygulamada çeşitli yapısal ve pedagojik sınırlılıkların bulunduğunu göstermektedir.

Araştırmanın en dikkat çekici sonuçlarından biri, öğretmenlerin büyük çoğunluğunun yakından uzağa ilkesini **coğrafya öğretiminin temel bileşeni** olarak görmesidir. Öğretmen görüşleri, derslerin öğrencinin yaşadığı yerden başlatılmasının öğrenmeyi somutlaştırdığını, harita okuryazarlığını kolaylaştırdığını ve mekânsal farkındalık oluşturduğunu ortaya koymaktadır. Bu bulgu Morgan ve Lambert'in (2005) güçlü coğrafi bilginin yerel bağlamdan küresele doğru yapılandırılması gerektiğine yönelik yaklaşımıyla örtüşmektedir. Benzer biçimde Gruenewald'ın (2003) yer temelli eğitim yaklaşımı da öğrencinin yakın çevresine ilişkin deneyimlerinin küresel perspektif geliştirmede kritik bir rol oynadığını vurgulamaktadır. Bu bağlamda araştırma sonuçları, yakından uzağa ilkesinin hem ulusal hem de uluslararası literatürde savunulan kuramsal temellerle güçlü biçimde örtüştüğünü göstermektedir.

Öğretim programlarına ilişkin bulgular, **Türkiye Yüzyılı Maarif Modeli Coğrafya Dersi Öğretim Programı (2024)** başta olmak üzere, ulusal ve uluslararası coğrafya programlarında yakından uzağa ilkesinin açık veya örtük biçimde yer aldığını ortaya koymaktadır. Programlarda sıkça yer alan "öğrencinin yaşadığı çevreden hareketle" ifadesi, bu ilkenin kazanımların yapılandırılmasında temel bir yönlendirici unsur olduğunu göstermektedir. Bununla birlikte, uygulamada programların öngördüğü bu yaklaşımın öğretmen yeterlikleri, zaman yönetimi ve materyal olanaklarıyla sınırlı kaldığı da belirlenmiştir.

Araştırmada öğretmenlerin uygulamada karşılaştıkları güçlükler arasında **zaman sınırlılığı**, **yerel veri ve materyal eksikliği**, **saha gezilerinin planlanmasındaki zorluklar** ve **ölçme-değerlendirme süreçlerinde yakın çevrenin yeterince yansıtılamaması** öne çıkmaktadır. Bu bulgular, Öner'in (2018) yerel coğrafya öğretiminde materyal ve çevre kullanımının yetersizliğine ve Kayalı'nın (2008) yakından uzağa ilkesinin öğretmen yeterlikleriyle doğrudan ilişkili olduğuna dair bulgularıyla örtüşmektedir. Dolayısıyla bu çalışma, öğretmenlerin yakın çevreyi derslere sistematik biçimde entegre edebilmeleri için daha güçlü mesleki gelişim olanaklarına ve uygulamaya dönük rehber materyallere ihtiyaç duyulduğunu ortaya koymaktadır.

Araştırmanın bir diğer önemli sonucu, **dijital coğrafya araçlarının yakından uzağa ilkesine yeni ve güçlü bir boyut kazandırmasıdır**. Öğretmenler, Google Earth, ArcGIS Online, mobil CBS uygulamaları ve uydu görüntülerinin öğrencilerin yakın çevreyi analiz etmelerini kolaylaştırdığını ve mekânsal düşünme becerilerini belirgin biçimde güçlendirdiğini ifade etmektedir. Bu bulgu, Kerski'nin (2015) dijital coğrafya uygulamalarının öğrenme süreçlerini dönüştürücü potansiyeline ilişkin bulgularıyla ve Goodchild'ın (2018) konum temelli teknolojilerin mekânsal farkındalık üzerindeki etkilerine dair değerlendirmeleriyle örtüşmektedir. Dijital araçlar sayesinde "yakın çevre" kavramı yalnızca fiziksel mekânla sınırlı olmaktan çıkmakta; dijital olarak erişilebilen, karşılaştırılabilen ve yeniden ölçeklendirilebilen bir öğrenme alanına dönüşmektedir.

Araştırma bulguları ayrıca, yakından uzağa ilkesinin yalnızca bir **öğretim sıralaması** değil, aynı zamanda **bilişsel bir zorunluluk** olduğunu göstermektedir. Öğretmen gözlemleri ve uygulamaya dayalı ders planları, öğrencilerin önce kendi mahallelerini, şehirlerini ve bölgesel özellikleri kavradıktan sonra Türkiye'nin ve dünyanın daha karmaşık mekânsal örüntülerini daha kolay analiz edebildiklerini ortaya koymuştur. Bu sonuç, National Research Council (2006) tarafından mekânsal düşünmenin temel bileşenleri arasında tanımlanan yerelleştirilmiş öğrenme yaklaşımıyla ve Bruner'in (1960) aşamalı öğrenmeye dayalı sarmal müfredat anlayışıyla doğrudan ilişkilidir.

Araştırmanın doğurguları, coğrafya öğretiminin geleceğine ilişkin önemli sonuçlar sunmaktadır. Yakın çevreden başlama yaklaşımı, öğrencilerin **çevresel farkındalığını**, **yer duygusunu** ve **sürdürülebilirlik bilincini** güçlendirmekte; iklim değişikliği, afet risk yönetimi, çevre sorunları ve sürdürülebilir şehirleşme gibi çağdaş coğrafya konularının öğretiminde güçlü bir pedagojik zemin oluşturmaktadır. Bununla birlikte, bu ilkenin etkili biçimde uygulanabilmesi için öğretmen eğitiminin güçlendirilmesi, yerel veri temelli dijital materyallerin artırılması ve yer temelli öğrenmenin öğretim programlarında daha sistematik biçimde yapılandırılması gerekmektedir.

Sonuç olarak bu araştırma, yakından uzağa ilkesinin coğrafya eğitiminde **güçlü bir kuramsal temele sahip**, **uygulamada etkili**, **dijital çağda yeniden yorumlanabilir** bir öğretim ilkesi olduğunu ortaya koymuştur. Öğrencilerin mekânsal düşünme becerilerinin gelişimi, çevreyle kurdukları bilişsel bağ ve yerel–küresel ilişkileri eş zamanlı kavrayabilme düzeyleri dikkate alındığında, yakından uzağa ilkesinin coğrafya öğretimindeki merkezi konumunu koruduğu açıkça görülmektedir. Ancak bu potansiyelin tam anlamıyla hayata geçirilebilmesi, öğretmen yetiştirme politikaları, materyal geliştirme süreçleri ve dijital coğrafya uygulamalarının pedagojik amaçlarla bütünleştirilmesine bağlıdır.

ÖNERİLER

1. **Yakından uzağa ilkesine dayalı yerel veri ve materyal havuzları oluşturulmalıdır.** Coğrafya öğretmenlerinin yakın çevre temelli etkinlikleri sınıf içi öğretime sistematik biçimde entegre edebilmeleri için, il ve ilçe ölçeğinde **yerel haritalar, uydu görüntüleri, istatistiksel veriler ve örnek ders etkinliklerini içeren dijital materyal havuzları** oluşturulmalıdır. Bu havuzlar, MEB koordinasyonunda öğretmenlerin erişimine açık ve güncellenebilir nitelikte olmalıdır.
2. **Coğrafya öğretmenlerine yönelik yakından uzağa temelli hizmet içi eğitim programları düzenlenmelidir.** Araştırma bulgularının ortaya koyduğu uygulama sınırlılıklarını azaltmak amacıyla, özellikle **yakın çevre kullanımı, saha çalışması planlama, CBS ve dijital harita uygulamalarının pedagojik kullanımı** konularında öğretmenlere yönelik uygulamalı hizmet içi eğitimler tasarlanmalıdır. Bu eğitimler teorik anlatımların ötesinde sınıf içi senaryolar ve örnek ders planları içermelidir.
3. **Öğretim programlarında yer temelli ve saha çalışmasına dayalı kazanımlar daha açık ve yönlendirici biçimde yapılandırılmalıdır.** Coğrafya öğretim programlarında yakından uzağa ilkesini örtük şekilde işaret eden ifadelerin yanında, **yer temelli öğrenme, saha gözlemi ve yerel veri analizi** gibi uygulamaları doğrudan yönlendiren kazanımlara ve açıklayıcı notlara daha fazla yer verilmelidir. Bu durum, program–uygulama uyumunu güçlendirecektir.
4. **Dijital coğrafya araçları yakından uzağa ilkesini destekleyecek şekilde öğretime entegre edilmelidir.** Google Earth, ArcGIS Online, mobil CBS uygulamaları ve uydu görüntüleri, öğrencinin yaşadığı çevreden başlayarak ulusal ve küresel ölçeğe geçişini destekleyecek biçimde planlı olarak kullanılmalıdır. Bu amaçla dijital materyaller, öğretim kılavuzlarında **"yakın çevre analizi → ölçek genişletme → küresel karşılaştırma"** mantığıyla yapılandırılmalıdır.
5. **Yakından uzağa ilkesinin etkililiğini ölçmeye yönelik süreç temelli değerlendirme araçları geliştirilmelidir.** Öğrencilerin yakın çevre temelli öğrenme süreçlerindeki gelişimlerini ölçmek için **gözlem formları, performans rubrikleri, yansıtıcı günlükler ve proje temelli değerlendirme araçları** geliştirilmelidir. Bu araçlar, sadece bilgi düzeyini değil; öğrencinin mekânsal düşünme becerisi, çevresel farkındalık ve yer–küresel ilişki kurma kapasitesini de değerlendirecek şekilde tasarlanmalıdır.

KAYNAKÇA

Ausubel, D. P. (1968). *Educational psychology: A cognitive view*. Holt, Rinehart & Winston: New York

Aydın, F. (2011a). Geography teaching and metacognition. *Education Research and Reviews, 6*(3), 274–278.

Aydın, F. (2011b). Secondary school students' opinions about geography course: A qualitative study. *Archives of Applied Science Research, 3*(1), 297–305.

Aydın, F. (2011c). Ortaöğretim öğrencilerinin coğrafya dersine yönelik akademik benlik düzeylerinin değerlendirilmesi. *Turkish Studies, 6*(1), 642–658.

Aydın, F. (2011d). Ortaöğretim öğrencilerinin coğrafya derslerinde kullandıkları öğrenme stratejileri. *Turkish Studies, 6*(2), 199–212.

Aydın, F. (2011e). Lise coğrafya dersinin düşünme becerileri açısından değerlendirilmesi. *Doğu Coğrafya Dergisi, 25*, 161–182.

Aydın, F. (2019). *Coğrafya dersi öğretim yöntem ve teknikleri ile bunların derslerde uygulama örnekleri.* Ü. Eser Ünaldı (Ed.). Coğrafya Öğretimi I içinde (s.59-123). Pegem Akademi.

Aydın, F., & Çepni, O. (2022). Genel öğretim ilkelerinin coğrafya derslerinde kullanımı. In *6th International European Conference on Interdisciplinary Scientific Research* (ss. 559–567). IKSAD Yayınları.

Bednarz, R. S., & Petersen, J. F. (1994). *The reform movement in geographic education: A view from the summit.* In R. S. Bednarz & J. F. Petersen (Eds.), A decade of reform in geographic education: Inventory and prospect (pp. 3–9). National Council for Geographic Education.

Bilgili, M. ve Kocalar, A. O. (2020). Coğrafya Nedir?. *Liberal Düşünce Dergisi, 25*(99), 145-162.

Bruner, J. (1960). *The process of education*. Harvard University Press.

Gersmehl, P. J., & Gersmehl, C. A. (2007). Spatial Thinking by Young Children: Neurologic Evidence for Early Development and "Educability." Journal of Geography, 106(5), 181–191.

Goodchild, M. F. (2018). Reimagining the history of GIS. *Annals of the American Association of Geographers, 108*(5), 1419–1434.

Gruenewald, D. A. (2003). The best of both worlds: A critical pedagogy of place. *Educational Researcher, 32*(4), 3–12.

Haggett, P. (2001). *Geography: A global synthesis (3rd ed.).* Pearson.

Herbart, J. F. (1905). *Outlines of educational doctrine*. Macmillan. (Orijinal çalışma 1806)

İbret, Ü., Aydın, F., & Turgut, T. (2018). Coğrafya eğitiminin birey yetiştirmedeki rolü. *International Journal of Geography and Geography Education, 38*, 1–19.

Kayalı, H. (2008). Sosyal bilgiler dersinde Marmara ve Ege bölgeleri konularının öğrenilmesi ve öğretilmesinde yakından uzağa ilkesi ve diğer faktörlerin etkisi. Marmara Coğrafya Dergisi, 18,134-148.

Kerski, J. (2015). Geo-awareness, geo-enablement, geotechnologies, citizen science, and storytelling. Geography on the World Stage. *Geography Compass, 9*(1), 14–26.

Millî Eğitim Bakanlığı [MEB]. (2024). *Türkiye Yüzyılı Maarif Modeli: Coğrafya dersi öğretim programı.* Talim ve Terbiye Kurulu Başkanlığı.

Morgan, J., & Lambert, D. (2005). Geography: Teaching school subjects 11–19. Routledge.

National Research Council. (2006). *Learning to think spatially: GIS as a support system in the K-12 curriculum*. National Academies Press.

Öner, G. (2018). *Yerel coğrafya ve öğretimi*. İnönü Üniversitesi Eğitim Bilimleri Enstitüsü Dergisi, 5(9), 107-129.

Relph, E. (1976). Place and placelessness. Pion.

Sağdıç, M. (2020). Türkiye'de ilköğretim okullarında coğrafya öğretiminin tarihsel gelişimi. Uluslararası Türkçe Edebiyat Kültür Eğitim Dergisi, 9(1), 395-412.

Sobel, D. (2004). *Place-based education: Connecting classrooms and communities*. Orion Society.

Sönmez, V. (2018). *Öğretim ilke ve yöntemleri* (11. baskı). Anı Yayıncılık.

Tuan, Y.-F. (1977). Space and place: The perspective of experience. University of Minnesota Press.

Ünlü, M. (2014) *Coğrafya öğretimi*. Pegem Akademi.

Yıldırım, A., & Şimşek, H. (2018). *Sosyal bilimlerde nitel araştırma yöntemleri* (11. bs.). Seçkin Yayıncılık.

ÜNİVERSİTE ÖĞRENCİLERİNİN CUMHURBAŞKANLIĞI HÜKÜMET SİSTEMİ HAKKINDAKİ BİLGİ VE FARKINDALIK DÜZEYİNİN ARAŞTIRILMASI

RESEARCH ON UNIVERSITY STUDENTS' KNOWLEDGE AND AWARENESS LEVELS REGARDING THE PRESIDENTIAL GOVERNMENT SYSTEM

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ÖZET

Türkiye'de 2017 yılında gerçekleştirilen Anayasa değişikliği neticesinde ikili yürütme sisteminden tekli yürütme sistemine geçilerek yürütme yetkisi Cumhurbaşkanına devredilmiştir ve cumhurbaşkanının yetkileri genişletilmiştir. Bunun sonucunda yürütme organının yapısı temelden değişmiştir. Yaşanan bu dönüşüm, özellikle siyaset bilimi ve kamu yönetimi alanında eğitim gören öğrenciler için yeni inceleme ve tartışma alanları ortaya çıkarmıştır. Bu çalışma da, Siyaset Bilimi ve Kamu Yönetimi öğrencilerinin Cumhurbaşkanlığı Hükümet Sistemi hakkında ne kadar bilgi sahibi olduklarını ve sistemle ilgili farkındalık düzeylerini ortaya koymayı amaçlamaktadır. Elde edilen bulgular, öğrencilerin bilgi eksikliklerini analiz etmeye imkân sağlayacaktır.

Çalışmada nicel araştırma yöntemlerinden anket yöntemi tercih edilmiştir. Araştırmacılar tarafından literatür taranarak hazırlanacak 5'li Likert ölçeğine göre hazırlanmış 20 soruluk bir anket kullanılacaktır. Anket, 2025–2026 eğitim öğretim yılında Süleyman Demirel Üniversitesi İktisadi ve İdari Bilimler Fakültesi Siyaset Bilimi ve Kamu Yönetimi bölümünde öğrenim gören lisans öğrencilerine uygulanmak üzere tasarlanacaktır. Toplanacak anket cevapları analiz edilerek öğrencilerin sisteme yönelik bilgi ve farkındalık düzeyleri belirlenecektir.

Anahtar Kelimeler: Cumhurbaşkanlığı Hükümet Sistemi, Üniversite Öğrencileri, SDÜ.

ABSTRACT

As a result of the constitutional amendment carried out in Turkey in 2017, the executive authority was transferred to the President, shifting from a dual executive system to a single executive system, and the President's powers were expanded. Consequently, the structure of the executive branch has fundamentally changed. This transformation has created new areas of study and discussion, particularly for students studying political science and public administration. This study aims to reveal how much knowledge Political Science and Public Administration students have about the Presidential Government System and their level of awareness regarding the system. The findings will enable the analysis of students' knowledge gaps.

The survey method, one of the quantitative research methods, was preferred in this study. A 20-question survey prepared according to a 5-point Likert scale, which will be prepared by the researchers by reviewing the literature, will be used. The survey will be designed to be administered to undergraduate students studying in the Department of Political Science and Public Administration at the Faculty of Economics and Administrative Sciences at Suleyman Demırel University during the 2025–2026 academic year. The collected survey responses will be analyzed to determine students' knowledge and awareness levels regarding the system.

Key Words: Presidential Government System, University Students, SDU.

1.GİRİŞ

Türkiye, 2017 anayasa değişikliğiyle parlamenter sistemden Cumhurbaşkanlığı Hükümet Sistemi' ne geçilmiştir. Bu geçişle devlet yapısında siyasal ve yönetsel paradigmatik bir dönüşüm yaşanmıştır ve yürütme organının yetki kapsamı, yasama ve yürütme ilişkisinin niteliği, siyasal karar alma süreçlerinin kurumsal çerçevesi ve bürokratik düzenin işleyişi literatürde büyük bir tartışma alanı yaratmış ve bu konuların incelenmesine zemin hazırlamıştır. Akademik çalışmalar, sistemin teorik ve pratik sonuçlarını bu gibi temel konuları merkeze alarak analiz etmektedir: yürütmenin güç yoğunlaşması, demokratik meşruiyet, kurumsal rasyonelleşme ve denge-denetleme mekanizmalarının işlevselliğiyle gibi konulardır.

Bununla beraber, literatürde Cumhurbaşkanlığı Hükümet Sistemi'nin kamuoyundaki algısı ve toplumun çeşitli kesimleri tarafından ne şekilde benimsendiği konusuna dair inceleme alanı oldukça dardır. Siyasal kültürün dönüşümünü ve demokratik katılımın niteliğini doğru bir şekilde analiz edebilmek için bireylerin de bilgi ve farkındalık düzeylerinin incelenmesi dönüşümün ve katılımın anlaşılmasında kritik bir rol oynar. Bu bağlamda siyasi gelişmeleri yakından takip eden ve eleştirel düşünme kapasitesi yüksek bir kitle olan üniversite öğrencileri, toplumsal algının ölçülmesi için ideal bir örneklem olarak öne çıkmaktadır.

Bu araştırma, üniversite öğrencilerinin Cumhurbaşkanlığı Hükümet Sistemi hakkındaki bilgi-algı düzeyleri ve değerlendirmelerini ortaya koymayı amaçlamaktadır. Bu kapsamda uygulanan nicel araştırma ile katılımcıların yeni hükümet sistemine yönelik farkındalık ve algılarını ölçmek için hazırlanmış 5'li Likert tipi ölçek kullanılarak bir anket çalışması yapılmaktadır. Ankette elde edilen veriler cinsiyet, yaş, sınıf düzeyi, gelir durumu, siyasal bilgi düzeyi gibi temel kişisel değişkenler açısından analiz edilerek, öğrencilerin hükümet sistemi hakkındaki algılarının kurumsal tartışmalarla nasıl örtüştüğünü ve hangi noktalarda ayrıştığını ortaya koyarak, üniversite öğrencilerinin siyasal sisteme ilişkin farkındalık düzeylerinin çok boyutlu bir çerçevede değerlendirilmesine olanak sağlamaktadır

2. LİTERATÜR TARAMASI

Cumhurbaşkanlığı Hükümet Sistemi üzerinde yapılan çalışmaların önemli bir kısmı sistemin yapısı, yetki dağılımı ve daha önceki parlamenter sistemle karşılaştırılması üzerinde yoğunlaşmışlardır.

Örneğin, Özkul (2023) yaptığı çalışmada Cumhurbaşkanlığı Hükümet Sistemi'nin parlamenter ve başkanlık sistemlerinden farklı olduğunu ve yürütmeye geniş yetkiler devrettiğini yasama ve yürütme ilişkilerini yeniden tanımladığını ortaya koymuştur.

Bayrak & Ölmez (2024), Türkiye'de sistem değişikliği bağlamında siyasal denetimin rolünü incelemiştir. Çalışmada, Cumhurbaşkanlığı Hükümet Sistemi sonrası dönemde denetim

mekanizmalarının zayıfladığı ve yasama-yürütme-yargı dengelerinin yeniden şekillendiği tespit edilmiştir. Yazarlar, demokratik meşruiyet ve güçler dengesi için denetimin güçlendirilmesi gerektiğini vurgulamaktadır.

Yücel (2024), Cumhurbaşkanlığı Hükümet Sistemini anayasal açıdan inceleyerek yürütme- yasama ilişkisi, kuvvetler ayrılığı ve denetim mekanizmalarının işleyişi konusu üzerinde durmuştur. Anayasa değişikliğiyle beraber oluşsan yapısal dönüşümü değerlendirirken, sistemin demokratik normlarla uyumunu ve potansiyel risklerini de ele almıştır. Bunun sonucunda yürütmenin yetki alanının genişlediğini ve kuvvetler ayrılığı mekanizmalarının etkinliğinin değiştiği sonucunu ortaya koymuştur.

Yıldız (2024), Cumhurbaşkanlığı Hükümet Sistemi üzerine hazırlanmış 82 tezi sistematik olarak derlemiştir. Çalışma akademik, literatürde hükümet sistemi tartışmalarının nasıl ele alındığını, hangi temalar üzerine yoğunlaştığını ve araştırma yöntemlerini ortaya koyar. Bulgular, sistem değişikliğinin kurumsal, anayasal ve toplumsal boyutlarıyla akademik olarak yoğun biçimde incelendiğini göstermektedir. Literatürdeki boşluklar, özellikle sosyal algı ve gençlik perspektifinin yeterince ele alınmadığı alanları işaret etmektedir.

Veznedaroğlu (2022), Türkiye'de hükümet sistemi tartışmalarının tarihsel evrimini incelemiş, 1982 Anayasası'ndan başlayarak parlamenter sistemin işleyişindeki sorunları ve 2017 Cumhurbaşkanlığı Hükümet Sistemi değişikliğinin kurumsal ve siyasal etkilerini analiz etmiştir. Çalışmanın sonucuna göre, Cumhurbaşkanlığı Hükümet Sistemi ile birlikte yürütmenin yetkilerinin genişlediği, parlamentonun denetim kapasitesinin azaldığı ve siyasal istikrarın kısa vadede güçlendiği; ancak uzun vadede demokratik denetim mekanizmalarında zayıflama riski bulunduğu tespit edilmiştir.

Kalkar ve Öcal (2020), referandum dönemi gazete içeriklerini analiz ederek Cumhurbaşkanlığı Hükümet Sistemi'nin medyada nasıl temsil edildiğini ortaya koymuştur. Bulgular, medyanın sistem değişikliğini kamuoyuna aktarmada kritik bir rol oynadığını ve farklı siyasi eğilimlere sahip gazetelerin farklı söylemler ürettiğini göstermektedir.

Yılmaz & Yıldız (2022), Cumhurbaşkanlığı Hükümet Sistemi'nin parlamenter sistemle karşılaştırmalı olarak incelendiği çalışmasında, yürütmenin yetkilerinin arttığını ve parlamentonun denetim kapasitesinin azaldığını tespit etmiştir. Çalışma, sistem değişikliğinin kısa vadede istikrar sağlasa da uzun vadede demokratik denetim ve güçler ayrılığı açısından riskler taşıdığını vurgulamaktadır.

Kılınç (2016) çalışmasında ise hükümet sistemlerinin teorik çerçevesi, yasama-yürütme ilişkileri ve Türkiye özelinde geçmiş parlamenter deneyimler ele alınmıştır. Çalışma, her sistemin kendi bağlamında avantaj ve dezavantajları olduğunu; Cumhurbaşkanlığı Hükümet Sistemi dâhil olmak üzere herhangi bir sistemin demokrasiyle uyumlu olabileceğini ortaya koymuştur.

Akçakaya ve Özdemir (2018), Cumhurbaşkanlığı Hükümet Sistemi'nin siyasal istikrar üzerindeki etkilerini ele almış, başkanlık ve parlamenter sistemleri karşılaştırmalı olarak incelemişlerdir. Çalışmanın sonucuna göre, Cumhurbaşkanlığı Hükümet Sistemi ile yürütmenin yetkileri genişlemiş ve karar alma süreçleri hızlanmış; bu durum kısa vadede siyasal istikrarı güçlendirirken, uzun vadede kuvvetler ayrılığı ve demokratik denetim açısından riskler doğurmuştur.

Turan (2018), Türkiye'de 2017 referandumu sonrası Cumhurbaşkanlığı Hükümet Sistemi'ne geçişi analiz etmiştir. Çalışmada, yürütme erkinin merkezî ve güçlü hale geldiği, Cumhurbaşkanının yetkilerinin arttığı ve karar alma süreçlerinin hızlandığı tespit edilmiştir. Ancak yasama ve denetim mekanizmalarının etkinliği azalmış, güçler ayrılığı ve demokratik denetim açısından riskler oluşmuştur.

Üniversite öğrencilerinin Cumhurbaşkanlığı Hükümet Sistemi hakkındaki bilgi ve farkındalık düzeyi üzerine yapılan çalışmalarda genç seçmenlerin sistem hakkındaki algıları ve eleştirel düşünce düzeyleri ortaya koyulmuştur.

Örneğin, Kutlu, Örselli ve Kahraman (2018) Konya Üniversitesi öğrencilerini inceledikleri çalışmada, öğrencilerin Cumhurbaşkanlığı Hükümet Sistemi hakkında sınırlı bilgiye sahip olduğunu ve sistemin işleyişine dair farkındalıklarının düşük olduğunu bulmuşlardır. Çalışma, öğrencilerin çoğunlukla sistemin avantaj ve dezavantajlarını doğru değerlendiremediklerini göstermektedir.

Kaplan (2023), Tokat Gaziosmanpaşa Üniversitesi öğrencilerinin Cumhurbaşkanlığı Hükümet Sistemi algısını araştırmış ve öğrencilerin sistemin işleyişi, yürütme yetkileri ve parlamentonun rolü konusunda bilinçli olduklarını, ancak bazı öğrencilerin sistemin demokratik denetim mekanizmalarıyla ilgili kaygılar taşıdığını ortaya konulmuştur.

Özkılıççı ve Yiğit Uyar (2025) ise 2023 Cumhurbaşkanlığı seçiminde üniversite öğrencilerinin oy verme eğilimini incelemiş; öğrencilerin ideolojik tercih ve lider algısının oy davranışlarını etkilediğini ve öğrencilerin çoğunun Cumhurbaşkanlığı Hükümet Sistemi hakkında genel bilgiye sahip olduğunu ancak ayrıntılarda bilgi eksiklikleri bulunduğunu sonucuna ulaşmışlardır.

Mumınjıang (2018), Atatürk Üniversitesi'nde okuyan yabancı öğrencilerin Türkiye'nin siyasi yapısı algısını araştırmış ve öğrencilerin Cumhurbaşkanlığı Hükümet Sistemini genellikle yürütmenin güçlü olduğu bir sistem olarak değerlendirdiklerini tespit etmiştir. Bu çalışma, Türkiye'deki sistem değişikliğinin uluslararası öğrenciler tarafından nasıl algılandığına dair farklı bir perspektif sunmaktadır.

3. YÖNTEM

3.1. Araştırmanın Amacı

Bu araştırmanın temel amacı, üniversite öğrencilerinin Cumhurbaşkanlığı Hükümet Sistemi'ne ilişkin bilgi düzeylerini, algılarını ve değerlendirmelerini ortaya koymaktır. Bu çalışma, öğrencilerin sistemin temel özellikleri ve kamu yönetimine etkilerine yönelik düşüncelerini analiz ederek, genç nüfusun mevcut hükümet sistemine dair farkındalık düzeylerini belirlemeyi hedeflemektedir. Bu yönüyle araştırma, Cumhurbaşkanlığı Hükümet Sistemi'ne ilişkin literatüre öğrenci perspektifinden katkı sunmayı amaçlamaktadır.

3.2. Araştırmanın Yöntemi

Araştırmada nicel araştırma yöntemi kullanılmıştır. Veri toplama aracı olarak 5'li Likert tipi ölçeğe göre hazırlanmış anket formu tercih edilmiştir. Anket formu, katılımcıların Cumhurbaşkanlığı Hükümet Sistemi'ne ilişkin bilgi düzeylerini ve algılarını ölçmeye yönelik ifadelerden oluşmaktadır. Elde edilen veriler frekans ve yüzde dağılımları üzerinden analiz edilerek değerlendirilmiştir.

3.3. Araştırmanın Evreni ve Örneklemi

Araştırmanın evrenini Süleyman Demirel Üniversitesi İktisadi ve İdari Bilimler Fakültesi Siyaset Bilimi ve Kamu Yönetimi bölümünde öğrenim gören lisans öğrencilerine uygulanmak üzere tasarlanmıştır. Bölümde 270 aktif öğrenci bulunmaktır. %95 güven aralığın da 160 kişiyle bu anket yapılmıştır ve anketler gönüllülük esasına göre gerçekleştirilmiştir. Örneklem grubunun büyük bir kısmı 17-24 yaş aralığında olup, lisans eğitiminin farklı sınıf düzeylerinde öğrenim gören öğrencilerden oluşmaktadır. Bu durum, araştırmanın genç nüfusun Cumhurbaşkanlığı Hükümet Sistemi'ne ilişkin algılarını yansıtması açısından önem taşımaktadır.

4. BULGULAR

4.1. Demografik Özelliklere İlişkin Bulgular

CİNSİYET	FREKANS(n)	YÜZDE(%)
Kadın	101	%63,1
Erkek	59	%36,9
Toplam	**160**	**%100**

Araştırmaya katılanların %63,1'i kadın, %36,9'u erkektir. Bu bulgu, örneklem içerisinde kadın katılımcıların erkeklere kıyasla daha yüksek oranda temsil edildiği sonucu elde edilmiştir.

YAŞ ARALIĞI	FREKANS (n)	YÜZDE(%)
17-24	156	%97,5
25-34	1	%0,6
35-44	2	%1,2
55 ve üzeri	1	%0,6
Toplam	**160**	**%100**

Katılımcıların büyük çoğunluğunu (%97,5) 17-24 yaş aralığındaki öğrenciler oluşturmaktadır. Bu durum araştırmanın ağırlıklı olarak üniversite eğitimine devam eden genç örneklem üzerinde gerçekleştirildiği sonucunun elde edildiğini göstermektedir.

AYLIK GELİR	FREKANS(n)	YÜZDE(%)
0-3.000	36	%22,5
3.001-5.000	32	%20
5.001-10.000	42	%26,3
10.001-15.000	20	%12,5
15.001-20.000	14	%8,8
20.001 ve üstü	16	%10
Toplam	**160**	**%100**

Katılımcıların gelir düzeyi incelendiğinde, örneklemin büyük bir bölümünün orta gelir grubunda yer aldığı görülmektedir.

BÖLGE	FREKANS(n)	YÜZDE(%)
Akdeniz	70	%43,8
Ege	35	%21,9
İç Anadolu	25	%15,6
Marmara	14	%8,8
Doğu Anadolu	8	%5,0
Karadeniz	6	%3,8

Güneydoğu Anadolu	6	%3,8
Yurt Dışı (Azerbaycan, KKTC, Irak)	4	%2,5
Toplam	**160**	**%100**

Katılımcıların memleketleri coğrafi bölgeler esas alınarak sınıflandırılmıştır. Bu doğrultuda örneklemin büyük bir bölümünün Akdeniz ve Ege bölgesinden oluştuğu görülmektedir.

SINIF DÜZEYİ	FREKANS(n)	YÜZDE(%)
1. Sınıf	25	%15,6
2. Sınıf	40	%25,0
3. Sınıf	62	%38,8
4. Sınıf	33	%20,6
Toplam	**160**	**%100**

Katılımcıların sınıf düzeylerine göre dağılımı incelendiğinde, örneklemin ağırlıklı olarak üçüncü sınıf öğrencilerinden oluştuğu sonucu elde edilmektedir. Bu durum, öğrencilerin lisans eğitiminin ileri aşamalarında hükümet sistemi hakkında daha fazla bilgi ve farkındalık düzeyine sahip olabileceklerini göstermektedir.

4.2. Likert Ölçekli Sorulara İlişkin Bulgular

1- Cumhurbaşkanlığı Hükümet Sisteminin temel özellikleri hakkında bilgi sahibiyim.

YANIT SEÇENEĞİ	FREKANS(n)	YÜZDE(%)
Kesinlikle Katılıyorum	32	%20,0
Katılıyorum	85	%53,1
Kararsızım	33	%20,6
Katılmıyorum	9	%5,6
Kesinlikle Katılmıyorum	1	%0,6
Toplam	**160**	**%100**

Katılımcıların Cumhurbaşkanlığı Hükümet Sistemi hakkındaki temel bilgi düzeylerine bakıldığında, katılıyorum ve katılmıyorum seçeneklerinin tercih edenlerinin oranının toplam %73,1 olduğu görülmektedir. Bu sonuca göre öğrencilerin büyük bir kısmı sistemin temel nitelikleri hakkında bilgi sahibi olduğunu düşündüğünü göstermektedir. Belirsiz katılımcıların oranın %20,6 olması ise bazı öğrencilerin bilgi düzeyinin yeterince net olmadığı sonucunu göstermektedir.

2- Cumhurbaşkanlığı Hükümet Sistemi'nin yasama ve yürütme ilişkilerini değiştirdiğini düşünüyorum.

YANIT SEÇENEĞİ	FREKANS(n)	YÜZDE(%)
Kesinlikle Katılıyorum	44	%27,5

Katılıyorum	69	%43,1
Kararsızım	37	%23,1
Katılmıyorum	10	%6,3
Kesinlikle Katılmıyorum	0	%0,0
Toplam	**160**	**%100**

Katılımcıların Cumhurbaşkanlığı Hükümet Sistemi'nin yasama ve yürütme ilişkilerini değiştirdiği yönünde görüşe sahip oldukları görülmektedir. Katılıyorum ve kesinlikle katılıyorum seçeneklerini tercih edenlerin toplam oranı %70,6'dır. Kararsız olduğunu belirten katılımcıların oranı ise %23,1 olup, olumsuz görüş bildirenlerin oranı oldukça azdır.

3-Yeni sistemin yürütme organını güçlendirdiğini düşünüyorum.

YANIT SEÇENEĞİ	**FREKANS(n)**	**YÜZDE(%)**
Kesinlikle Katılıyorum	32	%20,0
Katılıyorum	38	%23,8
Kararsızım	49	%30,6
Katılmıyorum	25	%15,6
Kesinlikle Katılmıyorum	16	%10,0
Toplam	**160**	**%100**

Katılımcıların bu soruya ilişkin verdikleri yanıtlara bakıldığında, kararsız olduklarını belirten oranın %30,6 ile diğer seçeneklere kıyasla daha yüksek olduğu görülmektedir. Kesinlikle katılıyorum ve katılıyorum görüşlerinin toplam oranı %43,8 iken, olumsuz görüş bildirenlerin oranı %25,6'dır. Bu bulgulara göre öğrenciler arasında yürütme organının güçlenip güçlenmediğine dair algıların net olarak ayrışmadığı sonucunu ortaya çıkartmaktadır.

4- Cumhurbaşkanlığı Hükümet Sisteminin karar alma süreçlerini hızlandırdığına inanıyorum.

YANIT SEÇENEĞİ	**FREKANS(n)**	**YÜZDE(%)**
Kesinlikle Katılıyorum	16	%10,1
Katılıyorum	62	%38,4
Kararsızım	39	%24,5
Katılmıyorum	31	%19,5
Kesinlikle Katılmıyorum	12	%7,5
Toplam	**160**	**%100**

Katılımcıların bu soruya ilişkin verdikleri yanıtlar incelendiğinde kesinlikle katılıyorum ve katılıyorum görüşlerinin toplam oranının %48,5 olduğu görülmektedir. Buna karşılık kararsız olduğunu belirtenlerin oranı %24,5, olumsuz görüşlerin oranı ise %27,0'dır. Sonuçlara göre öğrencilerin karar alma

süreçlerinin hızlanmasına ilişkin algılarının belirli ölçüde olumlu olduğu ancak önemli bir kısmı için ise tam olarak netleşemediği görülmektedir.

5- Cumhurbaşkanının yetkilerinin arttığını düşünüyorum.

YANIT SEÇENEĞİ	FREKANS(n)	YÜZDE(%)
Kesinlikle Katılıyorum	92	%57,2
Katılıyorum	55	%34,6
Kararsızım	8	%5,0
Katılmıyorum	4	%2,5
Kesinlikle Katılmıyorum	1	%0,6
Toplam	**160**	**%100**

Katılımcıların büyük çoğunluğunun Cumhurbaşkanının yetkilerinin arttığı yönünde güçlü bir algıya sahip olduğu görülmektedir. Kesinlikle katılıyorum ve katılıyorum seçeneklerini tercih edenlerin toplam oranı %91,8'dir. Buna karşılık kararsız ve olumsuz görüşlerin oranı oldukça az olduğundan öğrencilerin Cumhurbaşkanının yetkilerinin arttığına yönelik genel bir fikir birliğinde oldukları sonucuna ulaşılmaktadır.

6- Yeni sistemin bürokratik süreçleri azalttığını düşünüyorum.

YANIT SEÇENEĞİ	FREKANS(n)	YÜZDE(%)
Kesinlikle Katılıyorum	31	%19,5
Katılıyorum	50	%31,4
Kararsızım	54	%33,3
Katılmıyorum	18	%11,3
Kesinlikle Katılmıyorum	7	%4,4
Toplam	**160**	**%100**

Katılımcıların bu soruya verdikleri yanıtlar incelendiğinde, kararsız olduklarını belirtenlerin %33,3 oranla en yüksek düzeyde olduğu görülmektedir. Olumlu görüşlerin toplam oranı %50,9 iken, olumsuz görüşlerin oranı %15,7'dir. Bu sonuç doğrultusunda öğrencilerin bürokratik süreçlerin azalmasına ilişkin algılarının belirgin bir şekilde netleşmediği görülmektedir.

7- Sistemin Türkiye'nin yönetim kapasitesine olumlu katkı sağladığını düşünüyorum.

YANIT SEÇENEĞİ	FREKANS(n)	YÜZDE(%)
Kesinlikle Katılıyorum	14	%8,8
Katılıyorum	27	%16,9
Kararsızım	47	%29,4
Katılmıyorum	45	%28,1

Kesinlikle Katılmıyorum	27	%16,9
Toplam	**160**	**%100**

Katılımcıların bu soruya verdikleri cevap incelendiğinde, kararsız (%29,4) ve olumsuz (%45,0) görüş bildirenlerin oranının oldukça yüksek olduğu görülmektedir. Olumlu görüş bildirenlerin toplam oranı ise %25,7'de kalmıştır. Bu bulgular doğrultusunda öğrencilerin önemli bir bölümünün yeni sistemin yönetim üzerindeki etkilerinin yeterince olumlu değerlendirilmediği sonucu elde edilmektedir.

8- Sistem değişikliğinin kamu yönetimi yapısını olumlu etkilediğini düşünüyorum.

YANIT SEÇENEĞİ	**FREKANS(n)**	**YÜZDE(%)**
Kesinlikle Katılıyorum	10	%6,3
Katılıyorum	28	%17,5
Kararsızım	55	%34,4
Katılmıyorum	41	%25,6
Kesinlikle Katılmıyorum	26	%16,2
Toplam	**160**	**%100**

Katılımcıların bu soruya verdikleri cevap incelendiğinde, karasız olduklarını belirtenlerin oranının %34,4 ile en yüksek düzeyde olduğu görülmektedir. Olumsuz görüş bildirenlerin toplam oranı ise %41,8 iken, olumlu görüş bildirenlerin oranı %23,8'de kalmıştır. Bu bulgular doğrultusunda öğrencilerin önemli kısmının sistem değişikliğinin kamu yönetimi üzerindeki etkilerini yeterince olumlu değerlendirmedikleri ve bu konuda fikirlerinin belirgin bir şekilde ayrıştığı sonucu elde edilmiştir.

9- Yeni sistemin Türkiye'de yönetimde istikrarı arttırdığını düşünüyorum.

YANIT SEÇENEĞİ	**FREKANS(n)**	**YÜZDE(%)**
Kesinlikle Katılıyorum	12	%7,5
Katılıyorum	36	%22,5
Kararsızım	40	%25,0
Katılmıyorum	48	%30,0
Kesinlikle Katılmıyorum	24	%15,0
Toplam	**160**	**%100**

Katılımcıların bu soruya verdikleri cevaplar incelendiğinde, olumsuz görüş bildirenlerin oranının %45,0 olumlu görüş bildirenlerin ise %30,0 olduğu görülmektedir. Bu doğrultuda olumsuz görüş bildirenlerin oranı olumlu görüş bildirenlere kıyasla daha yüksek olduğu görülmektedir. Kararsız olduğunu belirten katılımcıların oranı ise %25,0'tir. Bu bulgu, öğrencilerin önemli bir kısmının yeni sistemin yönetimde istikrar sağladığı görüşüne katılmadığı ve bu konuda belirgin bir fikir ayrışmasının bulunduğu sonucu elde edilmektedir.

10- Yeni sistemde meclisin gücünün azaldığını düşünüyorum.

YANIT SEÇENEĞİ	FREKANS(n)	YÜZDE(%)
Kesinlikle Katılıyorum	53	%33,1
Katılıyorum	60	%37,5
Kararsızım	34	%21,3
Katılmıyorum	13	%8,1
Kesinlikle Katılmıyorum	0	%0,0
Toplam	**160**	**%100**

Katılımcıların bu soruya verdikleri cevaplar incelendiğinde, olumlu görüş bildirenlerin toplam oranının %70,6 gibi yüksek bir düzeyde olduğu görülmektedir. Buna karşılık kararsız olduğunu belirtenlerin onarı %21,3 iken, olumsuz görüş oranı oldukça sınırlı kalmıştır. Bu bulgular sonucunda öğrencilerin büyük bir bölümünün yeni sistemde yasama organının gücünün azaldığı yönünde güçlü bir algıya sahip olduğu sonucu elde edilmektedir.

11. Cumhurbaşkanlığı Hükümet Sisteminin uygulanma biçimi hakkında yeterli bilgiye sahibim.

YANIT SEÇENEĞİ	FREKANS(n)	YÜZDE(%)
Kesinlikle Katılıyorum	24	%15,0
Katılıyorum	77	%48,1
Kararsızım	48	%30,0
Katılmıyorum	9	%5,6
Kesinlikle Katılmıyorum	2	%1,3
Toplam	**160**	**%100**

Katılımcıların Cumhurbaşkanlığı Hükümet Sistemi'nin uygulanma biçimi hakkındaki cevapları incelendiğinde, olumlu görüş bildirenlerin toplam oranının %63,1 olduğu görülmektedir. Buna karşılık kararsız olduğunu belirtenlerin oranı %30,0'dur. Bu sonuç doğrultusunda öğrencilerin önemli bir kısmının sistemin uygulanışına ilişkin bilgi düzeyinden emin olduğu bir kısmının ise kararsız kaldığı görülmektedir. Olumsuz görüş bildirilerinin oranının ise oldukça sınırlı ve az olduğu sonucu elde edilmiştir.

5. BULGULARIN LİTERATÜR ÇERÇEVESİNDE DEĞERLENDİRİLMESİ

Bu araştırmada elde edilen bulgular, Cumhurbaşkanlığı Hükümet Sistemi üzerine yapılan önceki akademik çalışmalarla karşılaştırmalı olarak değerlendirildiğinde, literatürde ortaya konulan pek çok tespit ile benzerlikler taşımaktadır ancak bazı noktalarda farklılaşan sonuçlar da oraya çıkmıştır. Özellikle yürütmenin güçlenmesi, yasama-yürütme ilişkilerinin değişimi ve denetim mekanizmasının işleyişi konularında elde edilen bulgular, literatürdeki genel eğilimlerle büyük ölçüde örtüşmektedir.

Araştırma bulgularında, öğrencilerin büyük bir kısmının Cumhurbaşkanının yetkilerinin arttığı düşüncesine sahip oldukları tespit edilmiştir. Bu sonuç, Cumhurbaşkanlığı Hükümet Sistemi'nin yürütme organını güçlendirdiğini ortaya koyan çalışmalarla benzerlik göstermektedir. Nitekim Özkul (2023), CHS'nin parlamenter ve başkanlık sistemlerinden farklı bir yapıda olduğunu ve yürütmeye geniş yetkiler verildiğinin vurgulamıştır. Benzer biçimde Turan (2018) ve yılmaz ve yıldız (2022), sistem değişikliğiyle birlikte Cumhurbaşkanının yetki alanının genişlediği ve yürütmenin merkezi bir konuma geldiğinin belirtmişlerdir. Bu bağlamda, araştırma bulgularının literatürdeki anayasal ve kurumsal analizlerle uyum içerisinde olduğu sonucu elde edilmektedir.

Öğrencilerin büyük bir kısmı yeni sistemde Meclisin gücünün azaldığı düşüncesinde oldukları tespit edilmiş olup, literatürde sıklıkla tartışılan yasama organının denetim kapasitesine ilişkin değerlendirmelerle örtüştüğü görülmektedir. Bayrak ve Ölmez (2024), CHS sonrası dönemde siyasal denetim mekanizmalarının zayıfladığını ve yasama-yürütme dengesinin yeniden şekillendiği sonucunu ortaya koymuşlardır. Benzer şekilde Yücel (2024) ve Veznedaroğlu (2022), anayasal değişiklikle birlikte kuvvetler ayrılığı mekanizmalarının işleyişinde önemli dönüşümler yaşandığını ve yasamanın denetim gücünün kısmen de olsa azaldığı sonucuna ulaşmışlardır. Bu çalışmalar doğrultusunda öğrencilerde Meclisin gücünün azaldığına yönelik güçlü algının, akademik literatürdeki eleştirel yaklaşımlarla uyumlu olduğu sonucuna ulaşılmaktadır.

Araştırmada karar alma süreçlerinin hızlandığı ve bürokratik süreçlerin azaldığı yönündeki sorulara veriler cevaplar incelendiğinde, olumlu görüşlerin yanı sıra kararsızlığın da belirgin olduğu görülmektedir. Literatürde CHS'nin karar alma süreçlerinin hızlandırdığını ve yürütmenin etkinliğinin arttırıldığı yönünde değerlendirmeler yer almasıyla birlikte, bu durumun uzun vadeli sonuçlarına ilişkin temkinli yaklaşımlarda vardır. Akçakaya ve Özdemir (2018) ile Turan (2018), sistem değişikliğinin kısa vadede siyasal istikrar ve hızlı karar alma açısından riskler taşıdığı sonucuna ulaşmışlardır. Öğrenciler arasında görülen kararsızlık oranı ise literatürdeki bu temkinli yaklaşımın algılara yansıması olarak yorumlanabilir.

Araştırma bulgularında sistemin Türkiye'nin yönetim kapasitesine ve kamu yönetimi yapısına olumlu katkı sağladığına ilişkin algıların zayıf olduğu, kararsız ve olumsuz görüşlerin ağırlık kazandığı sonucuna ulaşılmıştır. Bu sonuç, literatürde CHS'nin kamu yönetimi üzerindeki etkilerine ilişkin tartışmalarla örtüşmektedir. Yılmaz ve Yıldız (2022) ile Veznedaroğlu (2022), sistem değişikliğinin yürütmeyi güçlendirirken demokratik denetim ve kamu yönetiminin uzun vadeli işleyişi açısından belirsizlikler ve riskler taşıdığını belirtmektedir. Bu duruma göre öğrencilerin yönetim kapasitesi ve kamu yönetimim yapısına ilişkin temkinli tutumları, literatürdeki eleştirel değerlendirmelerle benzer bir görünüme sahiptir.

Üniversite öğrencilerinin bilgi ve farkındalık düzeyine ilişkin bulgular da literatürle karşılaştırıldığında anlamlı sonuçlar ortaya çıkmaktadır. Kutlu, Örselli ve Kahraman (2018), Konya örneğinde öğrencilerin CHS hakkında sınırlı bilgiye sahip olduklarını tespit ederken: Kaplan (2023) ve Özkılıççı ve Yiğit Uyar (2025) öğrencilerin sistemin temel özellikleri ve uygulanma biçimi hakkında kendilerini oldukça bilgili görmelerine rağmen, sistemin sonuçlarına ilişkin kararsızlıkların yüksek olması, literatürde belirtilen bilgi varlığı- değerlendirme belirsizliği ikilemiyle örtüşmektedir.

Son olarak, bu çalışmanın bulguları, Yıldız'ın (2024) ortaya koyduğu literatür boşluğu tespitiyle doğrudan ilişkilidir. Yıldız (2024), CHS literatüründe gençlik perspektifinin ve algı çalışmalarının sınırlı kaldığını belirtmiştir. Bu bağlamda, üniversite öğrencilerinin algılarını nicel verilerle ortaya koyan bu araştırma, literatürde eksik olduğu vurgulanan bir alanı doldurmakta ve öğrenci perspektifini görünür kılmaktadır. Ayrıca Mumınjıang'ın (2018) yabancı öğrenciler üzerine yaptığı çalışmayla birlikte değerlendirildiğinde, CHS'nin farklı toplumsal gruplar tarafından algılanış biçimlerinin karşılaştırılmalı olarak ele alınmasına imkân sunduğu söylenebilir.

6.SONUÇ

Bu çalışmada, üniversite öğrencilerinin Cumhurbaşkanlığı Hükümet Sistemi'ne ilişkin bilge ve algı düzeyleri incelenmiştir. Araştırmada uygulanan anket çalışmasıyla beraber elde edilen bulgular, öğrencilerin hükümet sisteminin temel özelliklerini ve kurumsal yapısı konusunda genel bir bilgi düzeyine sahip olduklarını göstermektedir. Özellikle Cumhurbaşkanının yetki alanının genişlemesi ve yasama-yürütme ilişkisinin değiştiği yönündeki değerlendirmeler, araştırma katılımcıları arasında yüksek oranda kabul görmüştür.

Bununla karşın, yeni yönetim sisteminin bürokratik süreçleri azaltması, yönetsel istikrarın sağlanması ve Türkiye'nin yönetim kapasitesine olumlu katkı sağlaması gibi hususlarda öğrencilerin önemli bir kısmının kararsızlık veya olumsuzluk içinde olduğu tespit edilmiştir. Bu bulgu, hükümet sisteminin bazı taraflarının üniversite öğrencileri açısından net bir biçimde değerlendirilemediğini bir netlik kazanamadığını ve sistemin potansiyel etkilerine dair algıların farklılaştığını ortaya koymaktadır.

Araştırmada elde edilen sonuçlar, üniversite öğrencilerinin Cumhurbaşkanlığı Hükümet Sistemi'ne dair bilgi ve algılarının homojen bir yapıda olmadığını, bazı konularda güçlü bir fikir birliği oluşurken bazı alanlarda ise belirsizliklerin ve farklılaşmaların sürdüğü sonucu elde edilmiştir. Bu bağlamda, genç nüfusun siyasal sistemlere ilişkin bilgi ve farkındalık düzeyinin artırılmasına yönelik akademik ve kamusal enformasyon (bilgilendirme) faaliyetlerinin önem taşıdığı söylenebilir.

Çalışmanın, Cumhurbaşkanlığı Hükümet Sistemi'ne ilişkin literatüre öğrenci perspektifinden kayda değer bir katkı sağladığı değerlendirilmektedir. Elde edilen bulguların, üniversite öğrencilerinin mevcut hükümet sistemine yönelik bilgi ve algı düzeylerini ortaya çıkartmasıyla birlikte ilgili alandaki mevcut çalışmalara bir yenisinin daha eklendiği ilerde yapılacak nicel ve nitel araştırmalar için bir karşılaştırma modeli sunması beklenmektedir.

7.KAYNAKÇA

Akçakaya, M., & Özdemir, A. (2018). Cumhurbaşkanlığı hükümet sistemi ve siyasal istikrar. *Üçüncü Sektör Sosyal Ekonomi Dergisi, 53*(3), 922–944.

Bayrak, B., & Ölmez, M. (2024). Türkiye'de parlamenter hükümet sistemi ile cumhurbaşkanlığı hükümet sistemi açısından siyasal denetimin değişen rolü. *Dumlupınar Üniversitesi Sosyal Bilimler Dergisi*(81), 41–59.

Kalkar, Ö. Ş., & Öcal, A. (2020). Bir içerik analizi: Cumhurbaşkanlığı hükümet sistemi. *Balıkesir Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, 1*(2), 1–30.

Kaplan, Ç. (2023). Tokat Gaziosmanpaşa Üniversitesi öğrencilerinin cumhurbaşkanlığı hükûmet sistemi algıları üzerine bir araştırma. *Enderun, 7*(1), 65–95.

Kılınç, M. (2016). Türkiye'de bitmeyen tartışma: Hükûmet sistemi üzerine değerlendirmeler. *Gazi Üniversitesi Hukuk Fakültesi Dergisi, 20*(1), 1–20.

Kutlu, Ö., Örselli, E., & Kahraman, S. (2018). Üniversite öğrencilerinin cumhurbaşkanlığı hükûmet sistemi algısı: Konya örneği. *Gençlik Araştırmaları Dergisi, 6*(14), 55–82.

Mumınjıang, P. (2018). Atatürk Üniversitesi'nde okuyan yabancı uyruklu öğrencilerin Türkiye'nin siyasi yapısı hakkındaki görüşleri / Vıews of foreıgn students ın Ataturk Unıversıty about the polıtıcal structure of present day Turkey. *Atatürk Üniversitesi Sosyal Bilimler Dergisi*(55), 169–187.

Özkılıççı, G., & Yiğit Uyar, M. H. (2025). 2023 Türkiye Cumhurbaşkanlığı seçiminde üniversite öğrencilerinin oy verme eğilimi: Nitel bir inceleme. *Marmara Üniversitesi Siyasal Bilimler Dergisi, 13*(1), 23–50.

Özkul, F. (2023). Teorik çerçevede cumhurbaşkanlığı hükümet sistemi. *Kırklareli Üniversitesi Hukuk Fakültesi Dergisi, 1*(1), 47–104.

Veznedaroğlu, H. (2022). Türkiye'de hükûmet sistemi arayışları. *Acikbilim / MEF Üniversitesi*.

Yıldız, M. (2024). Cumhurbaşkanlığı hükümet sistemi alanında hazırlanan tezlerin sistematik derlemesi: 2018 – 2023 yılları incelemesi. *Uluslararası Yönetim Akademisi Dergisi, 7*(1), 379–389.

Yılmaz, V., & Yıldız, M. Ş. (2022). Cumhurbaşkanlığı hükümet sistemi üzerine tartışmalar ve yeni sistemin etkileri. *Bingöl Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, 6*(2), 507–532.

Yücel, B. (2024). 'Cumhurbaşkanlığı yönetim sisteminin' anayasal kurgusu. *Anayasa Hukuku Dergisi, 13*(26), 285–320.

Turan, A. M. (2018). Türkiye'nin yeni yönetim düzeni: Cumhurbaşkanlığı hükümet sistemi. Social Sciences Research Journal, 7(3), 42–91.

TÜRKİYE'NİN DOĞRUDAN ULUSLARARASI YATIRIM ÇEKME STRATEJİSİNDE YENİ BİR KURUM OLARAK YATIRIM VE FİNANS OFİSİ

THE INVESTMENT AND FINANCE OFFICE AS A NEW INSTITUTION IN TURKEY'S DIRECT FOREIGN INVESTMENT ATTRACTION STRATEGY

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ÖZET

Küresel dönüşümün hızlandığı günümüzde ülkeler yatırım ofisleri ya da ajansları vasıtasıyla, küresel rekabette görünürlük sağlamak, yatırımcılarla etkileşimi arttırmak ve ülkelerin ekonomik potansiyelini etkili bir biçimde aktarmayı amaçlamaktadırlar. Türkiye'nin yönetim yapısında gerçekleşen değişiklikle, 2018 yılında 1 sayılı Cumhurbaşkanlığı Kararnamesiyle Cumhurbaşkanlığı Yatırım Ofisi ihdas edilmiştir. Bu ofis, selefi olan 2006 kuruluşlu Türkiye Yatırım Destek ve Tanıtım Ajansı'nın vazifelerini üstlenmek üzere kurulmuştur. Ancak 2025 yılında yapılan değişiklikle Finans Ofisi ile birleşerek Yatırım ve Finans Ofisi ismini almıştır.

Türkiye'nin yatırım potansiyelini uluslararası arenada tanıtma ve yatırımcılara projelerinin her aşamasında rehberlik etmek Yatırım ve Finans Ofisinin en temel görevidir. Faaliyetlerini doğrudan Cumhurbaşkanı'na karşı sorumlu bir yapıda yürüten Ofis, ülkenin iktisadi kalkınmasını hızlandıracak nitelikteki yatırımları teşvik etmekle mükelleftir. Bu stratejik hedef doğrultusunda, teknoloji yoğunluğu ve katma değeri yüksek olan, aynı zamanda istihdam artışına katkı sağlayan yatırımları destekleyerek bu projelere ilişkin tüm idari ve operasyonel süreçleri yatırımcı namına takip etmek suretiyle projelerin hayata geçişini hızlandırmaktadır.

Bu çalışma, Türkiye Cumhuriyeti Yatırım ve Finans Ofisi'nin yapısı,, işleyişi ve faaliyetleri hakkında bilgi vermeyi amaçlamaktadır. Çalışmada nitel araştırma yöntemlerinden doküman analizi kullanılacaktır. Yatırım ve Finans Ofisinin web sitesi içerikleri, sosyal medya paylaşımları, yayınladığı raporları ve Uluslararası Doğrudan Yatırımlar Strateji Belgesi ile eylem planı incelenecektir.

Anahtar Kelimeler: Yatırım ve Finans Ofisi , Cumhurbaşkanlığı Hükümet Sistemi , Türkiye.

ABSTRACT

In today's world, where global transformation is accelerating, countries aim to increase their visibility in global competition, enhance interaction with investors, and effectively convey their economic

potential through investment offices or agencies. With the changes in Turkey's administrative structure, the Presidential Investment Office was established in 2018 by Presidential Decree No. 1.

Investment Support and Promotion Agency, founded in 2006. However, following changes made in 2025, it merged with the Finance Office and was renamed the Investment and Office.

Promoting Turkey's investment potential on the international stage and guiding investors through every stage of their projects is the primary mission of the Investment and Finance Office. Operating under a structure that reports directly to the President, the Office is responsible for encouraging investments that will accelerate the country's economic development. In line with this strategic objective, it supports investments that are technology-intensive, have high added value, and contribute to employment growth. It accelerates the implementation of these projects by monitoring all administrative and operational processes on behalf of investors.

This study aims to provide information about the structure, operation, and activities of the Investment and Finance Office of the Republic of Turkey. Document analysis, one of the qualitative research methods, will be used in the study. The contents of the Investment and Finance Office's website, social media posts, published reports, and the International Direct Investment Strategy Document and action plan will be examined.

Key Words: Investment and Finance Office, Presidential Government System, Turkey.

1.Giriş

Türkiye’de uzun süre devam eden parlamenter yönetim anlayışı , 2017 yılında yapılan anayasa değişikliği referandumu ile önemli bir değişim sürecine girmiştir. 16 Nisan 2017’de halk oyuna sunulan anayasa değişiklikleri, yürütme organının işleyişini yeniden yapılandırarak parlementer sistemden Cumhurbaşkanlığı Hükümet Sistemi’ne geçilmesini kararlaştırmıştır. Söz konusu değişiklikler, 24 Haziran 2018’de gerçekleştirilen seçimlerin ardındanCumhurbaşkanının göreve başlaması ile birlikte fiilen uygulanmaya başlanmıştır. (Turan ,2018:43-44).

Yeni hükümet sistemiyle birlikte yürütme gücü tamamen Cumhurbaşkanında birleşmiş; yürütme organı tek merkezli bir yapıya kavuşmuştur. Bu değişim, Türkiye’nin idari teşkilatı bakımından Cumhuriyet döneminde gerçekleştirilen en geniş kapsamlı kurumsal dönüşümlerden biri olarak değerlendirilmektedir.(Özdemir ,2021:284-285).

Yeni hükümet sistemi, yürütmenin çalışma biçimini dönüştürmekte kalmamış, Cumhurbaşkanlığı teşkilatının kurumsal yapısında da köklü değişikliklere yol açmıştır. Bu doğrultuda çıkarılan 1 No’lu Cumhurbaşkanlığı Kararnamesi , merkezi yönetimin başkent örgütlenmesini yeniden düzenlemiş ve Politika Kurulları ile Cumhurbaşkanlığı Ofislerini ihdas etmiştir. Cumhurbaşkanlığı Ofislerinin öne çıkan özelliklerinden biri , kamu tüzel kişiliği statüsüne sahip olmaları ve idari ile mali açıdan özerk bir yapıyla donatılmalıdır. Bu durum idare yapılanma içerisindeki yerlerine ilişkin çeşitli hukuki tartışmaları da beraberinde getirmiştir. (Nacak,2021:1026).

Özellikle ofislerin kamu tüzel kişiliğine sahip olmalarına rağmen merkezi yönetim yapısı içinde yer alması, idarenin bütünlüğü ve idari vesayet ilkeleri bakımından yapısal bir tutarsızlık ortaya çıkarmaktadır.Cumhurbaşkanlığı Kararnameleriyle oluşturulan bu tür kamu tüzel kişilerinin hangi idari denetim mekanizmasına tabi olacağının belirsizleştiği vurgulanmıştır.(Ocak , 2019:163-165).

Cumhurbaşkanlığı Hükümet Sistemi’nin yürürlüğe girmesinin ardından idari teşkilatta çeşitli değişiklikler yapılmaya devam edilmiş; özellikle 2025 tarihli 183 No’lu Cumhurbaşkanlığı

Kararnamesi , Cumhurbaşkanlığı Ofislerinin yapısında önemli bir sadeleştirmeye gidildiğini ortaya koymuştur. Bu kararname ile Dijital Dönüşüm Ofisi, İnsan Kaynakları Ofisi ve Finans Ofisi kaldırılmış, bu birimlerin bazı görevleri ise ilgili kurumlara aktarılmıştır. Bu kapsamda, kapatılan Finans Ofisi'nin belirli yetki ve sorumlulukları Yatırım Ofisi ile bir araya getirilerek Yatırım ve Finans Ofisi adı altında yeni bir yapılanma oluşturulmuştur. (Dilaveroğlu ,2025:769-797).

Bu birleşme, yatırım politikaları ile finans yönetimi süreçlerinin tek çatı altında bütünleşik biçimde yürütülmesini hedeflemekte; stratejik nitelikteki karar alma süreçlerinin Cumhurbaşkanlığı bünyesinde daha koordineli şekilde ilerlemesini amaçlamaktadır.

Yatırım ve Finans Ofisi , Cumhurbaşkanlığı teşkilatı içerisinde önemli bir yere sahiptir ve yeni hükümet sisteminin kurumsal işleyişinin anlaşılmasına önemli katkılar sunmaktadır. Bu bağlamda çalışmanın amacı, Yatırım ve Finans Ofisi'nin mevcut kurumsal yapısını, hukuki temelini ve örgütsel işleyişini ayrıntılı içimde analiz ederek Cumhurbaşkanlığı teşkilatı içindeki yerini ortaya koymaktır.(Dilaveroğlu ,2025: Özdemir ,2021 : Ocak ,2019).

2. Cumhurbaşkanlığı Hükümet Sisteminde Ofisler

10 Temmuz 2018 tarihli ve 30474 sayılı Resmi Gazete'de yayınlanan 1 numaralı Cumhurbaşkanlığı Teşkilatı Hakkında Cumhurbaşkanlığı Kararnamesi'nin 525. maddesi, Cumhurbaşkanlığına bağlı ofislerin yapısını düzenlemiştir. Bu madde uyarınca özel bütçeli, kamu tüzel kişiliğine sahip, idari ve mali özerkliği bulunan Dijital Dönüşüm Ofisi , Finans Ofisi , İnsan Kaynakları Ofisi ve Yatırım Ofisi kurulmuştur. (Öztürk , 2023:168).

Ofislerin temel işlevi, belirlenen kamu politikalarına yönelikinceleme ve analizler gerçekleştirmek ve elde edilen bulguları Cumhurbaşkanına iletmektir. Her ofisin başında bir başkan bulunmaktadır. Bu ofisler, yürütülen projelerin bürokratik süreçlere takılmadan doğrudan Cumhurbaşkanına aktarılmasında önemli bir role sahiptir. (Özdemir, 2021: 292).

Cumhurbaşkanlığı ofislerinin kurulmasının temel nedeni, hükümet sistemi değişikliğinin ardından Cumhurbaşkanına yüklenen görev ve yetkilerin önemli ölçüde artmasıdır.Cumhurbaşkanının tüm bu görevleri etkin biçimde yerine getirebilmesi için Cumhurbaşkanlığı Teşkilatının çağın ihtiyaçlarına uygun şekilde yeniden yapılandırılması ve bazı yeni birimlerin oluşturulması gereklilik haline gelmiştir. Bu doğrultuda ofisler, Cumhurbaşkanının artan sorumluluklarını yerine getirmesine destek olmak, değerlendirme ve önerileri ile danışmanlık sağlamak amacıyla ortaya çıkmıştır. (Nacak ,2021:1025).

Her bir ofise ilişkin görevler 527. maddede ayrıntılı bir şekilde belirtilmiş olup, maddenin sonunda ayrıca Cumhurbaşkanının vereceği diğer görevlerin de yerine getirileceği ifade edilmiştir. Ofis başkanları bulundukları ofisin en üst yöneticisi konumundadır ve ofisin işleyişinden Cumhurbaşkanına karşı sorumluluk taşır. Ofislerle Cumhurbaşkanı arasındaki ilişki idari vesayet niteliği gösterse de, 533. Maddede düzenlenen emir ve talimat verme yetkisi, bu ilişkiyi hiyerarşik yapıya daha yakın bir hale getirmektedir. (Üstün , 2019:33).

Dijital Dönüşüm Ofisine e devlet dönüşümünü koordine etmek ,Finans Ofisine İstanbul Finans Merkezi projesini takip etmek, Türkiye'nin finans piyasaları içindeki konumunu raporlamak, İnsan Kaynakları Ofisine Türkiye'nin insan kaynakları envanterini çıkarmak, kamuda kariyer yönetim modellerini hayata geçirecek projeler hazırlamak, Yatırım Ofisinin ise esas olarak yatırım ortamının iyileştirilmesine yönelik çalışmalar yapmakla görevlendirilmiştir. (Turan, 2018:33).

Bürokrasinin ne kadar etkili ve verimli çalıştığının, hem vatandaşların kamu hizmetinden duyduğu memnuniyeti hem de Siyasal sistemin işleyişi ile devamlılığını doğrudan etkilediği genel olarak kabul edilmektedir. Bu çerçevede ofislerin, belirlenen politikaların hızla hayata geçirilmesini sağlamak

ve bürokraside görülen yavaşlık ve verimsizliği ortadan kaldırmak amacıyla oluşturulmuş idari birimler olduğu değerlendirilmektedir. (Avanerve Fedai , 2021:221).

Ofislerin Türkiye Cumhuriyeti idari yapısı içindeki konumunun belirlenmesi konusunda bazı sorunlar ortaya çıkmaktadır. Bunun nedeni, her ne kadar ofisler merkezi idarenin başkent Teşkilatı içinde, Cumhurbaşkanlığı örgütlenmesinin bir parçası olarak bulunsa da, sahip oldukları nitelikler bakımından hizmet yönünden yerinden yönetim kuruluşlarına daha yakın bir görünüm sergilemeleridir. (Özdemir , 2021:293).

Ofislerin oluşturulması, 2018 tarihli 1 numaralı Cumhurbaşkanlığı Teşkilatı Hakkında Cumhurbaşkanlığı Kararnamesi 'ne dayanmaktadır. Bu nedenle kuruluşları bir kanunla değil , Cumhurbaşkanlığı Kararnamesi ile gerçekleşmiştir. Yetkide paralellik ilkesi gereğince , nasıl kararnamelerle kurulmuşlarsa , Cumhurbaşkanlığı tarafından çıkarılacak yeni kararnameler ile bu ofislerin faaliyetlerine son verilebilmesi yada farklı alanlarda yeni ofislerin oluşturulabilmesi de mümkündür. (Dinç ve Atmaca , 2023:138).

3. Yatırım ve Finans Ofisi'nin Yapısı , İşleyişi ve Görevleri

Cumhurbaşkanlığı Yatırım Ofisi , 10 Temmuz 2018 tarihli 1sayılı Cumhurbaşkanlığı Kararnamesi ile devletin idari yapılanmasına dahil edilmiştir. Bu düzenleme ile Ofis , daha önce Türkiye Yatırım Destek ve Tanıtım Ajansı tarafından yürütülen görevleri üstlenmiştir. Bu nedenle kararnamede yer alan Yatırım Destek ve Tanıtım Ajansı'na ilişkin tüm ifadelerin Yatırım Ofisi'ni kapsadı kabul edilmiştir.

Yatırım Ofisi'nin kurumsal yapısı; başta 1 sayılı ve 48 sayılı Cumhurbaşkanlığı Kararnameleri ile 703 sayılı KHK olmak üzere, 5523 sayılı Cumhurbaşkanlığına bağlı ofislere ilişkin çeşitli düzenlemeleri içeren Kanun, 4857 sayılı İş Kanunu ve Türkiye Yatırım Destek ve Tanıtım Ajansı'na dair yönetmelik hükümleri temelinde şekillenmektedir. (Küçük ve Dik , 2021:462).

Yatırım Ofisi'nin merkezi Ankara olarak belirlenmiştir. Bunun yanı sıra, ihtiyaç duyulduğu takdirde Ofisin hem yurt içinde hem de yurt dışında çalışma ofisleri kurabilmesine imkân tanıyan hükümlere de yer verilmiştir. (1 sayılı CBK,525/2 madde). Adayların en az dört yıllık bir yükseköğretim programından mezun olmaları ve kamu kurumlarında ya da sosyal güvenlik kapsamındaki uluslararası kuruluşlar veya özel sektörde en az beş yıllık iş tecrübesine sahip bulunmaları gerekmektedir.(3 sayılı CBK,2/2madde).

Toplamda ikisi Türkiye'de olmak üzere 12 adet Yatırım Ofisi birimi bulunmaktadır. Yurt içindeki birimler Ankara ve İstanbul'da konumlanmıştır. Ofis; İletişim Daire Başkanlığı, Kamu-Özel Sektör İş Birliği Daire Başkanlığı, Strateji Daire Başkanlığı, Yatırımcı Hizmetleri Daire Başkanlığı, Yurtdışı Faaliyetler Daire Başkanlığı, Yönetim Hizmetleri Daire Başkanlığı ile Hukuk Müşavirliği birimlerinden oluşmaktadır. (Küçük ve Dik, 2021:463-464).

Yatırım Ofisi'nin temel hedefi, ülkeye yatırım çekmeye yönelik teşvik ve destek faaliyetleri yürüterek ekonomik büyüme ve kalkınmaya katkı sağlamaktır. Ayrıca, kamu ve özel sektör tarafından uluslararası alanda gerçekleştirilen yatırımlara ilişkin tanıtım çalışmalarında ilgili kurum ve kuruluşlar arasında koordinasyon sağlamak da Ofisin görevleri arasındadır. (Dinç ve Atmaca , 2023:142).

5523 sayılı Kanun ile 1 sayılı Cumhurbaşkanlığı Kararnamesinin 530. maddesinde, Ofisin bütçesinin hangi kaynaklardan oluşacağı açıkça düzenlenmiştir. Buna göre, Ofisin elde ettiği gelirlerin Başkanın uygun gördüğü bankalarda açılacak hesaplarda tutulacağı, harcanmayan tutarların ise ilgili bütçe birimine bildirilerek Cumhurbaşkanınca onaylanan bütçeden karşılanacağı hükme bağlanmıştır. Ayrıca, Ofisin mali işlemleri Sayıştay denetimine tabidir. (Küçük ve Dik , 2021:466).

Yatırım Ofisi; ülkenin ekonomik kalkınması için gerekli yatırımların artırılmasına yönelik olarak Türkiye'de yatırım yapılmasını teşvik eden çalışmalar yürütür. Yatırımcıların karşılaşabileceği engel ve

sorunları belirleyip bunların giderilmesi için ilgili kurumlar nezdinde girişimlerde bulunur. Türkiye'de yatırım ortamını geliştirmeye hizmet edecek her türlü bilgi ve veriyi üretir, ilgili kuruluşlardan temin eder, günceller ve paylaşır. Ayrıca, Bakanlıklar ile diğer kamu kurum ve kuruluşlarına yapılması gereken yatırım başvurularını, Cumhurbaşkanı tarafından çıkarılacak yönetmelik doğrultusunda yatırımcı adına kabul ederek ilgili mercilere iletir. Bunun yanında, ulusal ölçekte yatırım destek ve tanıtım stratejisinin oluşturulması ve uygulanmasının izlenmesi de Ofisin görevleri arasındadır. (Coşkun ve Yıldırım , 2023:171-172).

Yatırım Ofisi, yukarıda sayılan görevler çerçevesinde çalışmalarını yürütmektedir. Bu kapsamda, özellikle teknoloji ağırlıklı, yüksek katma değer sağlayan ve istihdam oluşturan yatırımları teşvik etmekte; söz konusu yatırımlara ilişkin süreçleri yatırımcı adına takip ederek hızlandırmaktadır. Ayrıca Ofis, görev alanına ilişkin konularda bilgilendirme amacıyla çeşitli yayınlar hazırlamakta ve kamuoyunun erişimine sunmaktadır.

4. Sonuç

2018 yılında Türkiye'de parlementer sistemden cumhurbaşkanlığı hükümet sistemine geçilmesi ile birlikte, Cumhurbaşkanlığına bağlı idari yapının da yeniden düzenlenmesi gereği ortaya çıkmıştır. Bu doğrultuda atılan ilk adım, 10 Temmuz 2018 tarihinde yayınlanan 1 numaralı Cumhurbaşkanlığı Teşkilatı Hakkında Cumhurbaşkanlığı Kararnamesi ile atılmış ve Cumhurbaşkanlığı Teşkilatı yeni bir yapılanma çerçevesinde faaliyet göstermeye başlamıştır. Söz konusu yapılanmanın bir parçası olarak, belirli politika alanlarına yoğunlaşan dört ayrı cumhurbaşkanlığı ofisi oluşturulmuştur. (Dilaveroğlu , 2025:287).

Cumhurbaşkanlığı ofisleri, Cumhurbaşkanlığı teşkilatı içinde konumlanmakla birlikte, yürüttükleri hizmetler bakımından yerinden yönetim birimlerinin niteliklerini taşımaları nedeniyle Türkiye Cumhuriyeti idari teşkilatı içindeki konumlarının tam olarak belirlenmesini güçleştirmektedir. Kamu tüzel kişiliğine sahip olan bu ofisler, cumhurbaşkanına bağlı olmaları sebebiyle merkezi yönetimin başkent teşkilatının bir parçası gibi görünse de, doktrinde sundukları hizmetlerin niteliği açısından yerel yönetim birimleri kapsamında değerlendirilmektedir. (Özdemir , 2021:295).

Ofislerin kullandığı yetkiler ile bu birimlerde yürütülen personel yönetimi, klasik kamu yönetimi anlayışının dışında, daha esnek bir yapıda tasarlanmıştır. Bu düzenleme ile ofislerin geleneksel kamu bürokrasisinin ağır işleyen yapısından uzaklaştırılması hedeflenmiştir. Ayrıca, cumhurbaşkanlığı ofislerinin birer koordinasyon odağı olarak işlev göreceği ve teori, mevzuat ve uygulama arasındaki uyumsuzlukların giderilmesine katkıda bulunacağı belirtilmektedir. (Yılmaz ve Tamer , 2021:87).

Ofislerin Türk yönetim sistemine kazandırdığı önemli yeniliklerden biri, kamu politikalarının oluşturulması sürecinde düzenledikleri istişare ve çalışma toplantılarıyla, geçmiş dönemlere kıyasla çok daha geniş bir kesimin — sivil toplum kuruluşları, özel sektör temsilcileri, uzmanlar ve vatandaşlar — sürece dâhil edilmesidir. Bu durum, yönetimde katılımcılık ve yönetişim anlayışının güçlenmesine katkı sağlamıştır. Ayrıca ofisler, bakanlıklar başta olmak üzere diğer kamu kurumları ve çeşitli paydaşlarla yürüttükleri çalışmalar kapsamında görüş bildirme, tavsiyede bulunma, öneriler sunma ve yön gösterme fonksiyonlarıyla adeta danışma niteliğinde bir birim olarak konumlanmıştır. (Dinç ve Atmaca , 2023:146-147).

Yatırım Ofisinin, yatırımcılarla devlet arasında aracılık yapan bir köprü işlevi üstlenmesi amaçlanmaktadır. Bu çerçevede Ofis, hem yabancı sermayenin ülkeye çekilmesinde rol oynamakta hem de yatırım süreçlerinde karşılaşılan bürokratik engelleri azaltmayı hedeflemektedir. TDO sistemi aracılığıyla Ofis, yatırımcılara çeşitli hizmet alanlarında destek sunmakta ve yabancı yatırımcıların Türkiye'deki işlemlerini daha kolay ve hızlı bir şekilde yürütebilmelerine yardımcı olmaktadır. (Küçük ve Dik ,2021:470).

Sonuç olarak Yatırım ve Finans Ofisi, ülkenin ekonomik vizyonuna yön veren, koordinasyon sağlayan ve yatırım politikalarının etkinliğini artıran merkezi bir kurum niteliği kazanmıştır. Bu yönüyle Ofisin, Türkiye'nin küresel yatırım piyasalarındaki konumunu güçlendirmesi ve sürdürülebilir ekonomik büyümeye katkı sunması beklenmektedir.

Kaynakça

Cumhurbaşkanlığı hükümet sisteminde kamu politikası sürecinin yeni aktörleri: Politika kurulları ve ofisler. Dumlupınar Üniversitesi Sosyal Bilimler Dergisi, 76, 126–148. https://doi.org/10.51290/dpusbe.1202489

Cumhurbaşkanlığı ofislerinin yapısına ilişkin değerlendirme. Afyon Kocatepe Üniversitesi Sosyal Bilimler Dergisi, 23(3), 1023–1041. https://doi.org/10.32709/akusosbil.893446

Cumhurbaşkanlığı Hükûmet Sisteminde Kamu Yönetimi. Nobel Akademik Yayıncılık. ISBN: 978-625-397-582-1

Cumhurbaşkanlığı Dijital Dönüşüm Ofisi ve e-yönetişim. Dumlupınar Üniversitesi Sosyal Bilimler Dergisi, 78, 211–231. https://doi.org/10.51290/dpusbe.1337001

Cumhurbaşkanlığı kararnamesi ile idari vesayet yetkisi düzenlenmesinin bir örneği olarak Cumhurbaşkanlığı ofisleri. Anayasa Yargısı, 36(1), 163–193.

Türkiye'nin yeni yönetim düzeni: Cumhurbaşkanlığı hükümet sistemi. Social Sciences Research Journal, 7(3), 42–91.

183 nolu Cumhurbaşkanlığı Kararnamesi kapsamında Cumhurbaşkanlığı ofislerine yönelik gerçekleşen değişiklikler. Uluslararası Anadolu Sosyal Bilimler Dergisi, 9(3), 795–810. https://doi.org/10.47525/ulasbid.1753808

Bir politika transferi örneği: Cumhurbaşkanlığı politika kurulları ve ofisleri. Ardahan Üniversitesi İİBF Dergisi, 5(2), 163–172. https://doi.org/10.58588/aru-jfeas.1383107

Cumhurbaşkanlığı Hükümet Sisteminin Türkiye Cumhuriyeti idari teşkilatına getirdiği yenilikler. Journal of Academic Value Studies, 7(3), 284–297. https://doi.org/10.29228/javs.51971

Yatırım sürecinde bürokrasinin minimize edilmesi arayışı çerçevesinde yeni bir kurumsal yapılanma: Cumhurbaşkanlığı Yatırım Ofisi. Cilt 26(Sayı 4), 459–473.

SEYYİD BURHANEDDİN BELHÎ'NİN MUSTAFA KEMAL PAŞA'YA İTHAF ETTİĞİ MANZUM BİR ZAFER-NÂME

A VICTORY BOOK IN VERSE DEDICATED BY SEYYID BURHANEDDIN BELHI TO MUSTAFA KEMAL PASHA

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ÖZET

Klasik Türk edebiyatında bir seferin başlangıcından sonuna kadar geçen olayları, bir kalenin ya da şehrin fethiyle sonuçlanan askerî başarıları veya kazanılan büyük bir savaşın ayrıntılarını konu edinen edebî türe "zafernâme" adı verilir. Zafernâmeler, genellikle manzum (şiir) ya da mensur (düzyazı) biçimde yazılır. Bu tür yalnızca edebî değer taşımaz; aynı zamanda Osmanlı tarihine, özellikle de savaş politikaları, komutanların rolü ve zafer sonrası düzenlemelere dair bilgi vermesi bakımından tarihî bir kaynak niteliğindedir. Zafernâmelerde düşman ordusuna karşı elde edilen başarılar coşkulu bir dille anlatılırken padişah ya da komutanların övgüsü ön plandadır. Eserler çoğu zaman devlet erkânına sunulmak üzere yazılmıştır. Bu türde eser kaleme alan müelliflerden biri de Seyyid Burhaneddin Belhî'dir. Belhî dönemin kültürel atmosferiyle uyumlu, süslü ve sanatlı bir dil kullanarak zaferi hem belgeleyen hem de yücelten bir üslup kullanır. İzmir'in Yunan işgalinden kurtarılması ve Kurtuluş zaferinin ardından Mustafa Kemal Paşa'ya bu mektubu yazma ihtiyacı hisseden Burhâneddin Belhî mezkûr mektuba ek olarak sunulan sekiz bentten oluşan zafer temalı manzume kaleme almıştır. 1921 Nisan ayında aruzun "mefâîlün mefâîlün mefâîlün mefâîlün" kalıbıyla yazılan metin; dinî, ahlaki ve milli duyguları pekiştirici bir dille yazılmış klasik bir nazım şekliyle kaleme alınmıştır. Manzumede düşmanın bozguna uğratılmasına, Türk milletinin azmine ve Anadolu'nun işgal sonrası yeniden dirilerek toparlanmasına vurgu yapılmıştır.

Anahtar Kelimeler: Mustafa Kemal, Burhaneddin Belhî, Kurtuluş Savaşı, Anadolu, Şiir

ABSTRACT

In classical Turkish literature, the literary genre "zafer-name" is a literary genre that chronicles the events of a campaign from its beginning to its end, military achievements culminating in the conquest of a castle or city, or the details of a major battle. Zafernames are generally written in verse (poetry) or prose (prose). This genre not only holds literary value but also serves as a historical source for Ottoman history, particularly regarding war policies, the role of commanders, and post-victory arrangements. Victory-books enthusiastically recount victories against the enemy army, while praise of the sultan or commanders is prominent. These works were often written for presentation to high-ranking officials. One author who wrote in this genre is Seyyid Burhaneddin Belhi. Belhi employed a style that both documented and glorified victory, employing ornate and artistic language in harmony with the cultural atmosphere of the period. Following the liberation of Izmir from Greek occupation and the Turkish War of Independence, Burhaneddin Belhi felt compelled to write this letter to Mustafa Kemal Pasha, penning

an eight-stanza poem on the theme of victory as an appendix to the aforementioned letter. Written in April 1921 using the aruz pattern "mefaîlün mefaîlün mefaîlün mefaîlün" the text is written in a classical verse style, in a language that reinforces religious, moral, and national sentiments. The poem emphasizes the defeat of the enemy, the resolve of the Turkish nation, and the resurgence and recovery of Anatolia after the occupation.

Keywords: Mustafa Kemal, Burhaneddin Belhi, War of Independence, Anatolia, Poetry

"DEFTER-İ KUYÛDÂT"DA SAKLI MANZUM MEKTUBÂT

A LETTER IN VERSE HIDDEN IN THE "DEFTER-I KUYUDAT"

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ÖZET

Defter-i Kuyûdât, Seyyid Süleyman Belhî (Türkistanî) ve aile fertleri hakkında bilgi ve dokümanları içeren özel ve resmi evraklardan oluşan belgelerdir. Ailenin şeceresi ile başlayan defterde Seyyid Süleyman'ın hayat hikâyesi teferruatlı bir şekilde aktarılmıştır. Oğlu Burhaneddin Belhî tarafından telif edilen eser; Türkçe, Arapça ve Farsça kaleme alınmış icâzetnâme, zafernâme, mektûbât, pend-nâme, resmî dilekçe vb. belgelerden mütevellittir. Ayrıca tasavvufî terimlerin ve nasihatlerin yoğunluğu eserde dikkat çekmektedir. Klasik Türk şiirinde manzum mektup yazma geleneği, özellikle 16. yüzyıldan itibaren belirginleşmiş olsa da kökleri daha önceye, Osmanlı Devletinin kuruluş dönemlerine kadar dayanır. Mezkûr gelenekten istifade eden ediplerin başında Seyyid Burhaneddin Belhî gelmektedir. Belhî'nin kaleme aldığı bu şiirler dönemin Basra valisi Sami Paşa-zâde Hasan Bey'e ithaf edilmiştir. Mefâ'îlün, mefâ'îlün, mefâ'îlün, mefâ'îlün aruz kalıbıyla yazılan son manzum mektup, diğer mektupların özeti mahiyetindedir. Burhaneddin Belhî ile Sami-Paşa-zâde Hasan Bey arasındaki yazışmalar nihayetinde her iki şahsiyetin birbirlerine methiyeler dizmesine dönüşür. Sami-Paşa-zâde Hasan Bey son mektubunda Belhî'nin son rubâîsini tahmis ederek övgü dolu Farsça bir şiir yazar. Akabinde Seyyid Burhaneddin Belhî çalışmamıza konu olan son manzum mektubu yazarak süreci tamamlar. Bu çalışmada öncelikle Burhaneddin Belhî ve şiirini ithaf ettiği Sami-Paşa-zâde Hasan Bey hakkında bilgi verilmiş akabinde manzum mektup dönemin sosyopolitik ve edebi muhitinden yararlanılarak incelenmiştir. Manzum metin şekil, tür ve tema olarak tetkik ve tahlil edilmiştir.

Anahtar Kelimeler: Burhaneddin Belhî, Sami-Paşa-zâde Hasan, Şiir, Manzume

ABSTRACT

The "Defter-ı Kuyudat" consists of private and official documents containing information and documents about Seyyid Süleyman Belhı (Turkestani) and his family members. Beginning with the family's genealogy, the notebook details Seyyid Süleyman's life story.

Composed by his son, Burhaneddin Belhı, the work consists of documents such as ijazetname, zafername, mektubat, pend-name, official petitions, and other documents written in Turkish, Arabic, and Persian. The abundance of Sufi terms and advice in the work is also striking. While the tradition of writing letters in verse in classical Turkish poetry became particularly prominent from the 16th century onward, its roots date back even earlier, to the founding of the Ottoman Empire. Seyyid Burhaneddin Belhı was one of the leading writers who benefited from this work. These poems written by Belhı were

dedicated to Sami-Paşa-zade Hasan Bey, the governor of Basra at the time. The final verse letter, written in the prosodic form of mefa'ılün, mefa'ılün, mefa'ılün, mefa'ılün, serves as a summary of the other letters. The correspondence between Burhaneddin Belhı and Sami-paşa-zade Hasan Bey ultimately turns into a series of eulogies between the two figures. In his final letter, Sami-paşa-zade Hasan Bey praises Belhı's final rubaı and writes a Persian poem full of praise. Seyyid Burhaneddin Belhı then completes the process by writing the final verse letter that is the subject of our study. This study first provides information about Burhaneddin Belhı and Sami-paşa-zade Hasan Bey, to whom he dedicated his poem, and then presents the verse letter. The verse text was examined and analyzed in terms of form, genre, and theme.

Keywords: Burhaneddin Belhı, Sami-paşa-zade Hasan, Poetry, Poem

GİRİŞ

Defter-i Kuyûdât, Seyyid Süleyman Belhî (Türkistanî) ve aile fertleri hakkında bilgi ve dokümanları içeren özel ve resmi evraklardan oluşan belgelerdir. Ailenin şeceresi ile başlayan defterde Seyyid Süleyman'ın hayat hikâyesi teferruatlı bir şekilde aktarılmıştır.

Defter-i Kuyûdât, Arapça, Farsça ve Türkçe kaleme alınmış mektup, dilekçe, icâzetnâme, tavsiye mektubu, davetiye gibi özel ve resmî belgeleri içermektedir. Toplam 161 belgeyi içeren bu defter, bir nesep şeceresi ile başlar. Ailenin önde gelenlerinden Süleyman Belhî Hazretleri'nin hayatı da ayrıntılı olarak yazılmıştır. Oğlu Burhaneddin Belhî tarafından nakledilen hayat hikâyesi ve defterdeki diğer belge ve mektuplar derlenmiş, torunu Seyyid Mûsâ Efendi, belgeleri istinsah ederek açıklayıcı notlar ve kısa özetlerle zenginleştirmiştir (Uzunlar &Meral, 2022, 2-3)

Süleyman Belhî'nin hayatını anlatan bölüm kitabın mukaddime kısmını oluşturmuştur. O, ilim ve irfan ile yoğrulmuş, Türkistan coğrafyasına mensubiyeti ve şahsî faziletleri dolayısıyla büyük bir etkiye sahip olmuş, Anadolu'da son yüzyılda tasavvufî düşünce yapısının oluşmasında ve şekillenmesinde mühim rol oynamıştır. Onun kadar oğlu Burhaneddin Belhî de bu oluşumda ciddi rol oynamıştır.

Burhaneddin-i Belhî, tıpkı Mevlana Celaleddin-i Rumî (ö.672/1273) gibi kökeni itibarıyla aristokrat sınıfa mensup, Belh'ten Anadolu'ya göç etmek zorunda kalmış aynı zamanda şiirle de meşgul olmuş ünlü bir şeyh ailesinin çocuğudur (Kahraman, 2009, 641). 1849 yılında Kunduz'da doğmuştur. Adını, mektup ve imzalarında "Seyyid Muhammed Burhaneddin", "Seyyid Muhammed Burhaneddin Kılıç", nisbesini ise, genellikle "el-Hüseynı el Belhî şeklinde zikreder ve daha çok Burhaneddin Belhî adıyla bilinir. Burhaneddin Kılıç, on üç yaşlarında İstanbul' a gelmiştir. Burhaneddin Belhî resmi bir görevde bulunmamış, yalnızca şiir ve hat sanatıyla meşgul olmuştur. Geçimini, babasının vefatından sonra kendisine intikal eden maaşla sürdürmüş, maaşı zamanla yetersiz kaldığından geçim konusunda sıkıntı çekmiştir. Bazı mektuplarında bu sıkıntılarını dile getirmiştir (Öz, 2006, 204).

Eğitimini babasından alan Burhâneddîn Kılıç, 13 yaşlarında İstanbul'a gelmiş ve yalnızca şiir ve hat sanatıyla meşgul olmuştur. Farsça ve Türkçe gazellerinde, mesnevilerinde babasından ve yaşadığı topraklardan söz etmiştir. Burhâneddîn-i Belhî, ismini büyük dedesi Özkent hükümdarı Burhâneddîn Kılıç'tan almıştır. Şair, dedesinden şiirlerinde övgüyle bahseder. Burhân, bir mesnevisinde büyük dedesinin Türkistan mülkünün padişahı olduğunu, başkenti olan Özkent'te ikamet ettiğini ve adaletli bir hükümdar olduğunu söyler (Özkan,2016, 2-3).

Şair, Sadberk Hanım'la evlenmiş, eşi ölünce oğullarıyla meşgul olmuştur. Seyyid Kemaleddin, Seyyid Musa, Seyyid Süleyman Celaleddin ve Seyyid Ahmed İhsan isimlerini taşıyan dört oğlu vardır. Seyyid Kemaleddin, kendinden önce vefat etmiştir. Burhaneddin-i Belhî, şairliği kadar hattatlığı ile de kendi döneminde şöhret kazanmıştır. O, bir talik yazı ustasıdır. Talik hattı, Bursalı Abdülkadir Nesib Efendi'den meşk ederek 1290 yılında icazet almıştır (Kahraman, 2009, 646).

Burhaneddin-i Belhî, şiirlerinde çoğunlukla "Burhân" mahlasını kullanmıştır. Bunun yanında, taradığımız Türkçe manzumelerinde; "Burhân-ı Belhî", "Burhân-ı Hüseynî", "Belhî", "Merd-i Belhî", "Bülbül-i Belh", "Hüseynî" gibi mahlasları da yer yer tercih ettiği görülmüştür. Burhaneddin-i Belhî hakkında bilgi veren kaynaklar, onun, Türkçe ve Farsça kadar Çağatayca şiirlerinden de söz ederler. Şairin ailesi, zaten Çağatay yazı dilinin ana coğrafyasından geldiği için bu bilgilerde sıra dışı bir durum bulunmamaktadır. Aslında, sadece Burhaneddin değil, şiirle uğrasan bütün aile fertlerinin kendi öz lehçelerini, yani Çağatay Türkçesini, edebî alanda da kullanmayı sürdürdükleri anlaşılmaktadır. Geldiği toprakların edebî zevkini, yine o toprakların diliyle Anadolu'da canlandırmak istemiş, bu nedenle de, metinlerinde Çağatayca şiirler söylemiştir (Kahraman, 2009, 648).

Farsça yazmış olduğu rubaileri pend-nâme hüviyeti içermekte başta evlatları olmak üzere birçok kişiye bu çalışmada nasihat etmektedir. İdeal insan tipi olarak gördüğü "İnsan-ı Kâmil"e ulaşmanın mertebeleri, iyi insanın vasıfları, tevekkülün elzemliliği vb. konularda okuyucuya yol göstermektedir:

Şair, rubailerinde oğullarına nasihat etmeyi ihmal etmemiştir. Öğütlerinde evlatları için, dinî vecibelerinden geri kalmamaları, işlerinde Allah'a tevekkül etmeleri, ondan yardım dilemeleri, salih kul olmaları, iyi amel işlemeleri gibi dinî; kötülerle dost olmamaları, başkalarının ayıp, kusur ve namusuyla ilgilenmemeleri, muhabbetli, merhametli olmaları, kindar ve kötü niyetli olmamaları gibi ahlâkî nasihatlerde bulunmuştur. Sosyal ve dünyevî hayatları için de onlardan boş boş oturmamalarını, bugünün işini yarına bırakmamalarını, faziletli olmalarını, ilim öğrenmelerini ve ilim tahsilinde gayretli olmalarını, bilgili ve ileri görüşlü olmalarını, cahillerle oturup fitneye sebep olmamalarını, dünya nimetlerine ve dünya işlerine meyletmemelerini, makam mevki peşinde koşmamalarını; onurlu, âdil, faziletli, hüner ve hikmet sahibi ve yiğit olmalarını, ömrün kıymetini bilmelerini, düşmanların yenilgisi, İslâm ümmetinin muvaffakiyeti ve zaferi için dua etmelerini temenni etmektedir (Özkan, 2016, 9).

Muhammed Burhaneddin Kılıç, Ekim 1929'da hastalanmış ve 4 Mart 1930 tarihinde Heybeliada'da vefat etmiştir. Kabri, sağlığında şair mizacına uygun gördüğü Heybeliada mezarlığındadır. Şiirlerinde "Burhan" mahlasını kullanan şairin, 157 gazeli içeren Farsça Divan'ı, 183 gazelin yer aldığı Türkçe Divan'ı; Ahmed Yesevî, Ali Şîr Nevâyî, Fuzûlî ve Nef'î gibi ünlü şairlerimiz ile Fars edebiyatının seçkin şairlerinin bazı beyit ve gazellerine yazdığı toplam 44 tahmisin yer aldığı Mecmû'a-i tahmisât 'ı; Farsça ve Türkçe tarih manzumeleri ve bu şiirlerin yazılmasına dair bazı hatıraların yer aldığı bir defteri; nakaratlı Manzumât ve Şarkıyyât'ı, Farsça rubaiyât'ı, çoğunluğu Farsça ve Türkçe olmak üzere 11 mesnevisinin yer aldığı Mesneviyât'ı vardır. Özel ve resmi nitelikteki mektupları, Belhî ailesi ile büyük bir kısmı kendisine ait yazışmaların yer aldığı Defter-i Kuyûdât'ta toplanmıştır (Öz, 2006: 204-205).

"Defter-i Kuyûdât"daki Mektubât

Eserdeki yazışmalara geçmeden önce, Sami-Paşa-zâde Hasan Bey hakkında bazı anekdotlar paylaşalım. Hayatı hakkında çok kısıtlı bilgi edindiğimiz (Burhaneddin Belhî ile yazışmaları sonrası çıkarımlar) Sami-Paşa-zâde Hasan Bey devletin çeşitli kademelerinde üst düzey bürokratlık yapmış, Basra'da valilik görevini İzmir'de vali yardımcılığı görevini ifa etmiştir. Türk nesrinin önemli münevverlerinden

yazar Sami-Paşa-zâde Sezai'nin kardeşidir. Yine "Defter-i Kuyûdât"daki (s. 226-250) bilgilerden yola çıkarak mensur yazıları, rubaileri, beyitleri, gazelleri ve Farsça yazılmış tahmîsi mevcuttur. Ayastefanos (Yeşilköy) ve Maltepe'de uzun bir süre bulunduğu mektuplarda geçmektedir.

Yine belgelerde Burhaneddin Belhî'nin şair Örfî'nin ikinci gazelinin tahmisini yaptığı, şiirlerinde Ömer Hayyam ve Hafız-ı Şirâz'ın etkilerinin görüldüğü zikredilmektedir. Bu şiirleri Sami-Paşa-zâde Hasan Bey'e arz ettiğinde cevaben "Bu, şairâne bir eserdir; içten gelmiş bir eserdir; kalbin sesidir; hâldir; ruhtur; sevdiği dostunun hâlini, nasihatini, hâlini ve gönül ateşini anlatır."(s.239) diye övgü dolu mesajla bu satırları kaleme alır.

Burhaneddin Belhî Sami Paşa-zâde Hasan Bey'in yazışmalarından o kadar etkilenmiş ki nihayetinde aşağıda yer alan beyitleri kendisine ithaf etmiştir. Mezkûr beyitler klasik edebiyat üslubuyla yazılmış olup anlam, edebî sanatlar ve duygu yönünden oldukça zengindir. Manzum mektup edebi yönü güçlü, süslü bir dille yazılmış, samimi ve derin anlamlar içeren, öğüt, iltifat, manevi destek içeren yazılardan mütevellittir.

Mefâ'îlün, mefâ'îlün, mefâ'îlün, mefâ'îlün aruz kalıbıyla yazılan son manzum mektup, diğer mektupların özeti mahiyetindedir. Burhaneddin Belhî ile Sami-Paşa-zâde Hasan Bey arasındaki yazışmalar nihayetinde her iki şahsiyetin birbirlerine methiyeler dizmesine dönüşür. Sami-Paşa-zâde Hasan Bey son mektubunda Belhî'nin son rubâîsini tahmis ederek övgü dolu Farsça bir şiir yazar. Akabinde Seyyid Burhaneddin Belhî çalışmaya konu olan aşağıdaki manzum mektubu yazarak süreci tamamlar.

Dil-i dânânız ey mîr-i sohenver sihr-i mâ'nâdır
Bana gönderdiniz üç nâme-i dürdâne emsâli

İlk beyitte, şair kendisine gönderilen mektupları hem biçim hem de anlam açısından övmekte, gönderen kişiyi ise "sözün efendisi" gibi görerek büyük bir saygı göstermektedir. Burhaneddin Belhî şiire nida sanatıyla başlar ve muhatabını çok yüksek bir edebî üslupla över. Mîr-i suhenver "söz ustalarının efendisi" diyerek Hasan Paşa'yı yüceltir. Kalbin sihirli anlamlara sahip olmasından dolayı mecaz, mektupların inciye benzetilmesi istiare ve teşbih, muhatabına doğrudan seslenme olduğu için nida sanatına yer verilmiştir. Bununla beraber beyitte geçen "üç name-i dürdâne emsâli" yani "üç inci değerinde mektup" ifadesi yalnızca fiziksel bir yazının değil aynı zamanda yüksek anlam taşıyan edebî ve duygusal değeri olan metinler olduğunu gösteriyor. Şair önceki mektuplardan öylesine etkilenmiştir ki onları yalnız içerikleriyle değil, zarafetiyle de "inciye" benzetir. Bu da mektupların sadece mesaj değil, aynı zamanda bir sanat eseri gibi olduğunu düşündüğünü gösterir. Sami Paşa-zâde Hasan Bey'in sözleri, Burhâneddin Belhî için sihirli bir anlam taşımakta ve onu büyülemektedir. Sonuç olarak, bu beyit sadece bir teşekkür değil; aynı zamanda muhatabın hem kalbini hem de söz ustalığını överek gönderdiği yazılı ifadelerin şair üzerinde derin bir etki bıraktığını bildirir. Bu klasik edebiyatta sıkça rastlanan zarif bir edebi nezaket örneğidir.

Vürûd-ı sadrıma se gevherin verdi safâ hem de
O nazm u nesri hayrân itdi bu şûrîde ahvâlî

Burhaneddin Belhî kendisine gönderilen üç yazının (iki nesir bir manzum) sadece içerik olarak değil, ruh hâlini değiştirecek kadar etkileyici olduğunu ifade ediyor. Hem sükûnet (safâ) vermiş hem de hayran bırakacak derecede etkileyici bulunmuş. İkinci mısra bir anlamda duygusal ve sanatsal bir teşekkür özeti mahiyetindedir.

Bu beyitte mektupların “gevher”e (cevhere) benzetilmesi teşbih, “gevher” ile hem değer hem de edebî nitelik kastedilmiş olabileceğinden kinaye sanatından söz edilebilir. İkinci mısrada ruh hâline vurgu yapılmış. Şairin içinde bulunduğu şûride yani kargaşa hâlinin birdenbire değişmesi dramatik bir etki oluşturmuştur.

Şair, muhatabına büyük bir saygı ve takdirle hitap ediyor. Mektupların sanatsal yönüne hayran kaldığını belirtiyor. Bu mektuplar hem ruh sağlığına iyi gelmiş hem de estetik bakımdan zengin. Duygusal anlamda şifa verici olarak sunulan bu mektuplarla Belhî’nin içinde bulunduğu "şûride ahvâl" yani karışık, sıkıntılı ruh hâli teskin olmuştur. Şair, muhatabını överken kendini "şûride", yani perişan bir durum ile özdeştirirken tevazu gösteriyor.

Ziyârette kusûrum vardır illâ afvı mer‘cûdur
Fakat bu hâne-i berdûşun duâda yokdur ihmâli

Birinci mısra bir özeleştiri ile başlamaktadır. Belhî, Hasan Paşa’yı ziyaret edemediği veya ziyarette geç kaldığı için özür dilemektedir. O, “ziyaret konusunda kusurum oldu elbette affınızı umuyorum fakat bu garip kişinin (benim) evinde, dua etmeyi hiç ihmal etmedim” diyerek bağışlanma temennisinde bulunuyor. Bu beyit hem tevazu, hem de vefa içeren bir dostane hitaptır. Şair, maddi olarak ziyarete gidememiştir ama manevi bağını dua ile korumuştur. Aynı zamanda içtenlik ve sadelikle yazılmış zarif bir özürdür.

Hudâ zâtınıza ömr-i füzûn bahş ide hem olsun
Füyûzâtı ile kalb-i tabnâk ü pâkîniz mâlî

Seyyid Belhi bu beyitte de “Allah zatınıza uzun bir ömür versin ve bu ömür, feyizleriyle sizin parlak ve temiz kalbinizi dolup taşıran (bereketli) bir ömür olsun” diyerek temennide bulunmaktadır. Bu beyitte, muhataba yönelik yüksek bir dua ve takdir ifadesi yer alır. Şair, kişinin sadece uzun yaşamasını değil bu hayatının feyizle, maneviyatla, nurla dolu olmasını temenni eder. “Kalb-i tabnâk ü pâk” ifadesiyle kişinin hem zihinsel hem ruhsal temizliğine övgüde bulunur. Mezkûr beyit bir arz-ı hürmet, bir dua, aynı zamanda da bir methiye (övgü) niteliğindedir.

İder tebrîk Burhân mısrâ-ı târîh-i tâmmı ile

Hele Hasan Bey’in ferruh ola nev-sâl-i i‘clâli

Son beyit hem edebi hem aritmetik bir sanat içermektedir. Burhâneddin Belh birinci mısrada Burhân mahlasını kullanır ve mısrâ-ı târîh-i tâmm (Ebced hesabıyla yazılan bir tarih) düşürerek Sami Paşa-zâde Hasan Bey’in yeni yılını kutlamaktadır. Şair Burhaneddin Belhî Sami-Paşa-zâde Hasan Bey ile yeni yılın başlangıcı hakkında iletişim kurmaktadır. Burhân mahlasını kullanan şair, Hasan Bey'in "nev-sâl-i i‘clâli"nin, yani yeni yılının kutlu olmasını dilediği "tam tarih” mısraı ile tebriklerini iletmektedir. Hasan Bey'in "nev-sâl-i i‘clâli" (yeni görkemli yılı) kutlanmaktadır. Burhaneddin Belhî bu durumu "târîh-i tamm" (tam tarih) mısraı ile tebrik ederek Hasan Bey'in yeni yılının (nev-sâl-i i‘clâli) kutlu (ferruh) olmasını temenni eder.

Divan edebiyatı geleneğini ihtiva eden ve sanatsal anlamı, inceliği öne çıkararak bir konuşma yeteneğine sahip olan kişiye hitap eden yukarıdaki beyitler mahir bir üslupla kaleme alınmıştır. Şair, kendisine gönderilen üç değerli mektuba karşılık olarak memnuniyetini belirtmekte ve bu yazılı eserlerin kendisinde hayranlık uyandırdığını ifade etmektedir. Metinde ayrıca, ziyaret eksikliğinden dolayı af dilenmekte ancak duada ihmal etmediği vurgulanarak bir tevazu sergilenmektedir. Son beyitte ise, uzun

ömür ve manevi bereket dilekleriyle birlikte Hasan Bey'in yeni yılını tebrik eden bir tarih mısrası bulunmaktadır.

SONUÇ

Defter-i Kuyûdât Belhî ailesi ile ilgili bütün belgeleri ihtiva eden ve Seyyid Burhaneddin Belhî tarafından bir araya getirilip telif edilen bir ilmi hazinedir. Eserde hem Seyyid Süleyman Belhî'nin hem de oğlu Burhaneddin Belhî'nin yazışmaları, icazetnameleri, manzum ve mensur yazıları mevcuttur. Burhaneddin Belhî'nin Sami-Paşa-zâde Hasan Bey ile yazışmaları eserin son sahifelerindedir. Karşılıklı mektuplaşma sonucu şair nihai olarak kendisine 5 beyitten oluşan manzum bir mektup gönderir. Burhaneddin Belhî kendisine gönderilen daha önceki mektuplardan memnuniyetini belirtir ve bu yazılı eserlerin kendisinde hayranlık uyandırdığını ifade eder. Bir türlü gerçekleştiremediği ziyaretinden dolayı da hayıflanıp özür diler. Akabinde Sami-Paşa-zâde Hasan Bey'in yeni yılını kutlayarak şiiri sonlandırır. Aruz ölçüsüyle yazılan mezkûr şiir klasik Türk şiirinde manzum mektup yazma geleneğini ihtiva etmektedir.

KAYNAKÇA

Kahraman, B. (2009). Burhaneddin-Belhî'nin Çağatayca Şiiirleri, Turkısh Studies, 4(2), 639-671.

Kahraman, B. (2012). Burhan-ı Belhi ve Türkçe Divanı. Kömen Yayınevi, Konya.

Öz. Y. (2006). Burhaneddin Belhi ve Türkçe Mektupları, Edebiyat Dergisi, (15) 203-224.

Özkan, M.A. (2016). Muhammed Burhâneddîn-i Belhî'nin Farsça Rubaileri- Kırıkkale Üniversitesi / Sosyal Bilimler Enstitüsü Yüksek Lisans Tezi. Kırıkkale.

Seyyid Burhaneddin, İkinci Defter-i Kuyudat. Süleymaniye Kütüphanesi Yazma Bağışlar,1394.

Uzunlar A. & Meral A. (2022) İkinci Defter-i Kuyudat. Revak Yayınları, İstanbul.

THE DEVELOPMENT OF DIGITAL ENTREPRENEURSHIP LITERATURE IN TÜRKİYE: AN EVALUATION BASED ON GRADUATE THESES

TÜRKİYE'DE DİJİTAL GİRİŞİMCİLİK LİTERATÜRÜNÜN GELİŞİMİ: LİSANSÜSTÜ TEZLER ÜZERİNDEN BİR DEĞERLENDİRME

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ABSTRACT

This study examines the current state, thematic orientations, and developmental dynamics of postgraduate research on digital entrepreneurship in Türkiye. A total of 12 theses accessible through the National Thesis Center (YÖKTEZ), identified using only the keyword "digital entrepreneurship," were analyzed. The findings reveal a significant increase in academic interest over the years, with a notable concentration of studies in 2023 and 2025. The fact that all theses were written in Turkish indicates the presence of an active national research environment but also highlights limited international visibility. The disciplinary distribution shows a strong concentration in business and entrepreneurship, while digital entrepreneurship is approached through both qualitative and quantitative methods. Surveys are the most commonly used data collection technique, reflecting a need for more in-depth qualitative and field-based studies. Thematically, the theses frequently address digital literacy, individual innovativeness, social media, influencer marketing, personality traits, unemployment anxiety, digital content creation, and blockchain applications. The findings demonstrate that although young individuals possess significant digital entrepreneurial potential, they face various challenges, including limited knowledge, inadequate access to financing, and intense market competition. Overall, the study concludes that digital entrepreneurship literature in Türkiye is expanding; however, there is a pressing need for more interdisciplinary approaches, qualitative fieldwork, and policy-oriented research to support the field's continued development..

Keywords: Digital Entrepreneurship, In-Depth Analysis, YÖK Thesis Database, Graduate Theses.

ÖZET

Bu çalışma Türkiye'de dijital girişimcilik alanında üretilen lisansüstü tezlerin mevcut durumunu, tematik yönelimlerini ve gelişim dinamiklerini incelemektedir. YÖK Ulusal Tez Merkezi'nde yalnızca "dijital girişimcilik" anahtar sözcüğüyle yapılan tarama sonucunda erişime açık 12 tez değerlendirilmiştir. Bulgular, dijital girişimciliğe yönelik akademik ilginin yıllar içinde belirgin biçimde arttığını; özellikle 2023 ve 2025 yıllarında yoğunlaştığını göstermektedir. Tüm tezlerin Türkçe yazılmış olması, alanın ulusal düzeyde geliştiğini ancak uluslararası görünürlüğün sınırlı kaldığını ortaya koymaktadır. Çalışmaların çoğu işletme ve girişimcilik disiplinlerinde yoğunlaşmış; araştırma yöntemleri ise nitel ve nicel olarak dengeli dağılmıştır. Veri toplamada en sık anket kullanılmış, daha derinlemesine yöntemlerin sınırlı olduğu görülmüştür. Tezlerde öne çıkan temalar arasında dijital okuryazarlık, bireysel yenilikçilik, sosyal medya, influencer pazarlaması, kişilik özellikleri, işsizlik

kaygısı, dijital içerik üreticiliği ve blokzincir uygulamaları bulunmaktadır. Bulgular, gençlerin dijital girişimcilik potansiyelinin yüksek olmasına rağmen bilgi eksikliği, finansmana erişim ve yoğun rekabet gibi sınırlayıcı unsurların güçlü şekilde hissedildiğini göstermektedir. Çalışma genel olarak Türkiye'de dijital girişimcilik literatürünün büyüme eğiliminde olduğunu; fakat alanda daha fazla disiplinlerarası yaklaşım, nitel saha araştırması ve politika odaklı analizlere ihtiyaç duyulduğunu vurgulamaktadır.

Anahtar Kelimeler: Dijital Girişimcilik, Derinlemesine İnceleme, YÖK Tez, Lisansüstü Tezler.

INTRODUCTION

Digitalization has become a fundamental cornerstone that not only transforms economic production models but also reshapes the very understanding of entrepreneurship (Kurt, 2020). While traditional entrepreneurship models operated within a structure dependent on physical capital, spatial limitations, and time-bound production, a new and more flexible technology-based entrepreneurial domain with expanded accessibility has emerged (Bilgiç & Göktaş, 2024). Digital entrepreneurship, supported by internet infrastructure, AI-driven analytical tools, social media networks, and e-commerce systems, offers the potential for sustainable growth and transforms not only business models but also economic competition and consumer behavior patterns. The increasing number of postgraduate studies on digital entrepreneurship in Türkiye demonstrates that this transformation is also reflected at the academic level (Akpınar, 2011). In recent years, the growing visibility of the concept has brought forward new business formation models as well as variables such as digital skills, innovativeness, social media influence, technology access, and youth entrepreneurial intention. This indicates that the field is expanding both theoretically and practically, yet still possesses dimensions that continue to develop at an exploratory stage (Bozkurt & Alparslan, 2013). A systematic examination of postgraduate theses on digital entrepreneurship in Türkiye is therefore critical for revealing trends in the literature, identifying areas of conceptual intensity, and highlighting research gaps. This study aims to analyze postgraduate theses on digital entrepreneurship conducted in Türkiye and to reveal the direction of the existing literature, the scale of development, and the thematic areas of focus. The findings demonstrate that digital entrepreneurship is not merely an economic activity, but rather a multi-layered process that must be examined through sociological, cultural, technological, and legal dimensions.

ENTREPRENEURSHIP AND DIGITAL ENTREPRENEURSHIP

Entrepreneurship is a dynamic process that emerges when individuals with the capacity to generate innovation identify opportunities and mobilize resources within an economic and social structure (Akarsu & Döven, 2022). This process is not limited to establishing new businesses; it also allows for transforming existing structures and redesigning value-creation mechanisms. The entrepreneur is an individual who can take risks, cope with uncertainty, observe their environment, and perceive change (Güney, 2008). Every emerging idea is the result of vision, creativity, and strategic thinking (Arıkan, 2004). Therefore, entrepreneurship is not merely an economic activity but a multilayered phenomenon involving cultural, psychological, and sociological dimensions. A society's capacity for innovation strengthens with the presence of entrepreneurial profiles, leading to the creation of new business fields, employment growth, and accelerated economic development (Dolgun, 2003).

Over time, technological advancements have profoundly transformed the entrepreneurial landscape and have led to the emergence of a new approach known as digital entrepreneurship. Digital entrepreneurship encompasses entrepreneurial activities conducted through digital infrastructures such as internet networks, social media platforms, AI-supported analytical tools, and electronic commerce systems (Alay, 2023). In this model, production and marketing processes take shape in virtual environments. Unlike traditional entrepreneurship, digital entrepreneurship requires less physical capital; a single idea can reach large audiences in a short time with the right digital strategy (Eyel & Sağlam, 2021). The integration of data analytics into decision-making processes personalizes marketing efforts and facilitates competitive advantage. This structure makes trial-and-error more risk-free; entrepreneurs can make rapid adjustments based on feedback and continuously improve products and

services by tracking consumer expectations (Çevik Tekin & Küsbeci, 2021). Digital entrepreneurship expands participation in economic systems by creating diverse opportunities and enabling individuals to engage more actively in production processes. Through digital platforms, micro-scale commerce, personal branding, content production, and online service delivery have become widespread, resulting in a more democratized entrepreneurial ecosystem (Boz & Serinkan, 2022). Unlike traditional models, the digital environment eliminates geographical boundaries and positions the user as both producer and consumer simultaneously. Within this structure, the entrepreneur carries responsibility not only for economic opportunities but also for digital ethics, data security, intellectual property rights, and user privacy (Altıntaş & Barkuş, 2023). The fast-paced and competitive nature of the digital ecosystem makes sustainability dependent on strategic planning; ventures that fail to keep up with technological innovation can easily lose visibility.

The relationship between entrepreneurship and digital entrepreneurship is crucial for understanding the source of transformation (Güğerçin & Onan, 2021). The former is rooted in human initiative and the pursuit of innovation, while the latter enables this initiative to take place in a faster, more flexible, and measurable digital environment. Entrepreneurship has historically played a decisive role in the development of societies, while digital entrepreneurship advances this role into a more inclusive, accessible, and global dimension (Dinçay, 2024). In a world where digitalization continues to advance, economic competitiveness is no longer measured solely by production capacity but by information management, algorithmic thinking, and the ability to generate user experience.

METHODOLOGY

Digital entrepreneurship is a rapidly expanding field of research, particularly within the context of innovative business models and the digital economy. Therefore, a comprehensive analysis of postgraduate theses on the subject in terms of content, theoretical frameworks, and thematic approaches is essential for understanding the current position of the scholarly literature as well as its future developmental trajectory. This study is a qualitative research that employs in-depth document analysis to examine postgraduate theses that include the concept of digital entrepreneurship, as indexed in the Council of Higher Education Thesis Center Database (YÖKTEZ).
The population of the study consists of all theses accessible through the YÖKTEZ system by searching solely for the term “dijital girişimcilik” (digital entrepreneurship) in the search bar. No additional filters, secondary concepts, or related keywords were used during the search, ensuring that the dataset remained directly and exclusively focused on the concept itself. As a result of this screening, twelve postgraduate theses, whose full texts were accessible and deemed suitable for content analysis, were selected to form the sample of the study. During the data collection process, all 12 theses were downloaded and examined in detail in their available formats. For each thesis, a review card was prepared and transferred into an Excel table. These studies were systematically coded based on year, department, research method, data collection technique, author gender, advisor title, thesis language, university, and thesis type. In this way, the theses were classified using both structural and content-oriented criteria, and the findings were transferred into a shared matrix to enable comparative analysis. The data analysis was conducted in three stages. In the first stage, the theses were descriptively categorized to reveal their overall distribution. In the second stage, an in-depth coding process was applied to analyze how the concept of digital entrepreneurship was defined, framed, and thematically approached within the theses. In the final stage, the emerging themes were comparatively interpreted to identify common tendencies within the literature, differing methodological preferences, and research gaps to be explored in future studies. This methodological process enabled a detailed examination of the general profile, developmental dynamics, and conceptual focus of postgraduate studies on digital entrepreneurship. Therefore, the findings not only reflect the current state of the field but also provide a guiding foundation for subsequent academic research.

FINDINGS

The data obtained from the study were evaluated and presented below through graphs and tables.

Table 1. Distribution of Theses by Year

Year	Frequency	Percentage
2018	1	8%
2020	1	8%
2021	1	8%
2022	1	8%
2023	3	25%
2024	1	8%
2025	4	33%
Total	12	100%

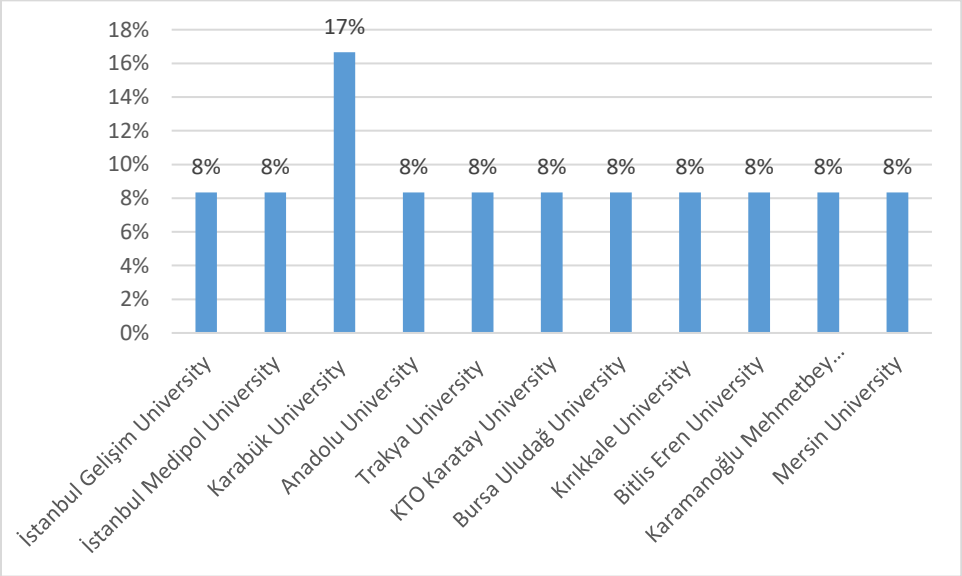
Upon examining Table 1, it is observed that the distribution of theses on digital entrepreneurship demonstrates a clear upward trend over the years. While only one thesis (8%) was produced in 2018, 2020, and 2021, there is a noticeable concentration in 2023 and 2025. The production of three theses (25%) in 2023 and four theses (33%) in 2025 indicates a significant increase in academic interest toward digital entrepreneurship in recent years.

Table 2. Distribution of Theses by Publication Language

Publication Language	Frequency	Percentage
Turkish	12	%100
Total	12	%100

Upon examining Table 2, it is seen that all theses evaluated within the scope of the study were written in Turkish (100%). The absence of theses prepared in a foreign language indicates that academic production in this field is predominantly oriented toward the local scholarly literature.

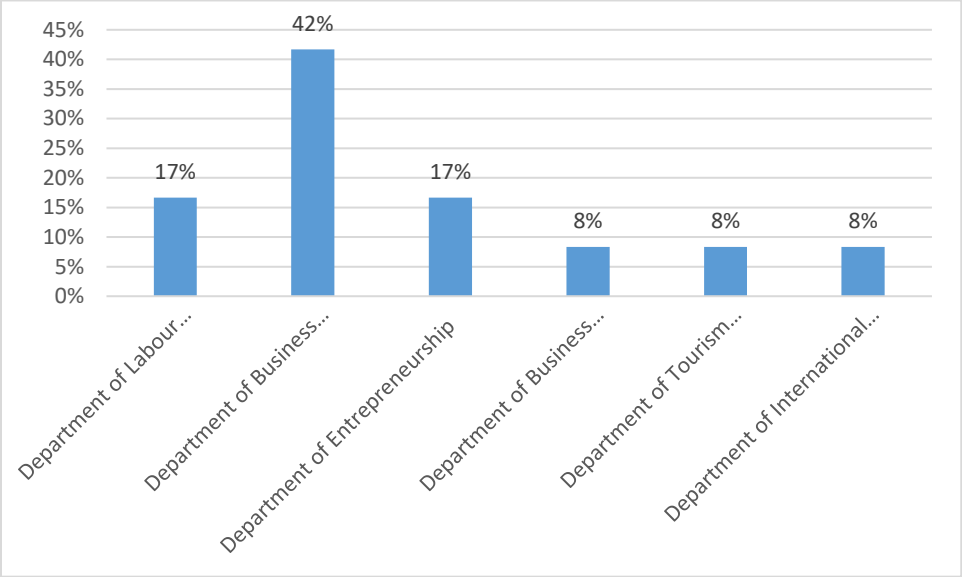
Figure 1. Distribution of Theses by University



When Figure 1 is examined, the distribution of theses by university reveals that Karabük University appears most frequently with 2 theses (17%), while the remaining institutions each contribute 1 thesis (8%). These universities include Istanbul University, Istanbul Medipol University, Anadolu University, Trakya University, KTO Karatay University, Bursa Uludağ University, Kırıkkale University, Bitlis Eren University, Karamanoğlu Mehmetbey University, and Mersin University. This distribution indicates that

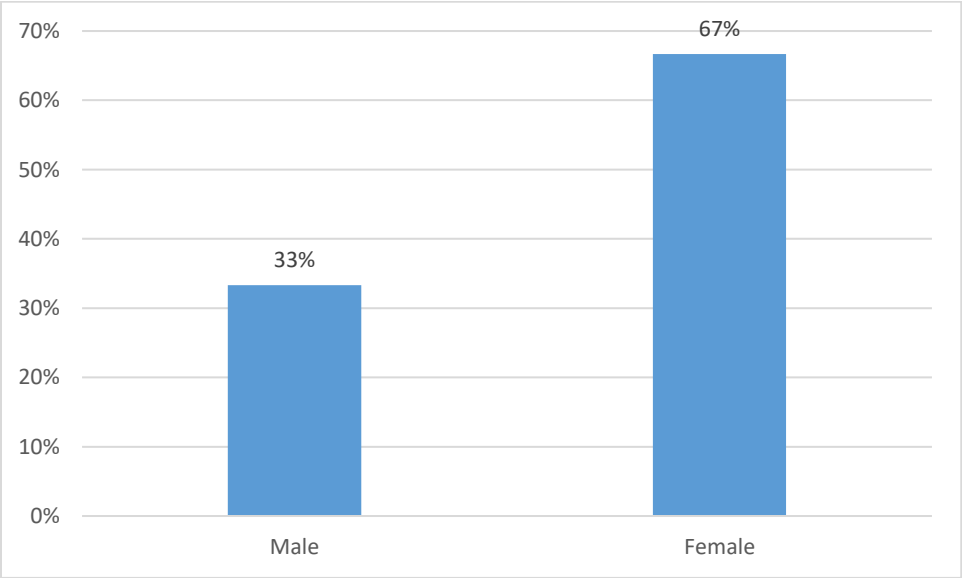
research on digital entrepreneurship is not concentrated in a single academic center but is dispersed across various universities throughout Türkiye.

Figure 2. Distribution of Theses by Academic Department



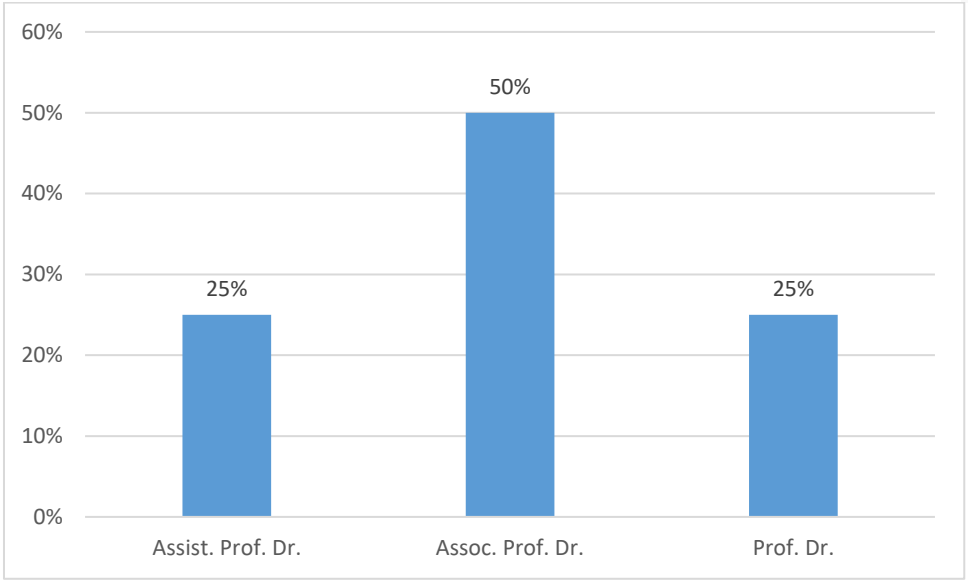
When Figure 2 is examined, the distribution of theses by academic department shows that the Department of Business Administration accounts for the highest number with 5 theses (42%). This is followed by the Departments of Labour Economics and Industrial Relations and Entrepreneurship, each represented by 2 theses (17%). Additionally, 1 thesis (8%) was produced in the Departments of Business Management, Tourism Management, and International Trade and Logistics. This distribution suggests that research on digital entrepreneurship is predominantly situated within business-oriented disciplines, while related fields contribute to a lesser but notable extent.

Figure 3. Distribution of Thesis Authors by Gender



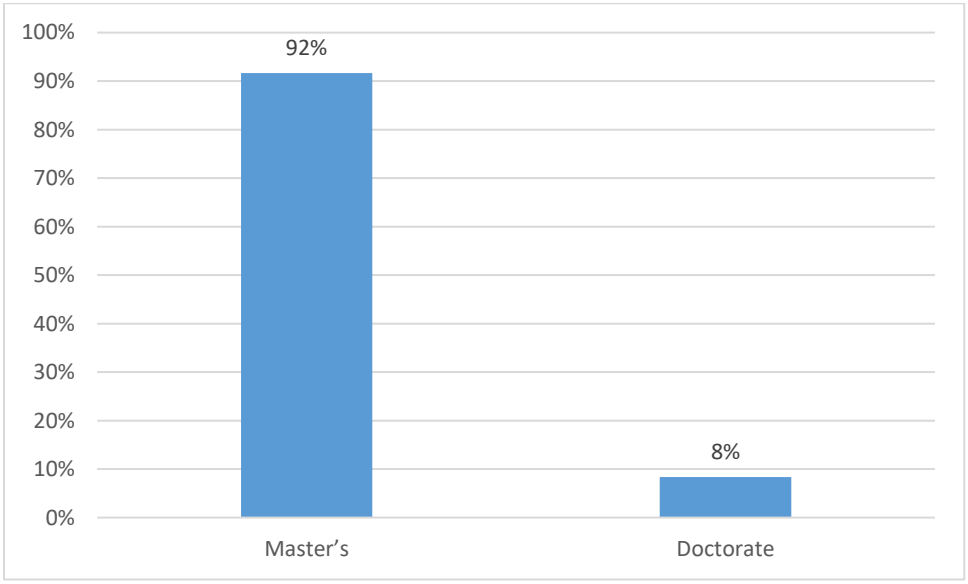
When Figure 3 is examined, it is observed that female authors constitute the majority with 8 theses (67%), while male authors account for 4 theses (33%).

Figure 4. Distribution of Thesis Advisors by Academic Title



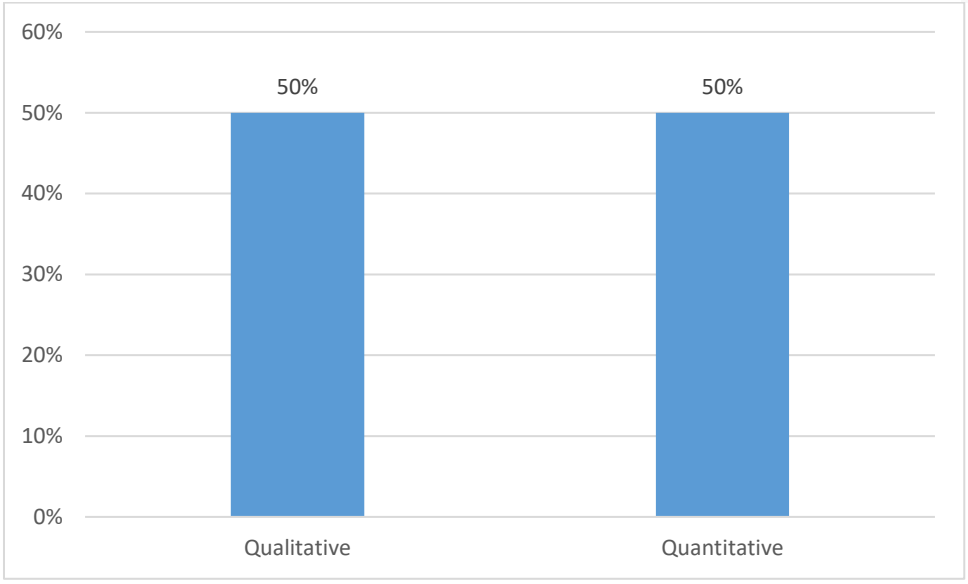
When Figure 4 is examined, it is seen that thesis advisors most commonly hold the title of Associate Professor (Assoc. Prof. Dr.), with 6 theses supervised (50%). This is followed by Assistant Professors (Assist. Prof. Dr.) and Professors (Prof. Dr.), each supervising 3 theses (25%). This distribution indicates that advisory roles in digital entrepreneurship studies are predominantly undertaken by mid-career academics.

Figure 5. Distribution of Theses by Type of Degree



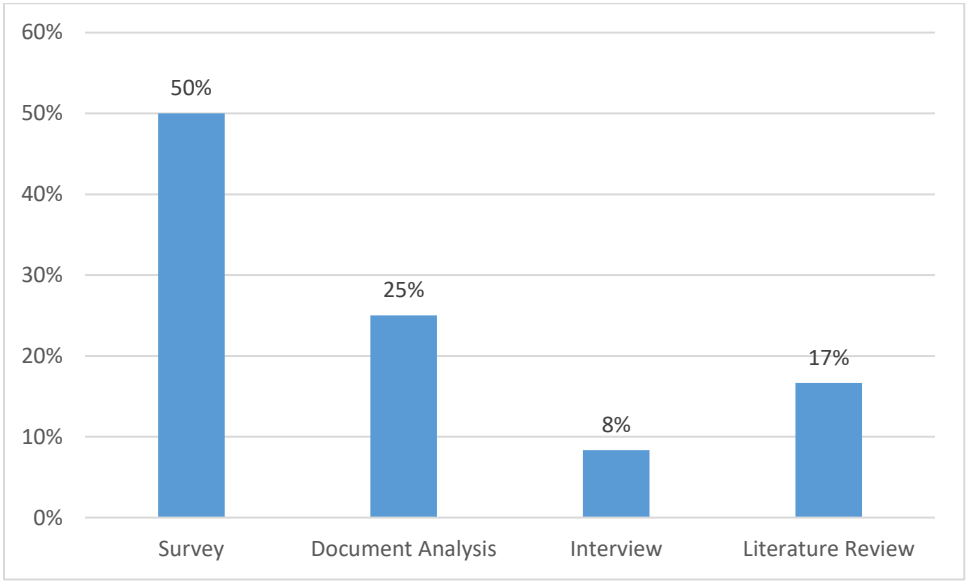
When Figure 5 is examined, the distribution of theses by degree level shows that master's theses constitute the vast majority with 11 theses (92%), while doctoral dissertations account for only 1 thesis (8%).

Figure 6. Distribution of Theses by Research Method



When Figure 6 is examined, it is observed that the theses are evenly distributed in terms of research methodology: 6 qualitative studies (50%) and 6 quantitative studies (50%). This balanced structure suggests that digital entrepreneurship research in graduate theses does not lean towards a single dominant methodological preference, and instead reflects a dual orientation toward both qualitative and quantitative approaches.

Figure 7. Distribution of Theses by Data Collection Technique



When Figure 7 is examined, the distribution of theses according to data collection techniques reveals that surveys are the most commonly employed method, used in 6 studies (50%). This is followed by document analysis in 3 theses (25%), while literature review appears in 2 theses (17%), and interview-based studies constitute the smallest share with 1 thesis (8%).

Table 3. Theses Containing the Term Digital Entrepreneurship in the Title

1. Thesis Title	E-Commerce Practices in Entrepreneurial Activities: Innovation and Digital Entrepreneurship
Year	2018
Academic Department	Department of Business Administration

Thesis Type	Master's Thesis
University	Istanbul Gelisim University
Method	Quantitative

This thesis was prepared with the aim of understanding the new dimension entrepreneurship has gained through the process of digital transformation and examining how e-commerce practices, together with innovation, affect contemporary entrepreneurial structures. The main focus of the study is how technological developments have changed business formation processes, the reasons behind the emergence of digital entrepreneurship, the impact of e-commerce on market structure, and the determining role of innovation in entrepreneurial success. Within the scope of the thesis, the economic, social, and technological dimensions of the concept of entrepreneurship are explained; it is revealed that with digitalization, speed, accessibility, low cost, and the advantage of entering the global market have become prominent in entrepreneurship. The research method is based on a survey conducted with individuals participating in entrepreneurship training programs. The entrepreneurial characteristics of the participants, their level of information technology use, and their innovation tendencies were measured, and the relationship between variables was analyzed. The findings show that increased technology use strengthens digital entrepreneurship capacity, and the ability to innovate is a key factor directly affecting entrepreneurial success. In addition, a positive relationship was found between the personal characteristics of participants and their innovation abilities, and it was determined that digital entrepreneurship potential is more pronounced among individuals with high adaptation to technology. As a result, the thesis reveals that digital entrepreneurship has become one of the driving forces of the modern economy and that e-commerce stands at the center of this transformation. It is observed that when information technologies, internet access, and innovative thinking are combined, entrepreneurial activities can reach large audiences, marketing and sales processes accelerate, and new competitive fields emerge for businesses. It is concluded that Türkiye has significant growth potential in terms of digital entrepreneurship, and that with the development of legal and technological infrastructure, a stronger ecosystem may emerge in this field (Özeroğlu, 2018). (Özeroğlu, 2018).

Table 4. Theses Containing the Term Digital Entrepreneurship in the Title

2. Thesis Title	Digital Entrepreneurship and the Role of Blockchain Technologies: A Model Proposal for a Blockchain-Based Second-Hand Vehicle Trading Platform (Sechandchain)
Year	2020
Academic Department	Department of Business Management
Thesis Type	Master's Thesis
University	Istanbul Medipol University
Method	Qualitative

This thesis aims to make sense of the phenomenon of digital entrepreneurship, which has emerged as a result of the transformation of economic and commercial structures by digital technologies, and to explain the effect of e-commerce and innovation on entrepreneurial processes. The main focus of the research is to identify how digital ventures differ from traditional entrepreneurship, the role of information technologies in entrepreneurial success, and the power of innovation in creating competitive advantage. By examining studies in the literature, it is concluded that digital ventures have rapidly gained importance due to their wide accessibility, low-cost market creation capacity, and innovation potential. In the study, literature review and document analysis were used as the research method, and theoretical approaches were compared to evaluate how digital entrepreneurship and blockchain systems may shape future entrepreneurial models. Findings obtained from digital entrepreneurship research indicate that ventures have stronger growth potential due to high connectivity and market diversity,

while innovation is essential for sustainable competition. The overall conclusion of the thesis is that digital entrepreneurship lies at the center of the new economic order and will become even more widespread in the future. Based on the evaluations, the likelihood of success significantly increases for entrepreneurs who can utilize information technologies, innovation, and digital market structures (Yener, 2020).

Table 5. Theses Containing the Term Digital Entrepreneurship in the Title

3. Thesis Title	Social Media and Social Networks' Impact on Digital Entrepreneurship
Year	2021
Academic Department	Department of Entrepreneurship
Thesis Type	Master's Thesis
University	Karabük University
Method	Qualitative

This thesis aims to examine the impact of social media and social networks on digital entrepreneurship activities. The subject of the study concerns the transformation of entrepreneurship alongside the digitalizing economy, the new marketing and interaction opportunities that social media offers to businesses, and the reflection of these developments on entrepreneurial success. The research is exploratory in nature, and documentary review along with literature analysis were used as the research methods. The data collection technique is based on the examination of existing academic studies, reports, and digital economy sources. No new field data were collected, and the study consists of theoretical evaluations. The findings indicate that social media is an important tool in digital entrepreneurship and that it enhances marketing processes, brand promotion, customer management, and sales activities. Social networks enable entrepreneurs to gain competitive advantage, achieve faster visibility, and easily reach target markets. As a result, the study reveals that social media is a fundamental element supporting digital entrepreneurship and significantly transforms entrepreneurial processes (Shiva, 2021).

Tablo 6. Theses Containing the Term Digital Entrepreneurship in the Title

4. Thesis Title	Entrepreneurship Education, Digital Literacy Skills and Individual Innovativeness: The Effect on Open Education Tourism Students' Digital Entrepreneurship Tendencies
Year	2022
Academic Department	Department of Tourism Management
Thesis Type	Master's Thesis
University	Anadolu University
Method	Quantitative

This study aims to determine the digital entrepreneurship tendencies of tourism students and to examine the relationship between these tendencies and digital literacy, entrepreneurship education, and individual innovativeness levels. The digitalizing economic structure is transforming the understanding of entrepreneurship, and as online platforms create new business models, the adaptation of young people to this system becomes increasingly important. The focus of the thesis is how this transformation is

reflected among tourism students. The research was conducted using a quantitative method, and a survey was employed as the data collection tool. The study population consists of tourism students enrolled in Anadolu University's Open Education System. Reliability and validity analyses of the scales were performed, and the data were evaluated through confirmatory factor analysis and hypothesis testing. The findings reveal that students' digital literacy levels are moderate and that those who have received entrepreneurship education demonstrate higher levels of digital entrepreneurship tendency. In addition, a positive relationship was found between individual innovativeness and digital entrepreneurship, indicating that innovative students are more inclined toward digital entrepreneurial ideas. In conclusion, digital entrepreneurship is a competence that is open to development and needs support within the field of tourism. This thesis provides a significant data foundation regarding entrepreneurial behavior among tourism students and establishes a basis for future research (Zeynalov, 2022).

Table 7. Theses Containing the Term Digital Entrepreneurship in the Title

5. Thesis Title	Students' Digital Entrepreneurship Intention, Digital Literacy, and Perception of Unemployment Anxiety
Year	2023
Academic Department	Department of Labour Economics and Industrial Relations
Thesis Type	Master's Thesis
University	Trakya University
Method	Quantitative

This thesis aims to determine how unemployment anxiety, digital entrepreneurship tendencies, and digital literacy perceptions of Trakya University students differ according to various demographic variables. The main focus of the study is to reveal whether young people experience job-related anxiety while simultaneously possessing entrepreneurial potential in the era of digital transformation, and to examine the relationship of both situations with digital literacy levels. The research is based on a quantitative method, and a survey form was used as the data collection tool. The scales were prepared in a five-point Likert format and included items related to demographic characteristics, unemployment anxiety, digital literacy, and digital entrepreneurship intention. The sample was determined using purposive sampling, and the data obtained from 1,320 valid questionnaires were analyzed using SPSS. The findings indicate that students generally have moderate digital literacy skills, that digital entrepreneurship intention differs significantly based on certain demographic variables, and that individual innovativeness is an important factor that increases entrepreneurial inclination. Additionally, high levels of unemployment anxiety were detected among specific groups of students. In conclusion, the study demonstrates that digital entrepreneurship intention is an emerging and important competence among young individuals, and that educational practices supporting digital literacy and innovative thinking should be encouraged to strengthen this intention. This thesis contributes to understanding university students' digital entrepreneurship potential and serves as a reference for future research (Sedesçi, 2023).

Table 8. Theses Containing the Term Digital Entrepreneurship in the Title

6. Thesis Title	Digital Entrepreneurship Perspective on Influencer Marketing
Year	2023
Academic Department	Department of International Trade and Logistics

Thesis Type	Master's Thesis
University	KTO Karatay University
Method	Qualitative

This thesis aims to examine influencer marketing from the perspective of digital entrepreneurship, based on the transformations generated by digitalization in the fields of entrepreneurship and marketing. With the advancement of information technologies following the Industrial Revolution and the acceleration of digitalization with Industry 4.0, marketing strategies of enterprises have evolved, making social media a new commercial space for entrepreneurs. Within this environment, influencer marketing, known as a form of influential person–based promotion, has emerged as a powerful digital entrepreneurship tool that enables brands to reach consumers more rapidly. The research method of the study is qualitative and based on documentary review. Existing resources, documents, and theoretical knowledge in the literature were analyzed, and the phenomenon of influencer marketing was conceptually addressed within the framework of digital entrepreneurship. According to the findings, influencer marketing increases brand awareness, reduces advertising costs, and provides direct access to target audiences. Additionally, it enhances brand loyalty and consumer trust, which are highlighted as major competitive advantages. For businesses, influencer collaborations are evaluated as an innovative and sustainable marketing model within digital entrepreneurship. In conclusion, the thesis reveals that influencer marketing holds strategic value in the field of digital entrepreneurship, offering brands a cost-effective, rapid, and wide-reaching digital marketing method (Bilgin, 2023).

Table 9. Theses Containing the Term Digital Entrepreneurship in the Title

7. Thesis Title	Rising Value: Digital Entrepreneurship – A Comparison of Selected European Union Countries and Türkiye
Year	2023
Academic Department	Department of Labour Economics and Industrial Relations
Thesis Type	Master's Thesis
University	Bursa Uludağ University
Method	Qualitative

This thesis addresses the concept of digital entrepreneurship—which has gained importance with the acceleration of digitalization—in terms of economic growth, innovation, competitiveness, and employment generation. It discusses in detail how digital entrepreneurship differs from traditional entrepreneurship, how it creates value within the digital economy, and how it generates new market opportunities. The purpose of the study is to analyze the current state of digital entrepreneurship in EU countries and Türkiye and to comparatively evaluate their levels of development. The method of the thesis is literature-based, and national and international academic publications, reports, official indicators, and policy documents were examined. At the country level, the digital entrepreneurship ecosystem was compared through economic data, innovation indexes, digital market structures, incentive programs, and entrepreneurship policies. The findings indicate that the digital entrepreneurship ecosystem in EU countries is more advanced in terms of policy support, funding mechanisms, and innovation culture, while Türkiye offers significant opportunities due to its large youth population, digital market capacity, and entrepreneurial potential. However, it is emphasized that in order to increase Türkiye's competitive strength, R&D investments must be reinforced, educational and digital competency programs should be expanded, and entrepreneurship financing needs to be supported. In conclusion, the study reveals that digital entrepreneurship is emerging as one of the

economic growth engines of the future and that, with the right strategies, it can provide significant growth advantages for Türkiye (Yaşa, 2023).

Table 10. Theses Containing the Term Digital Entrepreneurship in the Title

8. Thesis Title	Digital Entrepreneurship as an Example: Social Media Content Creators and Taxation
Year	2024
Academic Department	Department of Business Administration
Thesis Type	Master's Thesis
University	Kırıkkale University
Method	Qualitative

This thesis examines the position of social media content creators—one of the new entrepreneurship types emerging with digitalization—within the framework of digital entrepreneurship, as well as the taxation of their income. The transformation of the internet and social media platforms into marketing spaces has enabled content creators to generate income, which in turn has created new tax liability issues for both businesses and governments. The aim of the study is to explain how the income of social media content creators is taxed in Türkiye and globally, and to reveal the difficulties encountered in current taxation regulations. The research was conducted using the literature review method, and national and international sources concerning digital entrepreneurship, the social media economic model, income formation, and tax legislation were examined. In particular, the 15% withholding tax applied to social media earnings under the regulations implemented in Türkiye in 2022 was evaluated. The findings show that there is no common international standard for the taxation of social media income and that legal gaps lead to revenue loss. In the case of Türkiye, although tax definitions have become clearer, problems persist in practice regarding monitoring, informality, and income reporting. In conclusion, the thesis emphasizes that the economic presence of digital content creators is becoming increasingly stronger, yet tax policy is unable to progress as rapidly as the evolving digital dynamics. As a solution, it recommends increasing tax awareness, updating legislation, and strengthening national and international integration (Tekin, 2024).

Table 11. Theses Containing the Term Digital Entrepreneurship in the Title

9. Thesis Title	Investigating Business Formation Processes in Digital Entrepreneurship: An Exploratory Field Study
Year	2025
Academic Department	Department of Entrepreneurship
Thesis Type	Master's Thesis
University	Karabük University
Method	Qualitative

This thesis examines the new business models emerging in the field of entrepreneurship as a result of digital transformation and aims to understand the business formation processes of digital entrepreneurs in a comprehensive manner. The subject of the study includes the concept of digital entrepreneurship, business start-up stages, entrepreneurial motivations, opportunity discovery, digital product/service

development, and marketing approaches. How elements such as low cost, speed, and technology-based scalability in digital entrepreneurship are reflected in business formation behavior constitutes the core of the research. The study was designed as a qualitative field research and conducted using semi-structured interview techniques. Interviews were held with a total of 10 digital entrepreneurs, and data were collected on digital marketing activities, opportunity discovery experiences, competitive strategies, revenue models, and business formation steps. This exploratory research aims to provide a foundation for larger-scale future studies. According to the findings, opportunity discovery, developing original ideas, actively using social media and digital marketing channels, pursuing innovation, and taking advantage of rapid scalability come to the forefront in the business formation process of digital entrepreneurs. Participants emphasized that the ability to start a business at low cost and reach large audiences in a short time is a significant advantage in digital entrepreneurship. However, intense market competition, difficulty in reaching the right target audience, and challenges in making the business model sustainable stand out as key obstacles. Overall, the thesis concludes that digital entrepreneurship is more flexible, faster, low-cost, and opportunity-oriented compared to traditional entrepreneurship. The study reveals that factors such as identifying the target audience correctly, using effective digital marketing strategies, developing innovations that differentiate from competition, and conducting analytical measurement are determinative for successful digital entrepreneurship. The research also forms an important foundation for future studies with broader samples (Khalilov, 2025).

Table 12. Theses Containing the Term Digital Entrepreneurship in the Title

10. Thesis Title	Analysis of the Relationships Between University Students' Attitudes Toward Digital Technologies, Digital Entrepreneurship Intention, and Motivation for Access to Digital Technologies
Year	2025
Academic Department	Department of Business Administration
Thesis Type	Master's Thesis
University	Bitlis Eren University
Method	Quantitative

This thesis focuses on determining university students' digital entrepreneurship tendencies and examining the relationship of these tendencies with digital literacy, entrepreneurship education, and individual innovativeness. The main aim of the research is to reveal the interaction between motivation to access digital technologies, interest in digital technologies, digital competence, and digital entrepreneurship intention, and to test how these variables influence one another. A quantitative method was employed, adopting a causal research design. A questionnaire was used as the data collection tool. The hypotheses developed within the study were tested using a structural model. The findings were evaluated through hypothesis tests and structural equation modeling, and data analysis was carried out using SPSS. According to the results obtained, all hypotheses were supported. It was determined that motivation for access to digital technologies had a significant effect on interest, competence, and digital entrepreneurship intention; interest in technology increased competence; and digital competence heightened digital entrepreneurship intention. Additionally, the mediating effects of interest and competence were confirmed. The results of the study indicate that digital technologies play a decisive role in the entrepreneurial future of university students. Increased technology access and interest were shown to motivate individuals toward digital entrepreneurship. Supporting digital skill development and entrepreneurship education enhances students' potential for venture creation (Çelik, 2025).

Table 13. Theses Containing the Term Digital Entrepreneurship in the Title

11. Thesis Title	Digital Entrepreneurship Awareness Level of the Big Five Personality Traits Taxonomy: An Attitude Study on University Students
Year	2025
Academic Department	Department of Business Administration
Thesis Type	Master's Thesis
University	Karamanoğlu Mehmetbey University
Method	Quantitative

This study aims to examine university students' digital entrepreneurship tendencies and the determinants of these tendencies, based on the new forms of entrepreneurship that have emerged through digitalization. The subject of the thesis is how digital technologies influence business formation behavior, the skills and motivational factors digital entrepreneurs possess, and the potential demonstrated by the young population in this field. The concept of entrepreneurship is discussed within a historical framework, and the entrepreneurship ecosystem, entrepreneurial behaviors, and opportunity creation processes are explained conceptually. A quantitative method was used in the research, and a questionnaire was applied during data collection to measure students' digital entrepreneurship tendencies, technology use, and digital awareness levels. The data were analyzed using SPSS. The scales were evaluated through variables such as entrepreneurial approach, perception of digital competence, and entrepreneurial intention, and interpreted through descriptive statistics and comparison tests. The findings indicate that the majority of students have high awareness of digital tools, are willing to engage in entrepreneurship, but decision-making processes are limited by factors such as lack of knowledge and experience, access to financing, and risk perception. Digital entrepreneurship intention was found to increase in parallel with technology use level and digital skill development. University students evaluated the ability to establish a business at low cost, offer products/services through social media, and access online markets as important advantages. In conclusion, the thesis reveals that digital entrepreneurship is a rapidly growing trend among the young population and that the digital entrepreneurship ecosystem in Türkiye holds significant opportunities for students. The study concludes with recommendations to strengthen entrepreneurship education, expand digital skill programs, and increase practical entrepreneurship support within universities (Kötemen, 2025).

Table 14. Theses Containing the Term Digital Entrepreneurship in the Title

12. Thesis Title	The Effect of Entrepreneurial Personality Traits and Digital Competence Level on Digital Entrepreneurship Intention: A Study on Associate Degree Students in Public and Foundation Universities in Mersin
Year	2025
Academic Department	Department of Business Administration
Thesis Type	Doctoral Dissertation
University	Mersin University
Method	Quantitative

This thesis examines the effect of entrepreneurial personality traits and digital competence levels on the digital entrepreneurship intentions of associate degree students studying at public and foundation universities in Türkiye. The main purpose of the study is to determine whether the personality

characteristics and digital competences of these Generation Z students significantly explain their intention to engage in digital entrepreneurship. The research was designed as a quantitative study based on a relational screening model, and a questionnaire consisting of entrepreneurial personality, digital competence, and digital entrepreneurship intention scales was used as the data collection tool. The sample consists of 1,477 associate degree students, formed after eliminating incomplete responses from the 1,500 questionnaires administered—some delivered online via Google Forms and others collected through the paper-based drop-and-collect method. The data were analyzed using IBM SPSS for descriptive statistics and preliminary analyses, and LISREL for confirmatory factor analyses, measurement model testing, path analysis, and structural equation modeling (SEM). The findings generally show that entrepreneurial personality traits and digital competence have significant and positive effects on digital entrepreneurship intention, and that the proposed theoretical model is largely validated for both public and foundation university samples. Limited variations in levels and relationships were identified depending on university type, field of study, and certain demographic characteristics. In conclusion, the study suggests that to strengthen the digital entrepreneurship intentions of associate degree students, entrepreneurship education, digital competence development programs, and university policies should be restructured in line with these findings (Pekduyurucu, 2025).

CONCLUSION

In this study, the aim was to reveal the current state of postgraduate research on digital entrepreneurship in Türkiye and to describe its conceptual orientations, methodological preferences, and thematic concentrations. A total of 12 theses accessed through YÖKTEZ using only the keyword “digital entrepreneurship” were examined in depth, and a detailed analysis was conducted based on year of publication, department, research method, data collection technique, author gender, advisor title, thesis language, university, and thesis type. Overall, the findings indicate that there is a steadily increasing academic interest in digital entrepreneurship at the postgraduate level in Türkiye. While only one thesis was produced in 2018, the notable rise observed in 2023 and especially in 2025 suggests that universities and researchers have increasingly turned toward new entrepreneurial models shaped by the digital economy. This aligns with global literature emphasizing that digitalization reshapes economic, cultural, and social structures, thereby transforming entrepreneurial paradigms. Another significant result of the study is that all theses were written in Turkish. This demonstrates the presence of an active national research environment while simultaneously highlighting certain limitations regarding international visibility and academic exchange. The disciplinary distribution reveals that most theses are concentrated in the fields of business and entrepreneurship, followed by labour economics, tourism, international trade, economics, and logistics. This suggests that the concept is primarily examined within an economic framework, yet it also signals considerable potential for future interdisciplinary expansion. Given that digital entrepreneurship encompasses sociological, communicative, cultural, and legal dimensions in addition to its economic outcomes, the development of interdisciplinary approaches is essential for the maturation of the field.

Another noteworthy finding is the balanced distribution between qualitative and quantitative research designs. However, survey-based methods were found to be dominant, while interview-based and in-depth qualitative studies were less common. This indicates that the field is still in an exploratory phase and that literature would benefit from more qualitative, field-oriented, and project-based research that offers deeper empirical insight. Analysis of the thematic focus areas reveals recurring topics such as social media, digital literacy, innovativeness, influencer marketing, content creation, digital marketing, unemployment anxiety, and personality traits. This illustrates that digital entrepreneurship extends beyond purely economic boundaries and increasingly intersects with youth culture, employment, communication behavior, and the social economy. The findings highlight that although young populations possess entrepreneurial potential through digital platforms, they also face challenges including lack of knowledge, limited access to financing, regulatory issues, and market competition. Consequently, the results point to the need for educational policies and public support programs that strengthen digital literacy, technological competence, and innovative thinking.

In summary, this study provides a meta-level perspective on the digital entrepreneurship literature and makes visible the direction, intensity, and developmental needs of academic production in Türkiye. Digital entrepreneurship is emerging as a rapidly expanding and strategically significant field of inquiry. By recording the current state of the literature, this research establishes a foundational reference for future interdisciplinary studies. The findings also offer guidance for the development of both scholarly research and applied entrepreneurship policies. In a period marked by accelerating digital transformation, initiatives that support innovation, encourage technology creation, and strengthen the entrepreneurial potential of young populations will become key drivers of economic and social change in Türkiye.

REFERENCES

Akarsu, O., & Döven, M. S. (2022). Girişimci ve girişimcilik kavramları üzerine tarihsel bir değerlendirme: Tanımlarda yer alan ortak vurgular. Yorum Yönetim Yöntem Uluslararası Yönetim–Ekonomi ve Felsefe Dergisi, 10(1), 1-24. https://doi.org/10.32705/yorumyonetim.1094253

Akpınar, S. (2011). *Girişimciliğin temel bilgileri* (2. Baskı). Umuttepe Yayınları.

Alay, H. K. (2023). Yeni normalin yeni girişimciliği: Dijital girişimcilik. İstanbul Esenyurt Üniversitesi İşletme ve Yönetim Bilimleri Fakültesi Sosyal Bilimler Araştırmaları Dergisi, 3(1), 1-9.

Altıntaş, S., & Barkuş, F. (2023). Dijital ortamlarda kişisel veri güvenliği kavramı üzerine bir derleme çalışması. Ejovoc (Electronic Journal of Vocational Colleges), 13(1), 46-69. https://doi.org/10.17339/ejovoc.1311027

Arıkan, S. (2004). *Girişimcilik: Temel kavramlar ve bazı güncel konular* (Genişletilmiş 2. Baskı). Siyasal Kitabevi.

Bilgiç, Ö. E., & Göktaş, P. (2024). Dijital girişimciliğin yetkinlik ve becerileri üzerine nitel bir araştırma: Start-up okulu örneği. Süleyman Demirel Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, (49), 227-265. https://doi.org/10.61904/sbe.1490995

Bilgin, B. (2023). *Dijital girişimcilik perspektifinden influencer marketing* (Yüksek Lisans Tezi). KTO Karatay Üniversitesi, Lisansüstü Eğitim Enstitüsü, Uluslararası Ticaret ve Lojistik Anabilim Dalı, Uluslararası Ticaret Tezli Yüksek Lisans Programı, Konya.

Boz, N., & Serinkan, C. (2022). Türkiye'de dijital girişimcilik ve KOBİ'ler. Girişimcilik İnovasyon ve Pazarlama Araştırmaları Dergisi, 6(12), 102-117. https://doi.org/10.31006/gipad.1204002

Bozkurt, Ö. Ç., & Alparslan, A. M. (2013). Girişimcilerde bulunması gereken özellikler ile girişimcilik eğitimi: Girişimci ve öğrenci görüşleri. Girişimcilik ve Kalkınma Dergisi, 8(1), 7-28.

Çelik, D. (2025). *Üniversite öğrencilerinin dijital teknolojilere yönelik tutum, dijital girişimcilik niyeti ve dijital teknolojilere erişim motivasyonları arasındaki ilişkilerin incelenmesi* (Yüksek Lisans Tezi). Bitlis Eren Üniversitesi, Lisansüstü Eğitim Enstitüsü, İşletme Anabilim Dalı, Bitlis

Çevik Tekin, İ., & Küsbeci, P. (2021). Dijital dönüşüm sürecinde yükselen bir değer: Dijital girişimcilik. Stratejik Yönetim Araştırmaları Dergisi, 4(1), 81-102.

Dinçay, İ. H. (2024). Girişimcilik ve girişimcilik kültürünün Türkiye'de tarihsel gelişim çizgisi üzerine bir inceleme. İstanbul Gelişim Üniversitesi Sosyal Bilimler Dergisi, 11(2), 614-631. https://doi.org/10.17336/igusbd.1202152

Dolgun, U. (2003). Girişimcilik. Alfa Basın Yayın Dağıtım.

Eyel, C. Ş., & Sağlam, H. (2021). Dijital dönüşüm ve girişimcilikteki değişim: Dijital girişimcilik. Atlas Sosyal Bilimler Dergisi, 1(6), 7-20.

Güğerçin, S., & Onan, G. (2021). Digital entrepreneurship: A literature review. European Journal of Managerial Research (EUJMR), 5(9), 291-305.

Güney, S. (2008). Girişimcilik temel kavramlar ve bazı güncel konular. Siyasal Kitabevi.

Khalilov, A. (2025). Dijital girişimcilikte iş kurma süreçlerinin araştırılması: Keşifsel bir alan çalışması (Yüksek Lisans Tezi). Karabük Üniversitesi, Lisansüstü Eğitim Enstitüsü, Girişimcilik Anabilim Dalı, Karabük.

Kötemen, A. (2025). Beş büyük kişilik özellikleri taksonomisinin dijital girişimcilik farkındalık düzeyi: Üniversite öğrencilerine yönelik bir tutum araştırması (Yüksek Lisans Tezi). Karamanoğlu Mehmetbey Üniversitesi, Sosyal Bilimler Enstitüsü, İşletme Anabilim Dalı, Karaman.

Kurt, A. S. (2020). Dijital dönüşümün ekonomiye etkileri: Türkiye ekonomisi'ne yansımaları. OPUS International Journal of Society Researches, 16(30), 3083-3109. https://doi.org/10.26466/opus.714393

Özeroğlu, A. C. (2018). Girişimcilik faaliyetlerinde e-ticaret uygulamaları: İnovasyon ve dijital girişimcilik (Yüksek Lisans Tezi). İstanbul Gelişim Üniversitesi, Sosyal Bilimler Enstitüsü, İşletme Anabilim Dalı, İstanbul.

Pekduyurucu, B. (2025). Girişimci kişilik özelliklerinin ve dijital yetkinlik düzeyinin dijital girişimcilik niyeti üzerindeki etkisi: Mersin'deki devlet ve vakıf üniversitelerinin önlisans öğrencileri üzerine bir araştırma (Doktora Tezi). Mersin Üniversitesi, Sosyal Bilimler Enstitüsü, İşletme Anabilim Dalı, Mersin.

Sedesçi, S. (2023). Öğrencilerin dijital girişimcilik niyeti, dijital okuryazarlık ve işsizlik kaygısı algısı (Yüksek Lisans Tezi). Trakya Üniversitesi, Sosyal Bilimler Enstitüsü, Çalışma Ekonomisi ve Endüstri İlişkileri Anabilim Dalı, Edirne.

Shiva, B. A. (2021). Sosyal medyanın ve sosyal ağların dijital girişimcilik üzerine etkisi (Yüksek Lisans Tezi). Karabük Üniversitesi, Lisansüstü Eğitim Enstitüsü, Girişimcilik Anabilim Dalı, Karabük.

Tekin, Ç. (2024). Dijital girişimcilik örneği olarak sosyal medya içerik üreticileri ve vergilendirilmesi (Yüksek Lisans Tezi). Kırıkkale Üniversitesi, Sosyal Bilimler Enstitüsü, İşletme Anabilim Dalı, Kırıkkale.

Yaşa, P. (2023). Yükselen değer dijital girişimcilik: Seçilmiş Avrupa Birliği ülkeleri ve Türkiye karşılaştırması (Yüksek Lisans Tezi). Bursa Uludağ Üniversitesi, Sosyal Bilimler Enstitüsü, Çalışma Ekonomisi ve Endüstri İlişkileri Anabilim Dalı, Bursa.

Yener, E. (2020). Dijital girişimcilikte blok zincir teknolojilerinin rolü ve bir model önerisi: Blok zincir tabanlı ikinci el araç alım satım platformu (Sechandchain) (Yüksek Lisans Tezi). İstanbul Medipol Üniversitesi, Sosyal Bilimler Enstitüsü, Tezli İşletme Yüksek Lisans Programı, İstanbul.

Zeynalov, S. (2022). Girişimcilik eğitimi, dijital okuryazarlık becerileri ve bireysel yenilikçiliğin açık öğretim turizm öğrencilerinin dijital girişimcilik eğilimlerine etkisi (Yüksek Lisans Tezi). Anadolu Üniversitesi, Sosyal Bilimler Enstitüsü, Turizm İşletmeciliği Anabilim Dalı, Eskişehir.

AFETLERİN GASTRONOMİ SEKTÖRÜNE ETKİSİ: DERLEME ÇALIŞMASI

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ÖZET

Tarihsel süreç boyunca küresel ölçekte yüksek yıkıcılığa sahip çeşitli afet türleri ortaya çıkmış olup bu afetler temel olarak doğal ve insan kaynaklı afetler şeklinde sınıflandırılmaktadır. Söz konusu afetlerin etkileri etkin biçimde yönetilemediğinde, geniş çaplı fiziksel, sosyal ve ekonomik tahribatların oluşmaktadır. Afet ve kriz durumlarında arama-kurtarma çalışmalarını izleyen aşamada ortaya çıkan ilk ve en kritik gereksinimler sağlık hizmetleri ile beslenmeye yönelmekte; bu durum gıda temininin afet yönetimindeki stratejik önemini açıkça ortaya koymaktadır. Bu bağlamda bir kentin gastronomik kapasitesi, toplu beslenme faaliyetlerinin hızlı ve güvenli biçimde yürütülmesi açısından belirleyici bir unsur hâline gelmektedir. Bununla birlikte afetlerin gastronomi sektörüne olan doğrudan ve dolaylı etkileri, özellikle gıda üretimi, tedarik zinciri ve tüketim alışkanlıkları boyutlarında önemli sonuçlar doğurmaktadır. Bu nedenle afet öncesine yönelik planlama, senaryo geliştirme ve koordinasyon çalışmaları, gıda temininin kesintisiz sürdürülebilmesi için temel bir gereklilik olarak karşımıza çıkmaktadır. Bu çalışma, afetlerin gastronomi sektörüne etkilerini incelemek amacıyla derleme yöntemiyle hazırlanmıştır. Literatürde yer alan çalışmalar değerlendirilerek afetlerin işletmelerdeki tedarik zinciri üzerindeki etkileri, afet sonrası oluşan koşullar ve ekonomik toparlanmayı desteklemeye yönelik stratejik yaklaşımlar ele alınmıştır. Derlenen bulgular doğrultusunda afet sonrası süreçlerde işletmelerin çok yönlü sorunlarla karşılaştığını; müşteri ve turizm hareketliliğinde dalgalanma, tedarik zincirine ilişkin aksaklıklar, altyapı yetersizlikleri ile hizmet kalitesi ve iş gücü kapasitesinde dalgalanma gibi çeşitli etkilerin ortaya çıktığı görülmektedir. Gastronomi işletmelerinin uygun konumlara yerleştirilmesi, tedarik zincirinin güçlendirilmesi ve kalifiye iş gücünün desteklenmesi, afet sonrası sektörlerin yaşadığı temel sorunların azaltılmasına katkı sağlayacağı düşünülmektedir. Bu düzenlemelerin hayata geçirilmesiyle maliyetlerin düşeceği, hizmet kalitesinin artacağı ve şehirdeki gastronomi yaşamının yeniden canlanacağına destek sağlayacağı öngörülmektedir.

Anahtar Kelimeler: Afet, Gastronomi, Afet etkisi, Afet Yönetimi

ABSTRACT

Throughout history, various types of disasters with high destructive power have emerged on a global scale, and these disasters are primarily classified as either natural or artificial. When the effects of these disasters cannot be effectively managed, widespread physical, social, and economic damage occurs. In the phase following search and rescue operations during disasters and crises, the first and most critical needs are health services and nutrition; this clearly demonstrates the strategic importance of food supply in disaster management. In this context, a city's gastronomic capacity becomes a decisive factor in the rapid and safe execution of mass feeding activities. However, the direct and indirect effects of disasters on the gastronomy sector have significant consequences, particularly in terms of food production, the supply chain, and consumption habits. Therefore, planning, scenario development, and coordination

efforts before a disaster are essential to ensure the uninterrupted supply of food. This study was prepared using a compilation method to examine the effects of disasters on the gastronomy sector. Studies in the literature were evaluated, addressing the impact of disasters on businesses' supply chains, the conditions that arise after disasters, and strategic approaches to support economic recovery. Based on the findings, it is observed that companies face multifaceted problems in the aftermath of disasters, including fluctuations in customer and tourism activity, disruptions in the supply chain, infrastructure deficiencies, and declines in service quality and workforce capacity. It is believed that placing gastronomy businesses in suitable locations, strengthening the supply chain, and supporting a qualified workforce will contribute to reducing the fundamental problems experienced by sectors after disasters. It is anticipated that implementing these regulations will reduce costs, enhance service quality, and revitalize the city's culinary scene.

Key Words: Disaster, Gastronomy, Disaster impact, Disaster management

1. GİRİŞ

Bir toplum ya da topluluğun işleyişinde can, mal, ekonomik ya da çevresel düzeyde kayıplara neden olan ve söz konusu toplumun mevcut kaynaklarıyla üstesinden gelmekte yetersiz kaldığı olaylar afetler olarak tanımlanmaktadır (UNISDR, 2009). Afet ve Acil Durum Yönetimi Başkanlığı (AFAD) resmi internet kaynağında afetlerin, doğal kaynaklı afetler ve insan kaynaklı afetler olmak üzere iki temel sınıfta ele alındığı belirtilmektedir (AFAD, 2025). Son dönemlerde sıklıkla gündeme gelen afetlerin, toplumsal yapıyı yalnızca fiziksel açıdan değil, aynı zamanda sosyolojik ve psikolojik boyutlarda da etkilediği literatürde ifade edilmektedir (Ergünay, 2009). Çeşitli türleri bulunan afetler arasında, ani gelişen doğal afetlerin en kaçınılmaz olanlar arasında yer aldığı görülmektedir. Zamanı ve konumu önceden kesin olarak belirlenemeyen bu afetler, ani bir şekilde meydana gelerek dünya genelinde önemli düzeyde kayıplara neden olmaktadır (Gökçekuş ve diğerleri, 2018). Afetler; ölüm, yaralanma, barınma kaybı ile enerji, gıda ve su yetersizliği gibi sonuçlara yol açarak küresel ölçekte insan yaşamını etkileyen başlıca sorunlar arasında yer almaktadır. Özellikle ani şekilde gerçekleşen deprem, çığ, sel ve yangın gibi olaylar, insan yaşamının yanı sıra diğer canlıların yaşam koşullarını da önemli ölçüde olumsuz etkilemektedir (Özcan ve Duru, 2021).

Yüksek düzeyde yıkıcılığa sahip afetlerin sonrasında beslenme ve gıda güvenliğine yönelik çeşitli sorunlar ortaya çıkmaktadır. Bu tür acil durumlarda afet mağduru bireylerin temel besin gereksinimlerinin karşılanması ve yetersiz beslenmeye bağlı sağlık risklerinin azaltılması, halk sağlığının sürdürülebilirliği açısından kritik önem taşımaktadır (Aldemir, 2023: 686). Gıda yetersizliğine karşı direnç düzeyi düşük olan ve desteğe ihtiyaç duyan bebekler, hamileler ve yaşlı bireyler, afet sonrası süreçte öncelikli olarak ele alınması gereken risk gruplarını oluşturmaktadır. Bu nedenle afetlerin ardından uygulanacak beslenme yaklaşımlarına yönelik gerekli hazırlıkların önceden yapılması; özel gereksinimler ve mevcut sağlık durumları doğrultusunda diyet amaçlı besinlerin, süt gibi temel içeceklerin ve mama ürünlerinin uygun şekilde stoklanmasını zorunlu kılmaktadır (Özcan ve Duru, 2021).

Afetin kapsamı ve şiddetinin büyüklüğü, kurtarma çalışmalarını önemli ölçüde etkilemiştir. Kurtarma faaliyetlerinin yanı sıra, beslenme zincirinin sağlanması ve barınma olanaklarının oluşturulabilmesi için devlet kurumları ve sivil toplum kuruluşları arasında iş birliği yapılmıştır. Yapılan araştırmalar, afetin akut dönemlerinde kamu kurum ve kuruluşlarının özel sektörle iş birliği yapmalarının gerekli olabileceğini göstermektedir (Quarantelli, 1989).

Bu çalışmanın temel amacı, afetler bağlamında gastronomi sektörünün karşılaştığı sorunları bütüncül bir bakış açısıyla ele almak; özellikle beslenme sistemleri, tedarik zinciri ve işletme sürdürülebilirliği üzerindeki etkileri ortaya koymaktır. Bu doğrultuda çalışma, afet yönetimi literatürü ile gastronomi alanını ilişkilendirerek, afetlerin sektör üzerindeki çok boyutlu etkilerini sistematik biçimde değerlendirmeyi hedeflemektedir. Mevcut literatür incelendiğinde, afet çalışmalarının çoğunlukla arama-kurtarma, barınma ve sağlık hizmetlerine odaklandığı; gastronomi sektörünün ise genellikle dolaylı ve sınırlı biçimde ele alındığı görülmektedir. Bu bağlamda çalışma, gastronomi sektörünü afet

yönetiminin stratejik bir bileşeni olarak konumlandırarak, literatürdeki bu boşluğu doldurmayı ve gelecekte yapılacak araştırmalara kuramsal bir zemin sunmayı amaçlamaktadır.

2. LİTERATÜR TARAMASI

Afet kavramı, literatürde farklı yaklaşımlar doğrultusunda çeşitli biçimlerde tanımlanmaktadır. Bu kapsamda, öncelikle afetin tanımı ve afet türleri ele alınacak ardından doğal afetler ve gastronomi ilişkisi ele alınacaktır.

2.1 Afet Tanımı

Afet, bir toplum ya da topluluğun olağan işleyişini ciddi biçimde sekteye uğratan; etkilenen kesimin kendi kaynak ve kapasitesiyle başa çıkamayacağı ölçüde yaygın maddi, insani, çevresel ve/veya ekonomik kayıplara yol açan durumlar olarak tanımlanmaktadır (WHO, 2015). Günlük yaşamda sıkça karşılaşılan kavramlardan biri olan afet terimi, Türk Dil Kurumu'nun (TDK) tanımına göre çeşitli doğal olayların neden olduğu yıkıcı sonuçları ifade etmektedir (TDK, 2025). İl Afet ve Acil Durum Müdürlüğü'nün (AFAD) resmi internet kaynağında ise toplumun tamamında ya da belirli bir kesiminde fiziksel, ekonomik ve sosyal düzeyde kayıplara yol açan; yaşamın olağan akışını ve insan faaliyetlerini kesintiye uğratan ve toplumun kendi imkânlarıyla başa çıkma kapasitesini aşan doğal, teknolojik ya da insan kaynaklı olaylar afet olarak tanımlanmaktadır (AFAD, 2025).

Afet, çeşitli kurumların iş birliği gerektiren ve insan hakları üzerinde etkileri bulunan olgulardır. Doğal, teknolojik ya da insan kaynaklı biçimlerde ortaya çıkabilen bu olaylar, toplumların düzenli işleyişini kesintiye uğratarak normal yaşam akışını ve insan faaliyetlerini durma noktasına getirebilir. Doğal afetler; deprem, sel ve volkanik patlama gibi doğa olaylarını kapsamaktadır ve bu olayların afet niteliği kazanabilmesi için can ve mal kaybına yol açması gerekmektedir (Erkal ve Değerliyurt, 2011). Afet, insanlar ile onların yaşadıkları çevreye zarar veren çeşitli olayları ifade etmektedir. Kaynağını doğal süreçlerden alan olaylar doğal afet, insan faaliyetlerinden kaynaklananlar ise beşerî afet olarak adlandırılmaktadır (Dikmenli ve Gafa, 2017).

2.2 Afet Türleri

AFAD resmi internet kaynağında afet türleri, doğal kaynaklı afetler ve insan kaynaklı afetler olmak üzere iki temel sınıfta ele alındığı belirtilmektedir. Bu doğrultuda ise doğal afetlerin, yavaş gelişen ve ani gelişen afetler olmak üzere iki alt kategoriye ayrıldığı anlaşılmaktadır. Yavaş gelişen doğal afetler arasında şiddetli soğuklar, kuraklık ve kıtlık gibi süreçlerin yer aldığı görülmektedir. Buna karşılık ani gelişen doğal afetlerin deprem, sel, su taşkınları, toprak kaymaları, kaya düşmeleri, çığ, fırtına, hortum, volkanik faaliyetler ve yangınlar gibi olayları kapsadığı belirlenmiştir. İnsan kaynaklı afetler olarak tanımlanan diğer afet türünde ise nükleer, biyolojik ve kimyasal kazalar ile taşımacılık ve endüstriyel faaliyetlere bağlı kazaların yer aldığı görülmektedir. Ayrıca aşırı kalabalık nedeniyle ortaya çıkan olaylar ile göçmenler ve yerinden edilmiş kişilerle ilişkili durumlardan kaynaklanan kazalar da bu kapsamda değerlendirilmektedir (AFAD, 2025).

AFAD tarafından 2025 yılında yayımlanan rapora göre 2024 yılında Türkiye'de meydana gelen doğal afetlerle ilgili veriler Afet Yönetim ve Karar Destek Sistemi'nden (AYDES) derlenmiştir. Söz konusu verilere göre; yıl içerisinde 83 çığ–aşırı kar ve tipi olayı, 194 adet (4.0 ve üzeri büyüklükte) deprem, 332 heyelan, 5.321 orman yangını, 19 maden kazası ve 1.818 su baskını olayı gerçekleşmiştir. Bu afet türlerinin toplam sayısı 7.767 olarak kaydedilmiştir (AFAD, 2025).

2.2.1 Deprem

Yer kabuğunda meydana gelen kırılmaların ürettiği ani titreşimlerin, yayıldıkları ortamı sarsarak ilerlemesi depremlere sebebiyet vermektedir (İşçi, 2008). Deprem, yerkabuğunda biriken enerjinin ani bir şekilde açığa çıkarak yeryüzünde sarsıntı oluşturması biçiminde tanımlanmaktadır. Yer kabuğunda meydana gelen gerilmelerin ise yeraltındaki ısı ve basınç koşullarından kaynaklandığı ifade edilmektedir (Demirtaş ve Erkmen, 2000). Depremler, şiddetli sarsıntılar oluşturarak önemli ölçüde can ve mal kaybına neden olabilmektedir. Ayrıca, zemin özellikleri, odak derinliği ve büyüklük gibi çeşitli değişkenlere bağlı olarak farklı nitelikler sergilemektedir (Arslaner, 2025).

1990–2024 yılları arasında dünya genelinde çeşitli ülkelerde büyük ölçekli depremler meydana gelmiştir. 1990–2024 dönemine ilişkin veriler, en çok deprem sayısının Çin Halk Cumhuriyeti'nde gerçekleştiğini; aynı dönem içerisinde Türkiye'nin ise deprem sıklığı bakımından altıncı sırada yer aldığını göstermektedir (Buccholz, 2024).

Türkiye, Alp–Himalaya deprem kuşağı üzerinde konumlanmış olup bu jeolojik yapı nedeniyle tarih boyunca çeşitli dönemlerde büyük depremlerle karşı karşıya kalmıştır. Ülke topraklarının yaklaşık %92'sinin deprem tehlikesi altında bulunmasına karşın, kentleşme ve sanayileşme süreçlerinde bu riskin yeterince dikkate alınmaması, teknik çalışmaların yetersiz kalması, depreme dayanıklı yapı üretiminde yapılan hatalı uygulamalar ve bilgi eksiklikleri gibi faktörler, depremlerin yol açtığı olumsuz sonuçların azaltılmasını güçleştirmektedir (Demirelli, 2001).

2.2.2 Yangın

Akdeniz iklimi, sıcak ve kurak geçen yaz mevsimi nedeniyle orman yangınlarının ortaya çıkması ve hızla yayılması için elverişli koşullar sunmaktadır. Bu iklimsel özellikler, bitki örtüsünün kurumasına ve yanıcılığının artmasına yol açmaktadır. Türkiye gibi Akdeniz ikliminin etkili olduğu ülkelerde özellikle yaz aylarında orman yangınlarının sıkça görülmesi bu nedenle olağandır. Orman yangınları; insan kaynaklı ihmal ve kasıtlı eylemler ile yıldırım düşmesi ve elektrik hatlarındaki arızalar gibi çeşitli doğal ya da insan kaynaklı etmenlerden kaynaklanabilmektedir (Kaya, 2024).

Türkiye'de özellikle Akdeniz ikliminin hâkim olduğu Akdeniz kıyıları ile Ege Bölgesi'nde orman yangınlarına sıkça rastlanmaktadır. Bu yangınlar çoğunlukla yaz mevsiminde, kuraklık dönemlerinde ortaya çıkmakta ve rüzgârın etkisiyle kısa sürede geniş alanlara yayılabilmektedir. Orman yangınları; ekosistemlere, doğal yaşam alanlarına, tarım arazilerine ve yerleşim bölgelerine önemli düzeyde maddi ve manevi zararlar verebilmektedir. Ayrıca bu yangınlar, çevresel tahribata, hava kirliliğinin artmasına ve iklim değişikliği süreçlerinin hızlanmasına da katkıda bulunmaktadır (Kaya, 2024).

2.2.3 Sel

Sel, suların olağan koşullarda bulunmadığı alanlara doğru yükselmesi veya başka bölgelerden taşarak gelmesi sonucunda genellikle kuru olan alanların suyla kaplanması şeklinde tanımlanmaktadır. Sel felaketi ise su baskınlarının ekonomik, sosyal ve fiziksel kayıplara yol açarak normal yaşamın aksamasına ya da kesintiye uğramasına neden olduğu ve yerel imkânlarla yönetilemeyen olumsuz durumları ifade etmektedir (Kadıoğlu, 2008).

Aşırı yağışlar, kar örtüsünün hızla erimesi, şiddetli fırtınalar ve su seviyelerindeki yükselmeler sonucunda oluşan sel suları; set ve baraj taşmaları, heyelanlar, akarsu yataklarının değişmesi ile kanalizasyon sistemlerinin taşması gibi durumlar, normal koşullarda su altında kalmayan alanların geçici olarak suyla kaplanmasına veya bu bölgelerde su birikmesine yol açabilmektedir (TÜBA, 2011).

2.2.4 Heyelan

Kaya, toprak ya da arazi kütlelerinin; yer çekiminin etkisiyle veya deprem, yoğun yağış gibi dış faktörlerin tetiklemesi sonucunda eğim doğrultusunda gözlemlenebilir biçimde hareket etmesi ya da yer değiştirmesi, toprak kayması olarak tanımlanmaktadır (AFAD, 2025).

Türkiye'de en fazla yağış alan illerden biri olan Trabzon, aynı zamanda heyelanların en sık görüldüğü bölgelerden biridir. Bu bölgede meydana gelen heyelanların büyük çoğunluğu; yüzeysel ve sığ kaymalar ile moloz ve çamur akıntıları şeklinde gerçekleşmektedir (Akçalı, 2011).

2.2.5 Çığ

Çığ, dağlık, engebeli ve eğimli arazilerde, bitki örtüsünün sınırlı veya hiç bulunmadığı bölgelerde vadi yamaçlarında tabakalar hâlinde birikmiş kar kütlesinin; içsel veya dışsal kuvvetlerin ya da her ikisinin birlikte etkisiyle harekete geçmesi sonucunda, büyük bir hızla yamaç aşağı ilerlemesi şeklinde tanımlanmaktadır (Aslan ve Karabay, 2024).

2.3 Doğal Afetler ve Gastronomi İlişkisi

Afetler, gastronomi sektörünü doğrudan etkileyen temel unsurlar arasında yer almakta; afetlerin meydana geldiği kentlerde tarımsal üretim, gıda arzı ve yerel mutfak kültürü üzerinde önemli aksaklıklar ortaya çıkabilmektedir. Uluslararası literatürde, doğal afetlerin gıda tedarik zincirlerini ciddi biçimde bozduğu ve yerel mutfaklarda kullanılan temel girdilerin erişilebilirliğini azalttığı sıklıkla vurgulanmaktadır (Putri ve diğerleri, 2024; Sharmin ve diğerleri, 2024). Deprem sonrası süreçte bireylerin beslenme alışkanlıklarında belirgin değişimlerin ortaya çıktığı; acil durum koşullarında dengeli ve yeterli beslenmenin toplum sağlığının korunması açısından kritik bir öneme sahip olduğu vurgulanmaktadır (Akgöz ve diğerleri, 2023).

Literatürde, Türkiye'de 2023 yılında meydana gelen depremlerin gastronomi sektörü üzerindeki etkilerini çok boyutlu bir perspektifle inceleyen çeşitli çalışmaların bulunduğu görülmektedir. Bu çalışmalar incelendiğinde, Ünüvar ve El (2023) afet sonrası ilk 72 saatin hayati önem taşıdığını, bölgeye yapılan yoğun gıda yardımlarına rağmen koordinasyon eksikliklerinin faaliyetlerin etkinliğini sınırladığını vurgulamaktadır. Benzer şekilde Akgöz ve diğerleri (2023), afet öncesi hazırlık kapsamında acil durum gıda stoklarının oluşturulmasının gerekliliğine dikkat çekmiş; uygulanan beslenme programlarının afetzedelerin sağlık durumunun korunması açısından kritik rol oynadığını ifade etmiştir.

Afetin tüketici davranışları ve turizm üzerindeki yansımalarını ele alan Pehlivan (2023) ise, deprem sonrasında bireylerin çok katlı yapıların zemin katlarındaki gıda işletmelerinden kaçınma davranışı gösterdiğini ve kamuoyundaki hatalı haberlerin Gaziantep gastronomi turizmi üzerinde olumsuz etkiler yarattığını tespit etmiştir. Beyazgül ve Öz (2025) de bu durumu destekleyerek, artan risk algısıyla birlikte yiyecek-içecek sektöründe belirgin yapısal ve işlevsel değişimlerin yaşandığını; sektörün yalnızca kısa vadeli kayıplarla değil, toparlanma sürecinde çözüm bekleyen yapısal sorunlarla da mücadele ettiğini belirtmektedir. Tüm bu verilerin bütüncül bir değerlendirmesi, gastronominin kriz dönemlerinde yalnızca temel beslenme gereksinimlerini karşılayan bir alan olmanın ötesinde, toplumsal dayanışmayı pekiştiren ve bölgesel kalkınma süreçlerini destekleyen stratejik bir sektör olarak öne çıktığını göstermektedir.

3. YÖNTEM

Bu araştırmada, öncelikle konuyla ilişkili ulusal ve uluslararası literatür taranmıştır. Bu literatür taraması, 1989–2025 yılları arasında yayımlanmış tez, makale ve raporları kapsamaktadır. Çalışmada Ulusal Tez Merkezi, TR Dizin, GoogleScholar ve DergiPark veri tabanları kullanılmış; afet, afet ve gastronomi ile afet etkisi anahtar kelimeleri aracılığıyla ayrıntılı ve kapsamlı taramalar gerçekleştirilmiştir. Afetler bağlamında gastronomi sektörüne ilişkin yaklaşımlar analiz edilmiş olup çeşitli kurum raporları ile basın ve yayın kaynaklarından elde edilen veriler derlenmiştir. Disiplinlerarası bir perspektifle yürütülen çalışmada; gastronomi, afet yönetimi ve afetlerin gastronomi sektörüne ilişkisi bir arada ele alınarak çok boyutlu ve bütüncül bir yaklaşım benimsenmiştir.

4. SONUÇ ve ÖNERİLER

Bu araştırma, afetler bağlamında gastronomi sektörünün afet yönetimi içerisindeki yerini ortaya koymak ve sektörün afetlere karşı dayanıklılığının artırılmasına yönelik bir farkındalık oluşturmaktır. Bu doğrultuda derleme yöntemiyle yürütülen araştırmada, literatürde yer alan bulgular değerlendirilmiş ve gastronomi sektörünün beslenme sistemleri, tedarik zinciri ve işletme sürdürülebilirliği açısından afet süreçlerinde stratejik bir öneme sahip olduğu ortaya konulmuştur. Mevcut kaynaklar, gastronomi sektörünün afet yönetimi ve kriz süreçlerinde bütüncül bir yaklaşımla ele alınmasının hem toplumsal beslenme güvenliği hem de sektörün sürdürülebilirliği açısından gerekli olduğunu göstermektedir.

Literatürdeki çalışmalar, gastronomi sektörünün afetlerden hem fiziksel hem de psikososyal açıdan belirgin düzeyde etkilendiğini göstermektedir. Araştırmalar, afet sonrası birçok işletmenin ciddi gelir kaybı yaşadığını, bazı işletmelerin ise faaliyetlerini sürdüremediğini ortaya koymaktadır. Tedarik zincirinde meydana gelen kesintiler, maliyet artışları ve ürün teminindeki güçlükler menü yapısını ve fiyat politikalarını doğrudan etkilemekte; hizmet kalitesi ve operasyonel sürdürülebilirlik üzerinde baskı

oluşturmaktadır. İnsan kaynağına ilişkin ise literatür, kalifiye personel kaybı, göç hareketliliği ve artan ücret taleplerinin işletmeler için önemli sorun alanları olduğunu vurgulamaktadır.

Sonuç olarak, afetlere karşı kırılgan bir yapıya sahip olan gastronomi sektörünün, doğru planlama ve bütüncül yaklaşımlarla ekonomik ve toplumsal açıdan yeniden yapılandırılabileceği görülmektedir. Afet öncesi hazırlıkların güçlendirilmesi, afet sonrası beslenme ve gıda temininin etkin biçimde yönetilmesi ve gastronomik kapasitenin sürdürülebilir şekilde değerlendirilmesi, sektörün yalnızca ekonomik bir faaliyet alanı olmanın ötesine geçerek toplumsal iyileşme ve dayanıklılık sürecine önemli katkılar sunmasını sağlayacaktır. Bu doğrultuda gastronomi sektörü, afet yönetimi süreçlerinde stratejik bir unsur olarak ele alındığında hem yerel ekonominin canlanmasına hem de toplumun normal yaşam düzenine dönüşüne destek olabilecek önemli bir araç niteliği taşımaktadır.

Araştırmadan elde edilen bulgular ve ulaşılan sonuçlar çerçevesinde aşağıda bazı öneriler sunulmaktadır;

- Afet sonrası dönemde gastronomi sektörünün yeniden canlandırılmasına katkı sağlamak amacıyla, yerel mutfak kültürünü görünür kılacak etkinlikler, tanıtım faaliyetleri ve destek programları planlanmalıdır.

- Turizm paydaşları, gastronomi işletmelerini afet sonrası süreçte güvenli ve sürdürülebilir destinasyonlar olarak yeniden konumlandıracak iletişim ve tanıtım stratejileri geliştirmelidir.

- Kamu kurumları, sivil toplum kuruluşları ve özel sektör arasında afetlere yönelik koordinasyon ve iş birliği mekanizmaları güçlendirilerek, özellikle ilk 72 saatlik kritik süreçte gıda temini ve dağıtımının etkinliği artırılmalıdır.

- Bu çalışma, literatür taramasına dayalı bir derleme niteliği taşımaktadır. Gelecek araştırmalarda; nicel yöntemler, karma araştırma tasarımları ya da saha çalışmaları kullanılarak, afetlerin gastronomi üzerindeki etkilerine dair bulguların derinleştirilmesi ve genellenebilirliğinin artırılması önerilmektedir.

KAYNAKÇA

AFAD (Afet ve Acil Durum Yönetimi Başkanlığı). (2025a). "Açıklamalı Afet Yönetimi Terimleri Sözlüğü", https://www.afad.gov.tr/aciklamali-afet-yonetimi-terimleri-sozlugu, (Erişim tarihi: 14.12.2025).

AFAD (Afet ve Acil Durum Yönetimi Başkanlığı). (2025c). "Afet Yönetimi ve Karar Destek Sistemi", https://aydes.gov.tr, (Erişim tarihi: 14.12.2025).

Akçalı, E. (2011). Heyelan-Yağış İlişkisinin Modellenmesi ve Analizi; Trabzon İli Örneği (Doctoral Dissertation, Sakarya Universitesi (Turkey).

Akgöz, E., Çıkı, S., Çıkı, D, 2023). Depremlerde Beslenme ve Sonrasında Oluşan Beslenme Alışkanlıkları (Maraş Depremi Sonrası Turizm Sektörü Değerlendirmeleri) (273-286s.) Eğitim Yayınevi, Editörler: Ç., Ünüsan, M., Sezgin, A., Köseoğlu, İstanbul, Türkiye 365s

Aldemir, T. (2023). Doğal Afetler Sonrası Afetzedelerin Beslenmesi:2023 Kahramanmaraş Depremi Örneği. Avrasya Sosyal ve Ekonomi Araştırmaları Dergisi. 10(4):686–701.

Arslaner, E. (2025). Afetlerden Etkilenen Kişilerin Değişen Yeme Alışkanlıklarının Duygusal Beslenme Açısından Değerlendirilmesi (Yüksek lisans tezi, Çanakkale Onsekiz Mart Üniversitesi). YÖK Ulusal Tez Merkezi.

Aslan, G., & Karabay, B. (2024). Türkiye'nin Çığ Yönetimine Eleştirel Bir Bakış. Sosyal Aktörler ve Deneyimler Dergisi (3), 17-33.

Beyazgül, M., & Öz, H. (2025). 6 Şubat Depremleri Sonrasında Hatay Gastronomisi: Sorunlar, Öneriler ve Beklentiler [Hatay gastronomy after the February 6 earthquakes: Challenges, suggestions, and expectations]. Journal of Tourism and Gastronomy Studies, 13(3), 2977–2993.

Buchholz, K. (2024). "The Countries Hit By The Most Earthquakes", Statista, https://www.statista.com/chart/29243/countries-with-most-earthquakes, (Erişim tarihi: 20.02.2025).

Demirelli, K. (2001). İstanbul'da Meydana Gelen Büyük Depremler ve İstanbul'un Geoteknik Açıdan İncelenmesi, Yüksek Lisans Tezi, İstanbul Teknik Üniversitesi, İstanbul. https://polen.itu.edu.tr/bitstreams/c606ee54-4b5c-4dc3-a44c-602356e8f2f5/download, (Erişim tarihi: 21.02.2025).

Demirtaş, R. ve Erkmen, C. (2000). "Deprem ve Jeoloji". Jeoloji Mühendisleri Odası, Ankara. https://www.researchgate.net/profile/Ramazan-Demirtas/publication/369890677_ Deprem_ve_Jeoloji/links/643177904e83cd0e2f9d1ef3/ Deprem-ve-Jeoloji.pdf, (Erişim tarihi: 21.02.2025).

Dikmenli, Y., & Gafa, İ. (2017). Farklı Eğitim Kademelerine Göre Afet Kavramı. Mehmet Akif Ersoy Üniversitesi Eğitim Fakültesi Dergisi (44), 21-36.

Ergünay, O., Derneği, D. M., ve Sekreteri, G. (2009). Doğal Afetler ve Sürdürülebilir Kalkınma. Deprem Sempozyumu, 11, 12.

Erkal, T. ve Değerliyurt, M. (2011). Türkiye 'de Afet Yönetimi. Doğu Coğrafya Dergisi. 22:147–164.

Fırat, S. ve Dabak, R. (2023). Afetlerde Yardım Malzemeleri Ulaştırmasında İnsansız Hava Aracı Kullanımı. Meriç Uluslararası Sosyal ve Stratejik Araştırmalar Dergisi. 7: 35–58. https://orcid.org/0000-0002-4509-8879

İşçi, C. (2008). Deprem Nedir ve Nasıl Korunuruz? Yaşar Üniversitesi E-Dergisi, 3(9), 959-983. https://dergipark.org.tr/ tr/download/article-file/179169, (Erişim tarihi:22.02.2025).

Kadıoğlu, M., 2008: Sel, Heyelan ve Çığ için Risk Yönetimi; Kadıoğlu, M. ve Özdamar, E., (editörler), "Afet Zararlarını Azaltmanın Temel İlkeleri"; s.251-276, JICA Türkiye Ofisi Yayınları No: 2, Ankara.

Kaya, N. (2024). Depremlerde Gönüllü Mutfaklarının Kurulumu ve İşletilmesine İlişkin Bir Model Önerisi: 6 Şubat Kahramanmaraş depremlerinde "Gönül Mutfağı" örneği (Yüksek lisans tezi). Başkent Üniversitesi, Sosyal Bilimler Enstitüsü, Ankara, Türkiye. YÖK Ulusal Tez Merkezi.

UNISDR (2009). Terminology on Disaster Risk Reduction. Geneva: United Nations International Strategy for Disaster Reduction. https://www.preventionweb.net/files/7817_UNISDRTerminologyEnglish.pdf (Erişim tarihi: 18.08.2024).

Özcan, F. Ö., ve Duru, Ö. A. (2021). Doğal Afetlerde Gıda İhtiyaç Durumunun Değerlendirilmesi ve Beslenme Müdahaleleri: Deprem Örnekleri Açısından İncelenmesi. Sağlık Akademisyenleri Dergisi, 8(4), 337–341.

Öztürk, M. ve Kırca M. (Eds.).(2023). Kahramanmaraş Merkezli Depremler Sonrası İçin Akademik Öneriler. ISBN 978-975-447-613-2. DOI: https://doi.org/10.58830/ozgur.pub99..S. 608-609-610-611.

Pehlivan, T. (2023). 2023 Depremlerinin Gaziantep Gastronomi Turizmi Üzerine Potansiyel Etkileri. Turizm alanında çok yönlü araştırmalar (pp. 139-159). Özgür Yayın Dağıtım Ltd. Şti.

Putri, D. P., Bridha, R. L., Insani, H. M., Hindayani, P., Priatini, W. ve Tsaniah, I. (2024). Sustainable Gastronomy and Disaster Vulnerability in Majalengka District. E3s Web of Conferences, 600, 01002.https://doi.org/10.1051/e3sconf/202460001002

Sharmin, R., Hasan, M., Kadir, S. B., Hossain, M. J. ve Jadid, J. H. (2024). Disaster Impact on Supply Chain Management of Agricultural Products in Dacope, Khulna. 288-300. https://doi.org/10.2991/978-94-6463-478- 5_22

Türk Dil Kurumu. (2025). Afet kelimesinin anlamı. https://sozluk.gov.tr/ (Erişim tarihi: 14.12.2025).

Türkiye Bilimsel ve Teknolojik Araştırma Kurumu. (2011). TÜBA Türkçe Bilim Terimleri Sözlüğü. http://terim.tuba.gov.tr (Erişim tarihi: 15.12.2025).

Ünüvar, O., & El, M. N. (2023). Maraş depremi sonrası yiyecek içecek işletmeleri ve derneklerinin deprem bölgelerine yardımı. In Deprem ve Turizm, 65.

World Health Organization. (2015). Western Pacific Regional Framework for Action for Disaster Risk Management for Health. https://iris.who.int/bitstream/handle/10665/208200/9789290617082_eng.pdf

Quarantelli, E. L. (1989). How İndividuals and Groups React During Disasters. Planning And Managing İmplications for EMS Delivery, 1-37.

FONKSİYONEL BİLEŞEN OLARAK KOLAJEN: GASTRONOMİDEKİ ROLÜ VE UYGULAMA POTANSİYELİ

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ÖZET

Fonksiyonel gıdalar, temel beslenmenin ötesinde fizyolojik süreçleri destekledikleri için modern beslenmede önemli hale gelmiştir. Biyoaktif bileşenler hem sağlık yararları hem de teknolojik işlevleri nedeniyle gastronomi alanında değerlidir. Bu bileşenler arasında kolajen, jel oluşturma kapasitesi, su tutma kabiliyeti ve doku geliştirici özellikleri ile çok yönlü bir protein olarak öne çıkmakta ve hem geleneksel hem de modern mutfak uygulamalarında kullanışlıdır. Duyusal ve teknolojik nitelikleri iyileştirmenin ötesinde, hayvansal yan ürünlerin kullanımındaki rolü de kolajeni sürdürülebilirlik açısından değerli bir bileşen haline getirmektedir. Bu nedenlerle, kolajenin gastronomi sektöründeki yeri kapsamlı bir değerlendirmeyi gerektirmektedir. Bu çalışmanın amacı, fonksiyonel gıda bileşeni olarak temel özelliklerini ve gastronomik uygulamalardaki kullanımlarını belirleyerek kolajenin gastronomideki rolünü incelemektir. Bu çalışmada derleme yöntemi kullanılarak, kolajenin gıdalardaki işlevleri, yapısal ve duyusal niteliklere katkıları ve gastronomide potansiyel uygulamaları değerlendirmek için ilgili bilimsel kaynaklar analiz edilmiştir. Literatür, kolajenin çeşitli ürünlerdeki doku, kıvam ve stabiliteyi etkileyebileceğini ve gastronomik ürün geliştirmede fonksiyonel bir bileşen olarak hizmet edebileceğini göstermektedir. Ayrıca, hayvansal yan ürünlerden elde edilmesi, sürdürülebilir üretim yaklaşımı içindeki değerini vurgulamaktadır. Gastronomi alanında kolajenin daha sistematik ve bilinçli bir şekilde değerlendirilmesi, fonksiyonel gıdalar için yenilikçi formülasyonlar geliştirme, ürün kalitesini iyileştirme ve sürdürülebilir üretim uygulamalarını destekleme açısından önemli bir potansiyel sunmaktadır. Literatürdeki bilgiler, kolajenin gastronomi alanında sadece yapısal bir katkı maddesi olarak değil, aynı zamanda ürün tasarım ve geliştirme süreçlerine yön verebilen çok yönlü bir bileşen olarak da değerlendirilebileceğini göstermektedir. Bu bağlamda, kolajenin, gastronomi sektörünün teknolojik kapasitesini artıran ve sürdürülebilirlik hedefleriyle uyumlu çözümler sunan stratejik bir bileşen olarak gelecekte daha geniş bir uygulama alanı bulması beklenmektedir.

Anahtar Kelimeler: Fonksiyonel gıda bileşenleri, Kolajen, Gastronomi

ABSTRACT

Functional foods have become important in modern nutrition as they support physiological processes beyond basic nourishment. Their bioactive components are valued in gastronomy for both health benefits and technological functions. Among them, collagen stands out as a versatile protein with gel-forming capacity, water retention ability, and texture-enhancing properties, making it useful in both traditional and modern culinary applications. Beyond improving sensory and technological qualities, its role in utilizing animal by-products also positions collagen as a valuable component for sustainability. For these reasons, collagen's place in the gastronomy sector warrants careful consideration. This study aims to examine the role of collagen in gastronomy by identifying its fundamental properties as a

functional food ingredient and its applications in various gastronomic contexts. Using a review method, relevant scientific sources were analyzed to evaluate the functions of collagen in foods, its contributions to structural and sensory qualities, and its potential applications in gastronomy. The literature indicates that collagen can influence texture, consistency, and stability in various products, serving as a functional component in the development of gastronomic products. Moreover, its derivation from animal by-products highlights its value within a sustainable production approach. The more systematic and conscious evaluation of collagen in the field of gastronomy offers significant potential for developing innovative formulations for functional foods, enhancing product quality, and supporting sustainable production practices. Existing literature indicates that collagen can be considered not only a structural additive in gastronomy but also a versatile component that can inform product design and development processes. In this regard, collagen is expected to find a wider application area in the future as a strategic ingredient that both enhances the technological capacity of the gastronomy sector and offers solutions compatible with sustainability goals.

Key Words: Functional food ingredients, Collagen, Gastronomy.

GİRİŞ

Modern beslenme anlayışı, yalnızca temel besin gereksinimlerinin karşılanmasına odaklanan klasik yaklaşımın ötesine geçerek, fizyolojik süreçleri destekleyen fonksiyonel gıdalara yönelik artan ilgi doğrultusunda önemli bir dönüşüm yaşamaktadır (Önem ve Karaca, 2024). Birleşmiş Milletler Gıda ve Tarım Örgütü (FAO), fonksiyonel gıdaları belirli biyolojik işlevleri bilinen, temel besin öğelerine ek olarak sağlık açısından yararlı etkileri bilimsel olarak ortaya konmuş bileşenleri içeren gıdalar olarak tanımlamaktadır (Gülmez ve Güven, 2005). Bu kapsamda, sağlık yararları ve teknolojik fonksiyonları nedeniyle biyoaktif bileşenler gastronomi alanında giderek daha fazla önem kazanmaktadır.

Bu bileşenler arasında kolajen, jel oluşturma kapasitesi, su tutma özelliği ve doku geliştirici etkileriyle ön plana çıkan çok yönlü bir protein olarak dikkat çekmektedir (Gómez-Guillén vd., 2011). Fonksiyonel bir bileşen olarak kolajen hidrolizatı, vücutta kolajen sentezini desteklemesi nedeniyle özellikle kemik ve cilt sağlığına yönelik ürünlerde yaygın şekilde kullanılmaktadır. Kolajen, insan vücudundaki toplam proteinin yaklaşık %25'ini ve cilt dokusunun büyük bölümünü oluşturan temel bir yapısal proteindir (Sharma, Poddar ve Sen, 2008).

Kolajenin yapısal bütünlüğü destekleyen biyolojik rolü ve gıda ürünlerine kazandırdığı tekstürel nitelikler hem geleneksel hem de modern gastronomik uygulamalarda kullanım alanını genişletmektedir (Chen vd., 2023). Gıda teknolojisi açısından değerlendirildiğinde ise kolajenin jel oluşturma, kıvam geliştirme ve emülsiyon stabilizasyonuna katkı sağlayan özellikleri, onu fonksiyonel gıda formülasyonlarında önemli bir bileşen hâline getirmektedir (Ersus Bilek ve Kaya Bayram, 2015).

Literatürde, kolajenin çeşitli gıdalarda doku, kıvam ve stabiliteyi etkileyebildiği; ürün geliştirme süreçlerinde fonksiyonel bir bileşen olarak önemli potansiyeller sunduğu açıkça ortaya konulmaktadır (Farooq vd., 2024). Bu nedenle kolajenin gastronomi alanında sistematik ve bütüncül bir yaklaşımla ele alınması hem ürün kalitesinin artırılması hem de sürdürülebilir üretim pratiklerinin desteklenmesi açısından gereklidir. Bu çalışma, kolajenin temel yapısal ve fonksiyonel özelliklerini, gastronomideki kullanım potansiyelini ve sürdürülebilirlik bağlamındaki rolünü literatür temelli bir yaklaşımla incelemeyi amaçlamaktadır.

LİTERATÜR TARAMASI

Fonksiyonel Gıdalar

Birleşmiş Milletler Gıda ve Tarım Örgütü'nün tanımına göre fonksiyonel gıdalar, temel beslenmenin sağladığı yararların ötesine geçerek fizyolojik süreçler üzerinde olumlu etkiler gösteren, sağlık durumunun iyileştirilmesine ve hastalık riskinin azaltılmasına katkı sağlayan gıdalar olarak kabul edilmektedir. Bu doğrultuda fonksiyonel gıdalar, yalnızca temel besin ihtiyaçlarını karşılamakla kalmayıp metabolik ve fizyolojik işlevleri destekleyerek daha sağlıklı bir yaşam biçiminin sürdürülmesine yardımcı olan gıdalar veya gıda bileşenleri şeklinde değerlendirilmektedir (Kodaz, 2013).

Fonksiyonel gıda sektörü; tüketicilerin beslenme ve hastalık ilişkisine dair bilinç düzeyinin artması, nüfusun yaşlanması, sağlık hizmeti maliyetlerinin yükselmesi ve gıda-beslenme biliminin gelişmesi gibi etkenlere bağlı olarak hızla büyümekte ve gıda üretim trendlerine yön vermektedir (Anonymous, 2011). Fonksiyonel gıdaların bu kapsamda kabul edilebilmesi için belirli kriterleri karşılaması gerekmektedir. Bu kriterler; bireyin beslenmesine katkı sağlaması, sağlık üzerinde koruyucu veya iyileştirici etki göstermesi, besin öğelerinin bilimsel temellere dayanması, günlük alım miktarlarının belirlenmiş olması ve söz konusu gıdanın güvenilirliğinin ortaya konulması gibi unsurları içermektedir (Scrinis, 2008).

Fonksiyonel bir bileşen olarak kolajen hidrolizatı, son yıllarda özellikle gıda takviyelerinde ve çeşitli ürünlere fonksiyonel özellik kazandırma amacıyla gıdalara eklenerek yaygın bir kullanım alanı bulmuştur. Kolajenin küresel ölçekteki pazarı, kolajen hidrolizatlarının sağlık üzerindeki olumlu etkilerine ilişkin farkındalığın artmasıyla önemli ölçüde genişlemiştir. Yaşlanmaya bağlı olarak vücutta kolajen sentezinin azalması ve kalitesinin düşmesi sonucunda ortaya çıkan eksikliklerin giderilmesine yönelik bilimsel kanıtların güçlenmesi, kolajen hidrolizatlarının kullanımına olan ilgiyi artırmıştır (Doğan, 2023).

Kolajenin Yapısı ve Gastronomik İşlevselliği

Kolajen hem insan vücudunda hem de hayvansal dokularda en yaygın bulunan yapısal proteinlerden biridir ve özellikle bağ dokusunun dayanıklılığı ile et ürünlerinin yumuşaklığı üzerinde önemli bir rol oynar (Wang ve Tang, 2018). İnsan vücudundaki toplam proteinin yaklaşık üçte birini oluşturması ve cildin mekanik özelliklerini belirlemesi, kolajenin biyolojik açıdan ne kadar temel bir protein olduğunu göstermektedir (Ricard-Blum, 2011). Kolajenin tanımlanan 29 tipi içinde en yaygın olanlar Tip I, Tip II ve Tip III kolajenlerdir. Tip I kolajen kemik, deri ve tendonlarda; Tip II kolajen kıkırdak dokusunda; Tip III kolajen ise damar duvarları ve çeşitli iç organlarda yoğun olarak bulunur (León-López vd., 2019; Jafari vd., 2020). Bu yaygın dağılım, kolajenin hem fonksiyonel gıdalarda hem de gastronomik uygulamalarda değerli bir bileşen olmasının temel nedenlerinden biridir.

Kolajen yapısı gereği güçlü bir lifli protein formundadır ve bu nedenle gıdalara kazandırdığı jel oluşturma kapasitesi, su tutma yeteneği ve doku geliştirici özellikleriyle gastronomide önem taşır (Gómez-Guillén vd., 2011). Ancak doğal formunda çözünürlüğü düşük olduğundan, gıda uygulamalarında çoğunlukla kolajen hidrolizatı tercih edilmektedir. Kolajenin hidrolize edilmesi, yani daha küçük peptitlere parçalanması, çözünürlüğünü artırarak sindirilebilirliğini ve biyoyararlanımını yükseltir (Vidal vd., 2020). Hidroliz sonrası elde edilen kolajen peptitleri jelatin gibi jel oluşturmaz ancak soğuk suda kolay çözünür ve bu özellikleri nedeniyle içecek, tatlı, sos ve takviye ürünlerinde yaygın olarak kullanılmaktadır (León-López vd., 2019).

Gastronomik açıdan değerlendirildiğinde, kolajen farklı kaynaklardan elde edilebilmektedir. Son yıllarda özellikle deniz ürünleri, sürdürülebilir bir kolajen kaynağı olarak öne çıkmıştır. Somon, morina balığı, sünger, denizanası gibi türlerden elde edilen denizel kolajen, çevresel açıdan katma değer yaratmakta ve atıkların değerlendirilmesine olanak sağlamaktadır (Musayeva, Özcan ve Kaynak, 2022). Bununla birlikte, balık kaynaklı kolajenin zaman zaman ağır metal birikimi riski taşıyabileceği ve bazı bileşenleri nedeniyle vücutta istenmeyen reaksiyonlara yol açabileceğinin de ifade edildiği görülmektedir (Khatri vd., 2021). Öte yandan gıda sektöründe kullanılan ticari kolajenlerin önemli bir kısmı hâlâ sığır ve domuz gibi memeli yan ürünlerinden elde edilmektedir (Arumugam vd., 2018).

Kolajenin Ürün Geliştirmedeki Rolü

Kolajen, yüksek protein içerikleri ile su bağlama, jel oluşturma ve emülsiyon stabilizasyonu gibi fonksiyonel özellikleri sayesinde gıda endüstrisinde geniş kullanım alanına sahiptir (Schmidt vd., 2016). Geleneksel olarak deri ve kemik gibi kolajence zengin hayvansal materyallerden sıcak su ekstraksiyonu ile elde edilen jelatin, daha ileri hidroliz işlemleriyle parçalanarak suda kolay çözünebilen kolajen hidrolizatına dönüştürülür. (Song ve Li, 2017).

Ersus Bilek ve Kaya Bayram (2015), kolajen hidrolizatının gıda ürünlerinde fonksiyonel bir bileşen olarak önemli bir potansiyele sahip olduğunu ve pek çok üründe tat ya da koku üzerinde belirgin bir değişiklik oluşturmadan kolayca çözünebildiğini belirtmektedir. Ancak bazı balık kaynaklı kolajen hidrolizatlarının, kullanılan miktara bağlı olarak hafif koku sorunlarına yol açabileceği de ifade edilmektedir. Bu nedenle yeni ürün geliştirme çalışmalarında kolajen hidrolizatının diğer bileşenlerle uyumu göz önünde bulundurulmalı; özellikle kolajen üretimini destekleyici etkisi bilinen C vitamininin birçok formülasyonda tercih edildiği unutulmamalıdır. Bunun yanı sıra, kolajen hidrolizatının ısıya dayanıklı yapısı, pastörizasyon gibi ısıl işlem uygulanan gıdalarda sorunsuz şekilde kullanılmasına imkân tanımakta ve bu özelliği onu gastronomik yenilikler için uygun bir bileşen hâline getirmektedir.

Kolajenin Sağlık ve Sürdürülebilirlik Boyutu

Kolajenin gıdalarda ve sağlık alanında kullanımına ilişkin literatür, bu bileşenin güvenli ve işlevsel özellikler taşıdığını göstermektedir. Araştırmalar, kolajen hidrolizatının güvenli biçimde sindirilebildiğini ve gıdalarda kullanımının sağlık açısından risk oluşturmadığını ortaya koymaktadır (Wu vd., 2004). Geleneksel olarak kolajen; sığır, domuz ve tavuk gibi kara hayvanlarının dokularından elde edilmekte ve uzun yıllardır çeşitli tıbbi ve gıda uygulamalarında kullanılmaktadır. **Ancak bu kaynakların yüksek üretim maliyeti, geniş arazi gereksinimi, hayvancılığa bağlı çevresel yük, sığırlarda görülen deli dana hastalığı (Bovine Spongiform Encephalopathy – BSE) ve şap hastalığı (Foot and Mouth Disease – FMD) gibi hayvan hastalıkları ile bazı dini kısıtlamalar, geleneksel kolajen kullanımını küresel ölçekte sınırlandırmaktadır** (Cruz-López vd., 2021; Caruso, 2016).

Bu sınırlamalar nedeniyle balık kaynaklı kolajen, son yıllarda daha sürdürülebilir ve güvenilir bir alternatif olarak ön plana çıkmıştır. Balıkların deri ve pullarından elde edilen kolajenin yüksek biyoyararlanım göstermesi ve bazı çalışmalarda kara hayvanı kolajenlerinden daha iyi değerlendirilebilir olduğunun belirtilmesi, bu kaynağın önemini artırmaktadır (Yetim, 2011). Bunun yanı sıra kolajen hidrolizatları; jel oluşturma kapasitesi, doku geliştirme özellikleri, antioksidan ve antimikrobiyal aktiviteleri ile mineral bağlama potansiyelleri sayesinde fonksiyonel gıdalarda değerli bir bileşen olarak değerlendirilmektedir. Özellikle kalsiyum emilimini artırma etkisi, balık kaynaklı kolajeni beslenme destek ürünlerinde yaygın bir seçenek hâline getirmektedir (Gómez-Guillén vd., 2011).

Kolajenin sağlık boyutundaki en belirgin kullanım alanlarından biri cilt sağlığıdır. Yaşlanma ve çevresel etkenlerle birlikte vücuttaki kolajen miktarı azalmakta; bu durum ciltte esneklik kaybı, kırışıklık oluşumu ve doku bütünlüğünde bozulmalara yol açmaktadır (Schauss vd., 2019). Çeşitli çalışmalar,

kolajen hidrolizatlarının cilt ve bağ dokusu üzerinde onarıcı etkiler gösterebildiğini, inflamasyonun azalmasına yardımcı olduğunu ve eklem ağrılarının hafiflemesine katkıda bulunduğunu bildirmektedir (Guillerminet vd., 2010; Karaguzel ve Holick, 2010). Ayrıca zamanla kolajen üretiminin her yıl yaklaşık %1 oranında azalması nedeniyle, yetişkinlerde günlük 10 g kolajen hidrolizatı tüketiminin fayda sağlayabileceği ifade edilmektedir (Bruyère vd., 2012). Kolajenin gıdalarda kullanımının güvenli olduğu, Avrupa Gıda Güvenliği Otoritesi (European Food Safety Authority – EFSA) ve Amerika Birleşik Devletleri Gıda ve İlaç İdaresi (Food and Drug Administration – FDA) tarafından "Genel Olarak Güvenli Kabul Edilir" anlamına gelen GRAS statüsü ile onaylanmıştır (EFSA, 2011).

YÖNTEM

Bu çalışma, kolajenin fonksiyonel bir bileşen olarak gastronomideki rolünü, yapısal özelliklerini, sağlık etkilerini ve sürdürülebilirlik boyutunu incelemeyi amaçlayan bir derleme niteliğindedir. Bu kapsamda ulusal ve uluslararası literatürde yer alan bilimsel araştırmalar sistematik bir yaklaşımla değerlendirilmiştir. Literatür taraması 2004–2025 yılları arasında yayımlanan makaleler, tezler, raporlar ve incelemeleri kapsayacak şekilde gerçekleştirilmiş olup PubMed, ScienceDirect, Google Scholar, ve ResearchGate gibi veri tabanları kullanılmıştır. Tarama sürecinde *collagen, hydrolyzed collagen, functional food ingredients, collagen extraction, gastronomic applications, sustainability,* gibi İngilizce; *kolajen, kolajen hidrolizatı, fonksiyonel gıdalar, gastronomide kolajen kullanımı,* gibi Türkçe anahtar kelimelerden yararlanılmıştır.

Çalışmaya dahil edilme kriterleri arasında kolajenin yapısı, ekstraksiyon yöntemleri, gastronomide kullanım potansiyeli, sağlık etkileri ve sürdürülebilirlik boyutuna ilişkin bilimsel veri sunan çalışmalar yer almıştır. Buna karşılık konu kapsamına girmeyen, metodolojik açıdan yetersiz bulunan veya bilimsel nitelik taşımayan popüler içerikler değerlendirmeye alınmamıştır. Uygun bulunan çalışmalar içeriklerine göre tematik olarak sınıflandırılmış ve dört ana başlık altında analiz edilmiştir: fonksiyonel gıdalar; kolajenin yapısı ve gastronomik işlevselliği, kolajenin ürün geliştirmedeki rolü; kolajenin sağlık ve sürdürülebilirlik boyutu. Bu tematik çerçeve doğrultusunda elde edilen bilgiler karşılaştırmalı olarak incelenmiş ve literatürdeki bulgular bütüncül bir yaklaşımla yorumlanmıştır.

Bu yöntemsel yaklaşım sayesinde kolajenin gastronomi alanındaki kullanımına ilişkin güncel araştırmalar derlenmiş hem teknolojik hem duyusal hem de sürdürülebilirlik temelli etkileri bilimsel veriler ışığında değerlendirilmiştir.

SONUÇ VE TARTIŞMA

Bu derleme çalışması, kolajenin yapısal özelliklerinden ekstraksiyon yöntemlerine, fonksiyonel performansından gastronomik uygulamalardaki rolüne kadar geniş bir literatür taraması yaparak, bileşenin güncel bilimsel çerçevede nasıl konumlandığını ortaya koymayı amaçlamıştır. Kolajenin moleküler yapış ve ürün geliştirmedeki rolü literatürle tutarlı biçimde vurgulanmaktadır. Literatürde kolajenin yapısal özellikleri, ekstraksiyon yöntemleri ve gastronomik uygulamalardaki işlevine yönelik bulgular, özellikle son yıllarda gerçekleştirilen çalışmalarla daha belirgin bir çerçeve kazanmıştır.

Chen, Pei, Tang ve Albu-Kaya'nın (2023) çalışması, ekstraksiyon yönteminin kolajenin **jel oluşturma kapasitesi** ve **yapısal bütünlüğü** üzerinde kritik bir belirleyici olduğunu ortaya koymuş; farklı kaynaklardan elde edilen kolajenin gastronomik ürünlerde farklı dokusal ve stabilite özellikleri sergileyebileceğini göstermiştir. Bu bulgu, kolajenin tek tip bir fonksiyonel bileşen olarak değil, üretim sürecine bağlı şekilde değişen çok yönlü bir yapıtaşı olduğunu doğrulamaktadır.

Benzer şekilde Zuluğ'un (2025) beş yıldızlı otel mutfaklarından elde edilen balık yan ürünlerini değerlendirerek yürüttüğü çalışma ise, balık kaynaklı kolajenin özellikle **%1.0–1.5 düzeylerinde** soslar,

jeller ve diğer gastronomik ürünlerde **tekstürel güçlenme**, **stabilite artışı** ve **duyusal kabul yükselmesi** sağladığını göstermektedir. Ayrıca bu uygulamanın **atık azaltımı, karbondioksit salımının düşürülmesi ve su ayak izinin azaltılması** gibi sürdürülebilirlik katkıları sunduğu; dolayısıyla kolajenin yalnızca fonksiyonel değil, aynı zamanda **çevresel açıdan stratejik** bir bileşen olarak da değerlendirilmesi gerektiğini ortaya koymaktadır.

Sonuç olarak, kolajen gastronomide hem **teknolojik** hem **duyusal** hem de **sürdürülebilirlik temelli** katkılar sunan çok yönlü bir bileşen olarak öne çıkmaktadır. Yapısal stabilite, jel oluşturma kapasitesi, su/yağ tutma özellikleri ve emülsiyon davranışı, kolajenin gastronomik yeniliklerde güçlü bir araç olabileceğini göstermektedir. Bunun yanında, hayvansal yan ürünlerin değerlendirilmesi yoluyla **sürdürülebilir mutfak uygulamalarının ana bileşeni** olarak benimsenebileceğini göstermektedir. Ek olarak, literatürün sunduğu bütüncül bakış açısı kolajenin gastronomide giderek artan stratejik önemine işaret etmektedir. Bu genel değerlendirmeler ışığında, gelecek çalışmalara yönelik bazı önerilerin geliştirilmesi önem taşımaktadır. Bu öneriler aşağıdaki gibidir:

- Kolajenli ürünlere ilişkin tüketici algısı, beğenisi ve satın alma eğilimini inceleyen geniş ölçekli duyusal çalışmalar yapılması, kolajenin gastronomideki ticari ve fonksiyonel potansiyelinin daha kapsamlı biçimde anlaşılmasına olanak sağlayacaktır.
- Otel, restoran ve toplu yemek işletmelerinde oluşan balık ve diğer hayvansal yan ürünlerin kolajen üretimi için verimli şekilde değerlendirilebilmesine yönelik döngüsel atık yönetimi modellerinin geliştirilmesi, sektörün sürdürülebilirlik kapasitesini güçlendirecektir
- Kolajen üretim sürecinin ekonomik fizibilitesini, maliyet avantajlarını ve işletme ölçeğine göre uygulanabilirliğini analiz eden çalışmaların artırılması, gıda işletmelerinin bu süreci benimsemesine yönelik daha somut veriler sunacaktır.
- Profesyonel mutfaklarda kolajen kullanımına yönelik pratik uygulama kılavuzlarının oluşturulması ve bu kılavuzların gastronomi eğitim programlarına entegre edilmesi, kolajenin sektör içinde doğru ve verimli kullanımını destekleyecektir.

KAYNAKÇA

Anonymous, 2011. Food and Drink Research Association. Leather Food Research 205.

Arumugam, G. K. S., Sharma, D., Balakrishnan,R. M., Ettiyappan, J. B. P. (2018). Extraction,optimization and characterization of collagenfrom sole fish skin. Sustainable Chem Pharm, 9: 19-26.

Caruso GJ. Fishery wastes and by-products: a resource to be valorised. J Fish Sci. 2016;10:12–5.

Chen, Q., Pei, Y., Tang, K., & Albu-Kaya, M. G. (2023). *Structure, extraction, processing, and applications of collagen as an ideal component for biomaterials: A review*. **Collagen and Leather**, 4, Article 127. https://doi.org/10.1186/s42825-023-00127-5

Cruz-López H, Rodríguez-Morales S, Enríquez-Paredes LM, Villarreal Gómez LJ, Olivera-Castillo L, Cortes-Santiago Y, et al. Comparison of collagen characteristic from the skin and swim bladder of Gulf corvina (Cynoscion othonopterus). Tissue Cell. 2021;72: 101593. 7.

Doğan, H. (2023). *Piyasada satılan kolajen hidrolizatlarının in vitro ortamda biyoyarışilebilirliğinin incelenmesi* (Yüksek lisans tezi, İstanbul Sabahattin Zaim Üniversitesi). İstanbul Sabahattin Zaim Üniversitesi, Lisansüstü Eğitim Enstitüsü.

Ersus Bilek, S., & Kaya Bayram, S. (2015). Kolajen Hidrolizatının Fonksiyonel Bir Bileşen Olarak Gıda Endüstrisinde Kullanılması. Akademik Gıda, 13(4), 327-334.

Farooq, S., Ahmad, M.I., Zheng, S. *et al.* A review on marine collagen: sources, extraction methods, colloids properties, and food applications. *Collagen & Leather* **6**, 11 (2024). https://doi.org/10.1186/s42825-024-00152-y.

Food and Agriculture Organization of the United Nations. (n.d.). *Functional foods* [Definition]. FAO Terminology Portal. Retrieved February 16, 2025, from https://www.fao.org/faoterm/viewentry/en/?entryId=170967

Gómez-Guillén, M.C., Giménez, B., López-Caballero, M.E., Montero, M.P. (2011). Functional and bioactive properties of collagen and gelatin from alternative sources: A review. Food Hydrocoll, 25: 1813–1827.

Guillerminet, F., Beaupied, H., Fabien-Soule, V., Tome, D., Benhamou, C.L, Roux, C. ve Blais, A. (2010). Hydrolyzed collagen improves bone metabolism and biomechanical parameters in ovariectomized mice: an in vitro and in vivo study, Bone. 46(3): 827-834.

Gülmez, M. ve Güven, A. (2005). Fonksiyonel Gıdalar ve Sağlıkla İlişkisi, Kafkas Üniversitesi Veteriner Fakültesi Besin Hijyeni ve Teknolojisi Anabilim Dalı, 11(1): 17-24.

Jafari, H., Lista, A., Siekapen, M.M., Ghaffari-Bohlouli, P., Nie, L., Alimoradi, H., ve Shavandi, A. (2020). Fish collagen: Extraction, characterization, and applications for biomaterials engineering, Polymers, 12, 2230.

Karaguzel, G., Holick, M., 2010. Diagnosis and treatment of osteopenia. Reviews in Endocrine & Metabolic Disorders 11: 237-251.

Khatri M, Naughton RJ, Clifford T, Harper LD, Corr L. The effects of collagen peptide supplementation on body composition, collagen synthesis, and recovery from joint injury and exercise: a systematic review. Amino Acids. 2021;53(10):1493-506.

Kodaz, D. (2013, Ağustos 29). *Fonksiyonel gıdalar*. T.C. Gıda, Tarım ve Hayvancılık Bakanlığı, Gıda ve Kontrol Genel Müdürlüğü.

León-López A, Morales-Peñaloza A, Martínez-Juárez VM, Vargas-Torres A, Zeugolis DI, Aguirre-Álvarez G. Hydrolyzed collagen - sources and applications. Molecules. 2019;24(22):4031.

Musayeva F, Özcan S, Kaynak MS. A review on collagen as a food supplement. Journal of Pharmaceutical Technology. 2022;3(1):7-29.

Önem, E. Ö., & Karaca, Ş. (2024). Fonksiyonel gıdaların zihinsel sağlık üzerindeki etkileri: Gastronomi perspektifinden bir inceleme. *Turkish Journal of Marketing*, *9*(3), 52–65. https://doi.org/10.30685/tujom.v9i3.200

Ricard-Blum S. The collagen family. Cold Spring Harb Perspect Biol. 2011;3(1):a004978.

Schauss A, Schwartz S, Hammon K, Hardy AG, Guttman N, Fong M, et al. The effects of skin aging associated with the use of Biocell collagen: a randomized, double-blind, placebo-controlled clinical trial (P06-122-19). Curr Dev Nutr. 2019;3(Suppl 1):nzz031.

Schmidt, M. M., Dornelles, R. C. P., Mello, R. O., Kubota, E. H., Mazutti, M. A., Kempka, A. P., Demiate, I. M. (2016). Collagen extraction process. Int Food Res J, 23(3): 913-922.

Scrinis, G., 2008. Functional foods or functionally marketed foods? A critique of, and alternatives to, the categories of functional foods. Public Health Nutrition 11(5): 541–545.

Sharma, S.R., Poddar, R., Sen, P., 2008. Effect of vitamin C biosynthesis degree of birefringence in polarization sensitive optical coherence tomography. African Journal of Biotechology 7: 2049-2054.

Song, H., Li, B. (2017). Beneficial Effects of Collagen Hydrolysate: A Review on Recent Developments. Biomed J Sci & Tech Res, 1(2): 1-4.

Vidal AR, Duarte LP, Schmidt MM, Cansian RL, Fernandes IA, de Oliveira Mello R, Demiate IM, Dornelles RCP. Extraction and characterization of collagen from sheep slaughter by-products. Waste Manag. 2020 Feb 1;102:838-846. doi: 10.1016/j.wasman.2019.12.004. Epub 2019 Dec 10. PMID: 31835061.

Wang, F.; Tang, H. Influence of Malic Acid Marination on Characteristics of Connective Tissue and Textural Properties of Beef Semitendinosus Muscle. CyTA—J. Food 2018, 16, 730–737

Wu, J., Fujioka, M., Sugimota, K., Mu., G., Ishimi, Y., 2004. Assessment of effectiveness of oral administration of collagen peptide on bone metobolism in growing and mature rats. Journal of Bone and Mineral Metabolism 22-47-553.

Yetim, H., 2011. Jelatin üretimi, özellikleri ve kullanımı. 1. Ulusal Helal ve Sağlıklı Gıda Kongresi: Gıda Katkı Maddeleri: Sorunlar ve Çözüm Önerileri, 19-20 Kasım, 2011, Erciyes Üniversitesi, Kayseri, 86-94p.

Zulug, Asli, From Waste to Plate: Valorization of 5-star hotels Fish By-Products into Collagen for Circular and Sustainable Gastronomic Applications. Available at SSRN: https://ssrn.com/abstract=5867963 or http://dx.doi.org/10.2139/ssrn.5867963

CANCER EPIDEMIOLOGY IN TÜRKİYE

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ABSTRACT

Cancer is a significant public health challenge in Turkey, reflecting both demographic shifts and lifestyle changes. The country has a relatively young population compared to Western Europe, which influences the overall age-standardized incidence rates (ASIRs). However, as the population ages, the cancer burden is steadily increasing, demanding more robust public health interventions.

According to data from the Turkish Ministry of Health, the most common cancers differ by gender. For males, the leading cancer sites are typically lung, prostate, and colorectum. Lung cancer incidence is notably high, primarily due to historically high rates of tobacco use, despite national anti-smoking policies. For females, the most common cancers are breast, thyroid, and colorectum. The high incidence of thyroid cancer is a distinctive feature of the Turkish profile, often attributed to increased detection through screening and possibly environmental factors.

Overall cancer survival rates are improving, reflecting advancements in early detection and treatment. The National Cancer Control Program (NCCP) is the central strategy, focusing on primary prevention (e.g., intensive anti-tobacco campaigns) and early diagnosis through widespread screening (Breast, Cervical, Colorectal). These vital screening services are primarily delivered through Community-Based Early Diagnosis, Screening, and Training Centers (KETEMs) established across the country. Key risk factors driving the Turkish cancer profile include tobacco use, obesity, and physical inactivity. Epidemiological surveillance, including the expansion of regional cancer registries, is crucial for monitoring trends, guiding prevention efforts, and understanding geographical disparities in incidence and mortality, thereby allowing for better resource allocation.

Keywords: Turkey, Cancer Incidence, Lung Cancer, Breast Cancer, Thyroid Cancer, KETEM.

INTRODUCTION

Non-communicable diseases (NCDs) have replaced infectious diseases as the primary cause of morbidity and mortality globally, a trend that is clearly observable in Turkey. As a developing country bridging Europe and Asia, Turkey has undergone rapid urbanization and demographic changes over the last three decades. These shifts have led to an epidemiological transition characterized by an increase in chronic diseases, with cancer being the second leading cause of death after cardiovascular diseases (Ministry of Health, 2023).

Epidemiological surveillance is crucial for planning cancer control strategies. Turkey established its active cancer registry system in 2002, which has since expanded to cover the entire population, providing high-quality data compliant with the International Agency for Research on Cancer (IARC) standards. According to recent estimates, the age-standardized incidence rate (ASR) of cancer in Turkey is approximately 220 per 100,000 population, which places it in an intermediate risk group globally

(Sung et al., 2021). However, the raw numbers are increasing due to the aging of the population and the accumulation of risk factors such as smoking, sedentary lifestyles, and unhealthy dietary habits.

This article aims to analyze the current status of cancer epidemiology in Turkey, examining incidence and mortality patterns by gender and site, identifying key risk factors, and discussing the public health implications of these findings.

METHODOLOGY OF CANCER REGISTRATION IN TURKEY

Data regarding cancer epidemiology in Turkey are primarily derived from the Active Cancer Registry System run by the General Directorate of Public Health. The registry covers 81 provinces, ensuring a representative sample of the Turkish population. Data quality is periodically evaluated by the IARC, and data from major hubs like Izmir and Antalya are included in the "Cancer Incidence in Five Continents" series, validating their accuracy (Gultekin et al., 2017). For the purpose of this review, national data from the Ministry of Health and global estimates from the GLOBOCAN 2020 database are utilized to provide a comparative perspective.

OVERALL CANCER INCIDENCE AND MORTALITY

General Trends

In Turkey, approximately 230,000 to 250,000 new cancer cases are diagnosed annually. The incidence rate is significantly higher in males than in females, a disparity largely attributed to the high prevalence of tobacco use among Turkish men. The Age-Standardized Rate (ASR) for all cancers (excluding non-melanoma skin cancer) is roughly 260 per 100,000 for men and 190 per 100,000 for women (Ministry of Health, 2023).

While incidence rates in Turkey are lower than the EU average, mortality rates for certain cancers, particularly lung cancer, remain concerningly high. This discrepancy suggests issues related to late-stage diagnosis and disparities in access to advanced oncological care in certain rural areas.

Gender Differences

The distribution of cancer types varies drastically by gender.

Males: Respiratory system cancers (trachea, bronchus, and lung) constitute the overwhelming majority, followed by prostate, colorectal, and bladder cancers.

Females: Breast cancer is the most frequent malignancy, accounting for nearly 25% of all female cancers. This is followed by thyroid, colorectal, and lung cancers (Eser et al., 2018).

SITE-SPECIFIC CANCER EPIDEMIOLOGY

Lung Cancer

Lung cancer is the leading cause of cancer-related death in Turkey. It ranks first among men with an incidence rate that is among the highest in the world, directly correlating with smoking prevalence. Although tobacco control measures implemented since 2008 have shown some positive effects, the lag time between exposure and carcinogenesis means incidence rates remain high. Alarmingly, lung cancer incidence is also rising among women, reflecting changing social norms regarding smoking (Koc & Ergör, 2019).

Breast Cancer

Breast cancer is the most common cancer in Turkish women, with an ASR of approximately 45-50 per 100,000. Interestingly, the epidemiological profile of breast cancer in Turkey differs slightly from Western countries; nearly half of the cases are diagnosed in premenopausal women (under 50 years of age). This "younger" age profile has necessitated the adjustment of screening guidelines, recommending the initiation of mammography at age 40 rather than 50 (Ozmen, 2014).

Colorectal Cancer

Colorectal cancer (CRC) ranks third in both men and women. The incidence of CRC in Turkey has been increasing, paralleling the adoption of a "Westernized" diet high in processed meats and low in fiber, alongside rising obesity rates. The implementation of population-based screening using Fecal Occult Blood Tests (FOBT) has begun to increase the detection of early-stage lesions (Gultekin et al., 2017).

Thyroid Cancer

A striking feature of cancer epidemiology in Turkey is the high incidence of thyroid cancer, particularly among women. It is the second most common cancer in females. This high rate is often attributed to "overdiagnosis" due to the widespread use of sensitive ultrasound imaging and fine-needle aspiration biopsies, capturing small, indolent papillary carcinomas that might not have caused clinical symptoms (Eser et al., 2018).

Gastric (Stomach) Cancer

Historically, Turkey had very high rates of gastric cancer. While incidence has declined due to better food preservation (refrigeration) and the eradication of *Helicobacter pylori*, it remains a significant health burden, particularly in the Eastern and Northeastern Anatolia regions. High salt consumption and traditional dietary habits in these regions contribute to the persistent risk (Tuncer, 2017).

REGIONAL DISPARITIES AND ENVIRONMENTAL FACTORS

Turkey's diverse geography leads to distinct regional cancer patterns.

Eastern Anatolia: Higher rates of gastric and esophageal cancers are observed, linked to dietary habits such as the consumption of salted foods and hot tea.

Aegean and Marmara Regions: These industrialized western regions show higher rates of breast, lung, and colorectal cancers, correlating with urbanization, pollution, and Westernized lifestyles.

Cappadocia Region: Historically, certain villages in this region had extremely high rates of mesothelioma due to environmental exposure to erionite, a mineral similar to asbestos. This "epidemic" has been largely controlled through village relocation and public health interventions (Baris et al., 2002).

MAJOR RISK FACTORS

Tobacco Use

Tobacco use is the single most preventable cause of cancer in Turkey. Despite the "National Tobacco Control Program," smoking rates remain high, estimated at over 40% for men and rising towards 15-

20% for women. This drives not only lung cancer but also bladder, laryngeal, and head and neck cancers (Koc & Ergör, 2019).

Obesity and Diet

The prevalence of obesity in Turkey has reached epidemic proportions, particularly among women (over 30% obesity rate). Obesity is a known risk factor for at least 13 types of cancer, including breast (postmenopausal), endometrial, and colorectal cancers. The shift from the traditional Mediterranean diet to a diet high in saturated fats and sugars exacerbates this risk.

Infectious Agents

Infections play a significant role in Turkey's cancer etiology. Hepatitis B and C are linked to hepatocellular carcinoma, though vaccination programs have reduced this risk. *Helicobacter pylori* prevalence is high, driving gastric cancer rates. Human Papillomavirus (HPV) is the primary cause of cervical cancer; however, cervical cancer incidence in Turkey is relatively low (ASR ~4 per 100,000) compared to global averages, partly due to cultural factors and the introduction of screening (Gultekin et al., 2017).

NATIONAL CANCER CONTROL PROGRAM AND SCREENING

The Turkish Ministry of Health operates a comprehensive National Cancer Control Program. A cornerstone of this program is the Cancer Early Diagnosis, Screening, and Education Centers (KETEM). There are three national screening programs currently in effect:

Breast Cancer: Mammography every two years for women aged 40-69.

Cervical Cancer: HPV-DNA testing every five years for women aged 30-65. Turkey was one of the first countries to transition to primary HPV screening on a national scale.

Colorectal Cancer: FOBT every two years for men and women aged 50-70, followed by colonoscopy if positive (Tuncer, 2017).

Despite these facilities, participation rates in screening programs vary significantly by region and education level, remaining a challenge for public health authorities.

CHILDHOOD CANCERS

Childhood cancers constitute approximately 2-4% of all cancers in Turkey. Leukemia, lymphomas, and central nervous system tumors are the most common types. The survival rates for childhood cancers in Turkey have improved significantly over the last two decades, approaching Western European standards due to the centralization of pediatric oncology care (Kutluk & Yeşilipek, 2015).

CONCLUSION

The epidemiology of cancer in Turkey reflects a nation in transition. While the country battles "diseases of affluence" like breast and colorectal cancer associated with urbanization and obesity, it simultaneously struggles with high rates of tobacco-related malignancies. The incidence of cancer is increasing, driven largely by the aging population.

The Turkish National Cancer Registry provides robust data that allows for effective policy-making. The KETEM network serves as a model for low-and-middle-income countries, particularly regarding the integration of HPV DNA testing. However, the sheer burden of lung cancer indicates that tobacco control must remain the top priority. Furthermore, the rising trend of obesity poses a "ticking time bomb" for future cancer statistics.

RECOMMENDATIONS

Based on the epidemiological evidence, the following recommendations are proposed:

Strengthen Tobacco Control: Implementation of stricter inspections on indoor smoking bans and increased taxation on tobacco products to curb consumption.

Enhance Screening Compliance: Public awareness campaigns should be intensified to increase participation in breast, cervical, and colorectal cancer screening, particularly in rural areas.

Obesity Prevention: National strategies to promote physical activity and healthy nutrition must be integrated into cancer prevention policies.

Regional Focus: Targeted interventions are needed for regions with specific risks, such as gastric cancer in Eastern Anatolia.

Genomic Profiling: Expanding access to genetic testing and personalized medicine in oncology centers to improve survival outcomes.

REFERENCES

Baris, Y. I., & Grandjean, P. (2006). Prospective study of mesothelioma mortality in Turkish villages with exposure to erionite. *Journal of the National Cancer Institute*, 98(6), 414-417.

Eser, S., Yakut, C., Özdemir, R., & Karakılınç, H. (2018). *Cancer Incidence in Turkey*. Turkish Ministry of Health, General Directorate of Public Health.

Gultekin, M., Karaca, M. J., Kucukyildiz, I., Dundar, S., Boztas, G., & Turan, S. H. (2017). Mega-HPV laboratories for cervical cancer screening: The Turkish experience. *Gynecologic Oncology*, 145, 18-20.

Koc, M., & Ergör, G. (2019). The burden of lung cancer in Turkey: A review of the literature. *Turkish Thoracic Journal*, 20(3), 201-206.

Kutluk, T., & Yeşilipek, A. (2015). Pediatric cancer registration in Turkey: Current status and future perspectives. *Journal of Pediatric Hematology/Oncology*, 37(2), 85-88.

Ministry of Health. (2023). *Health Statistics Yearbook 2022*. Republic of Turkey Ministry of Health.

Ozmen, V. (2014). Breast cancer in Turkey: Clinical and epidemiological characteristics. *The Journal of Breast Health*, 10(2), 64–65.

Sung, H., Ferlay, J., Siegel, R. L., Laversanne, M., Soerjomataram, I., Jemal, A., & Bray, F. (2021). Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. *CA: A Cancer Journal for Clinicians*, 71(3), 209-249.

Tuncer, A. M. (2017). *Cancer Control in Turkey*. Ministry of Health Publication No: 1083. Ankara.

GLOBAL CANCER EPIDEMIOLOGY

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ABSTRACT

Cancer is a leading cause of death globally, with its incidence and mortality varying significantly between regions, largely influenced by socioeconomic development. According to the World Health Organization (WHO) and the International Agency for Research on Cancer (IARC), there are nearly 20 million new cancer cases and around 10 million cancer-related deaths reported annually.

In high-income countries (HICs), the dominant cancer types are often associated with lifestyle and aging, such as breast, prostate, lung, and colorectal cancers. These nations often see higher survival rates due to advanced screening programs and access to comprehensive treatment. Conversely, low- and middle-income countries (LMICs) face a growing double burden. They still grapple with infection-related cancers, such as cervical cancer (linked to HPV), liver cancer (linked to HBV/HCV), and stomach cancer, while simultaneously experiencing a rapid increase in lifestyle-related cancers.

The overall global cancer burden is projected to increase substantially in the coming decades, primarily driven by population growth, aging, and the widespread adoption of Westernized lifestyles, including tobacco use, unhealthy diet, and physical inactivity. Tobacco remains the single greatest preventable cause of cancer worldwide.

Global efforts are focused on improving prevention, early detection, and treatment equity. This includes increasing vaccine coverage against cancer-causing viruses (e.g., HPV and HBV) and implementing effective population-based screening programs, particularly in underserved regions, to mitigate the rising global mortality.

Keywords: Global Cancer Burden, Incidence, Mortality, LMICs, Risk Factors.

INTRODUCTION

The global health landscape has undergone a profound transformation over the past few decades. As nations progress through the demographic and epidemiological transitions, non-communicable diseases (NCDs) have overtaken infectious diseases as the primary causes of death. Among these, cancer stands out as a complex, multifactorial challenge. According to the World Health Organization (WHO), cancer ranks as the first or second leading cause of death before the age of 70 in 112 of 183 countries (Sung et al., 2021).

Understanding the epidemiology of cancer is not merely an academic exercise but a prerequisite for effective national cancer control planning. The global cancer burden is not distributed equally; it varies significantly by geographic region, socioeconomic status, and gender. While high-income countries (HICs) grapple with cancers associated with "westernized" lifestyles—such as colorectal and breast cancer—low- and middle-income countries (LMICs) face a "double burden" of persistent infection-related cancers alongside rising rates of lifestyle-related malignancies (Bray et al., 2018). This article

aims to provide a detailed epidemiological overview of the global cancer status, analyzing current incidence and mortality data, exploring risk factors, and discussing the widening gap in cancer care equity.

GLOBAL INCIDENCE AND MORTALITY OVERVIEW

Current Estimates

Data from the International Agency for Research on Cancer (IARC) GLOBOCAN database indicates that in 2020, there were an estimated 19.3 million new cancer cases and almost 10.0 million cancer deaths worldwide. The global cancer burden is projected to rise by 47% from 2020 to 2040, reaching 28.4 million cases, solely due to demographic changes (Sung et al., 2021).

Geographic Distribution

Asia, home to nearly 60% of the global population, accounts for 49.3% of total cancer cases and 58.3% of cancer deaths. This disproportionately high mortality rate in Asia—and similarly in Africa—reflects the higher frequency of cancer types with poorer prognoses (such as liver and gastric cancers) and limited access to early diagnosis and treatment (Ferlay et al., 2019). In contrast, Europe accounts for 22.8% of total cancer cases but only 19.6% of cancer deaths, indicative of more effective screening programs and advanced therapeutic infrastructure.

SITE-SPECIFIC EPIDEMIOLOGY

The profile of common cancers varies dramatically based on the socioeconomic development of the region.

Lung Cancer

Lung cancer remains the leading cause of cancer incidence and mortality worldwide, with an estimated 2.2 million new diagnoses and 1.8 million deaths annually (Sung et al., 2021). It accounts for approximately one in ten (11.4%) cancers diagnosed and one in five (18.0%) deaths. While incidence rates are stabilizing or declining in men in western nations due to successful tobacco control, they are rising in women and in transitional countries where the tobacco epidemic has not yet peaked (Torre et al., 2016).

Breast Cancer

Female breast cancer has surpassed lung cancer as the most commonly diagnosed cancer globally, with an estimated 2.3 million new cases (11.7% of all cases). Incidence rates are highest in HICs (Australia/New Zealand, Western Europe, North America), exceeding 80 per 100,000. However, mortality rates are paradoxically higher in LMICs. For example, while the incidence in Eastern Africa is relatively low, the mortality-to-incidence ratio is high due to late-stage presentation and lack of access to adjuvant therapies (Wild et al., 2020).

Colorectal Cancer (CRC)

CRC is a distinct marker of socioeconomic transition. Incidence rates are approximately three to four times higher in developed nations compared to developing ones. However, as countries like Brazil, Russia, and China adopt western dietary habits—characterized by high consumption of processed meats and low physical activity—CRC rates are rapidly increasing (Arnold et al., 2017).

Prostate Cancer

Prostate cancer is the second most frequent cancer and the fifth leading cause of cancer death among men. Incidence rates show extreme variation, primarily driven by the utilization of Prostate-Specific Antigen (PSA) testing. The highest rates are found in Northern and Western Europe and the Caribbean, while the lowest are in South-Central Asia. The high rates in the Caribbean and among African American men in the US also suggest a strong genetic susceptibility (Culp et al., 2020).

Infection-Related Cancers (Stomach, Liver, Cervix)

Stomach cancer remains the fourth leading cause of cancer death, with high incidence rates in Eastern Asia and Eastern Europe, linked to *Helicobacter pylori* infection and dietary factors. Liver cancer, predominantly Hepatocellular Carcinoma (HCC), is the third leading cause of cancer death, driven by Hepatitis B and C prevalence in Asia and Africa. Cervical cancer, almost entirely attributable to Human Papillomavirus (HPV), remains a leading cause of death for women in Sub-Saharan Africa, highlighting global inequities in access to vaccination and screening (Arbyn et al., 2020).

MAJOR RISK FACTORS AND ETIOLOGY

Understanding the etiology is crucial for prevention. It is estimated that 30-50% of all cancer cases are preventable.

Tobacco Use

Tobacco is the single largest preventable cause of cancer, responsible for approximately 22% of cancer deaths (World Health Organization, 2018). It is causally linked to at least 15 types of cancer, including lung, oral cavity, bladder, and kidney. The shift of the tobacco industry's marketing focus to the developing world poses a significant future threat to global health.

Overweight, Obesity, and Physical Inactivity

Excess body weight is established as a risk factor for at least 13 cancer types, including esophageal adenocarcinoma, colorectal, breast (postmenopausal), and endometrial cancers. As the global prevalence of obesity doubles, particularly in urban environments, it is replacing smoking as the leading driver of carcinogenesis in some high-income populations (Lauby-Secretan et al., 2016).

Infections

Infections account for approximately 13% of all cancers diagnosed globally, but this figure rises to nearly 30% in Sub-Saharan Africa (Plummer et al., 2016). The primary agents—*H. pylori*, HPV, Hepatitis B (HBV), and Hepatitis C (HCV)—are targets for vaccination and antimicrobial treatments, offering a unique avenue for cancer elimination (e.g., the WHO strategy to eliminate cervical cancer).

Environmental and Occupational Exposures

Air pollution, specifically particulate matter (PM 2.5), has been classified as a Group 1 carcinogen by IARC and is a growing concern in rapidly industrializing nations like India and China. Additionally, occupational exposure to asbestos, benzene, and other carcinogens continues to contribute to the burden, often in regions with weak regulatory frameworks (Wild et al., 2020).

THE SOCIOECONOMIC GRADIENT AND DISPARITIES

Cancer epidemiology cannot be separated from economics. The Human Development Index (HDI) is a strong predictor of the cancer profile.

Very High HDI Countries: Characterized by high incidence rates but lower mortality-to-incidence ratios. The burden is dominated by lung, breast, colorectal, and prostate cancers.

Low and Medium HDI Countries: Characterized by lower overall incidence but high mortality. The burden is a mix of infection-related cancers (cervical, liver, stomach) and emerging lifestyle cancers. These countries often lack radiotherapy capacity, essential oncology drugs, and palliative care services (Fidler et al., 2018).

SURVIVAL TRENDS

Global surveillance data, such as the CONCORD-3 program, reveals vast disparities in survival. Five-year net survival for breast cancer exceeds 90% in the USA and Australia but remains below 66% in India and 40% in South Africa (Allemani et al., 2018). For childhood acute lymphoblastic leukemia, survival is over 90% in most high-income countries but remains below 60% in several low-income settings, primarily due to treatment abandonment and toxic death.

CONCLUSION

Global cancer epidemiology paints a picture of a dynamic and evolving crisis. The "cancer transition" is pushing the burden towards LMICs, which are least equipped to handle the high costs of complex oncological care. While progress in HICs is evident through declining mortality rates for major cancers, the global aggregate is worsening due to population growth, aging, and the globalization of risk factors like tobacco and obesogenic environments. The duality of the burden—battling both infectious and lifestyle malignancies—requires agile and data-driven health systems.

RECOMMENDATIONS

To mitigate the projected rise in global cancer burden, the following strategies are recommended for policymakers and public health leaders:

Prioritize Primary Prevention: Aggressive implementation of the WHO Framework Convention on Tobacco Control (FCTC) is non-negotiable. Furthermore, national strategies to combat obesity through taxation of sugar-sweetened beverages and promotion of physical activity are essential.

Universal Vaccination: Scaling up HBV vaccination and HPV vaccination programs to achieve herd immunity, particularly in LMICs, is the most cost-effective cancer control strategy available.

Early Detection: Implementation of population-based screening programs for cervical, breast, and colorectal cancers that are resource-appropriate. For example, using HPV DNA testing or visual inspection with acetic acid (VIA) for cervical cancer in low-resource settings.

Strengthening Health Systems: Investing in pathology services, surgical capacity, and radiotherapy infrastructure is critical. Essential cancer medicines must be included in universal health coverage packages.

Enhanced Cancer Registration: Support for high-quality population-based cancer registries in LMICs to provide the data necessary for monitoring trends and evaluating interventions.

REFERENCES

Allemani, C., Matsuda, T., Di Carlo, V., Harewood, R., Matz, M., Nikšić, M., ... & CONCORD Working Group. (2018). Global surveillance of trends in cancer survival 2000–14 (CONCORD-3): analysis of individual records for 37 513 025 patients diagnosed with one of 18 cancers from 322 population-based registries in 71 countries. *The Lancet*, 391(10125), 1023-1075.

Arbyn, M., Weiderpass, E., Bruni, L., de Sanjosé, S., Saraiya, M., Ferlay, J., & Bray, F. (2020). Estimates of incidence and mortality of cervical cancer in 2018: a worldwide analysis. *The Lancet Global Health*, 8(2), e191-e203.

Arnold, M., Sierra, M. S., Laversanne, M., Soerjomataram, I., Jemal, A., & Bray, F. (2017). Global patterns and trends in colorectal cancer incidence and mortality. *Gut*, 66(4), 683-691.

Bray, F., Ferlay, J., Soerjomataram, I., Siegel, R. L., Torre, L. A., & Jemal, A. (2018). Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA: A Cancer Journal for Clinicians*, 68(6), 394-424.

Culp, M. B., Soerjomataram, I., Efstathiou, J. A., Bray, F., & Jemal, A. (2020). Recent Global Patterns in Prostate Cancer Incidence and Mortality Rates. *European Urology*, 77(1), 38-52.

Ferlay, J., Colombet, M., Soerjomataram, I., Mathers, C., Parkin, D. M., Piñeros, M., ... & Bray, F. (2019). Estimating the global cancer incidence and mortality in 2018: GLOBOCAN sources and methods. *International Journal of Cancer*, 144(8), 1941-1953.

Fidler, M. M., Bray, F., & Soerjomataram, I. (2018). The global cancer burden and human development: A review. *Scandinavian Journal of Public Health*, 46(1), 27-36.

Lauby-Secretan, B., Scoccianti, C., Loomis, D., Grosse, Y., Bianchini, F., & Straif, K. (2016). Body fatness and cancer—viewpoint of the IARC Working Group. *New England Journal of Medicine*, 375(8), 794-798.

Plummer, M., de Martel, C., Vignat, J., Ferlay, J., Bray, F., & Franceschi, S. (2016). Global burden of cancers attributable to infections in 2012: a synthetic analysis. *The Lancet Global Health*, 4(9), e609-e616.

Sung, H., Ferlay, J., Siegel, R. L., Laversanne, M., Soerjomataram, I., Jemal, A., & Bray, F. (2021). Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. *CA: A Cancer Journal for Clinicians*, 71(3), 209-249.

Torre, L. A., Siegel, R. L., & Jemal, A. (2016). Lung cancer statistics. *Lung Cancer and Personalized Medicine*, 1-19.

Wild, C. P., Weiderpass, E., & Stewart, B. W. (Eds.). (2020). *World Cancer Report: Cancer Research for Cancer Prevention*. International Agency for Research on Cancer.

World Health Organization. (2018). *WHO Global Report on Trends in Prevalence of Tobacco Smoking 2000-2025, Second Edition*. World Health Organization

LEMNA MİNOR (SU MERCİMEĞİ) ÖRNEKLERİNDE KLOROFİL, PİGMENT VE PROTEİN İÇERİKLERİNİN BELİRLENMESİ

DETERMINATION OF CHLOROPHYLL, PIGMENT, AND PROTEIN CONTENTS IN *LEMNA MİNOR* (DUCKWEED) SAMPLES

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ÖZET

Küçük boyutlu ve basit morfolojik yapıya sahip bir su üstü bitkisi olan su mercimeği (*Lemna minör*), ekolojik değerlendirmeler ve biyoteknolojik uygulamalar açısından dikkate değer bir model organizma olma niteliği taşımaktadır. Özellikle hızlı büyüme kapasitesi, kolay kültüre alınması ve çevresel değişimlere duyarlı yapısı sayesinde ekotoksikoloji, su kalitesi değerlendirilmesi ve biyoteknoloji araştırmalarında kullanılmaktadır. Büyüme hızı besin elementleri özellikle azot ve fosfor miktarına, ışık şiddetine ve sıcaklık gibi faktörlere bağlı olarak değişebilmektedir. Bitkilerin enerji üretim kapasitesini şekillendiren ve fotosentezin merkez pigmenti konumunda bulunan klorofil miktarı, çevresel ışık yoğunluğu ile besin elementlerinin sınırlı ya da aşırı düzeyde bulunmasına bağlı olarak farklılık göstermektedir. Klorofil miktarındaki azalma, fotosentetik kapasitenin baskılandığını ve metabolik stresin arttığını gösterirken; artış, aktif fotosentez ve sağlıklı büyümenin göstergesi kabul edilmektedir. Karotenoidler ise fotosentezde yardımcı pigmentler olarak görev yapar ve klorofilleri aşırı ışık hasarından korumaktadır. Antioksidan özellikleri sayesinde oksidatif stres koşullarında hücreleri koruyucu rol üstlenmektedir. Karotenoid düzeylerindeki değişimler, bitkinin ışık adaptasyonu ve stres yanıtlarının değerlendirilmesinde önemli bir parametredir. Toplam protein miktarı, hücresel metabolizmanın genel durumu hakkında bilgi verir ve protein sentezi, büyüme ve gelişmenin biyokimyasal temeli olduğundan, protein düzeyleri çevresel koşullara duyarlı olarak değişebilmektedir. Bu çalışmada Tekirdağ Namık Kemal Üniversitesi Fen-Edebiyat Fakültesi Biyoloji Bölümü Sucul Omurgalı Deney Ünitesi'nde kapalı devre sisteminde yetiştirilen *Lemna minor* örneklerinin klorofil, pigment ve protein içerikleri belirlenmiştir. Gerçekleştirilen analizler sonucunda, klorofil-a düzeyi 188,99±11,58 mg/g, klorofil-b düzeyi 106,06±14,01 mg/g, karotenoid miktarı 16280,13±1430,04 mg/g olarak saptanmış; ayrıca kuru ağırlığın %24,22±3,56'sını protein içeriğinin oluşturduğu belirlenmiştir. Analizler sonucunda klorofil-a ve klorofil-b düzeylerinin yüksek olduğu, karotenoid miktarının dikkate değer seviyelere ulaştığı ve kuru ağırlığın yaklaşık %24'ünü protein içeriğinin oluşturduğu saptanmıştır.

Elde edilen bulgular, *Lemna minor*'un fotosentetik kapasitesinin güçlü olduğunu ve biyoteknolojik uygulamalarda sürdürülebilir protein kaynağı olarak değerlendirilebileceğini göstermektedir.

Anahtar Sözcükler: Su mercimeği, Klorofil, Karotenoid, Protein.

ABSTRACT

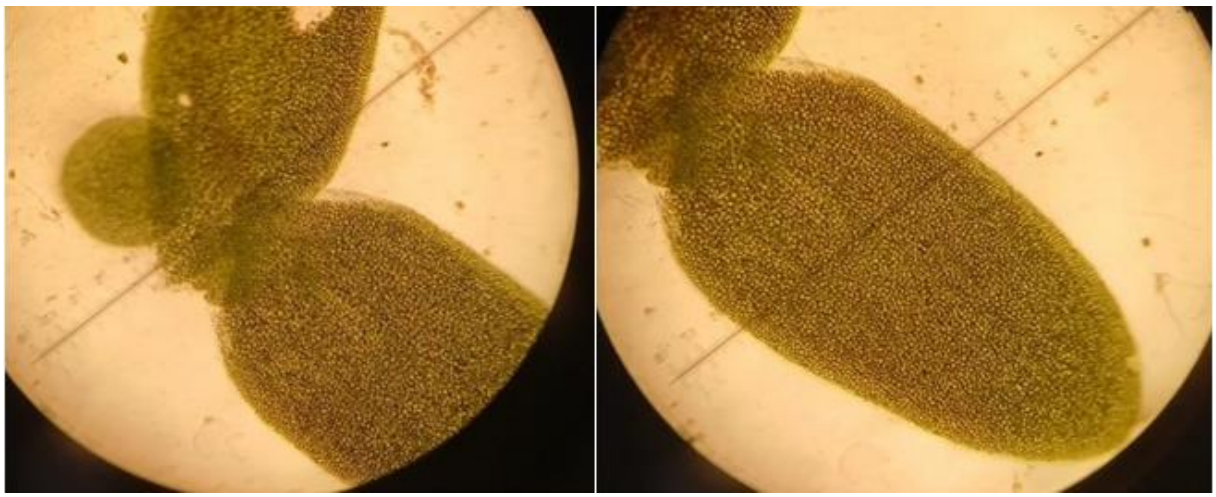
Duckweed (*Lemna minor*), an aquatic plant with a small size and simple morphological structure, is a remarkable model organism for ecological assessments and biotechnological applications. It is used in ecotoxicology, water quality assessment, and biotechnology research, particularly due to its rapid growth, ease of cultivation, and sensitivity to environmental changes. Growth rate may vary depending on factors such as nutrient levels, especially nitrogen and phosphorus, as well as light intensity and temperature. The amount of chlorophyll, which determines the energy production capacity of plants and is the central pigment of photosynthesis, varies depending on environmental light intensity and the limited or excessive availability of nutrients. While a decrease in chlorophyll indicates suppressed photosynthetic capacity and increased metabolic stress, an increase is considered an indicator of active photosynthesis and healthy growth. Carotenoids act as accessory pigments in photosynthesis and protect chlorophyll from excessive light damage. Thanks to its antioxidant properties, it plays a protective role in cells under conditions of oxidative stress. Changes in carotenoid levels are an important parameter for evaluating plant light adaptation and stress responses. Total protein amount provides information about the general status of cellular metabolism. As protein synthesis is the biochemical basis of growth and development, protein levels can vary sensitively in response to environmental conditions. In this study, the chlorophyll, pigment, and protein contents of *Lemna minor* samples grown in a closed-loop system at the Aquatic Vertebrate Experimental Unit, Department of Biology, Faculty of Arts and Sciences, Tekirdağ Namık Kemal University, were determined. The chlorophyll-a level was found to be 188.99±11.58 mg/g, the chlorophyll-b level 106.06±14.01 mg/g, and the carotenoid amount 16280.13±1430.04 mg/g. It was also found that the protein content constituted 24.22±3.56% of the dry weight. As a result of the analyses, it was determined that the levels of chlorophyll-a and chlorophyll-b were high, the amount of carotenoids reached significant levels, and approximately 24% of the dry weight consisted of protein. The findings indicate that *Lemna minor* has strong photosynthetic capacity and can be considered a sustainable protein source for biotechnological applications.

Keywords: Duckweed, Chlorophyll, Carotenoids, Protein.

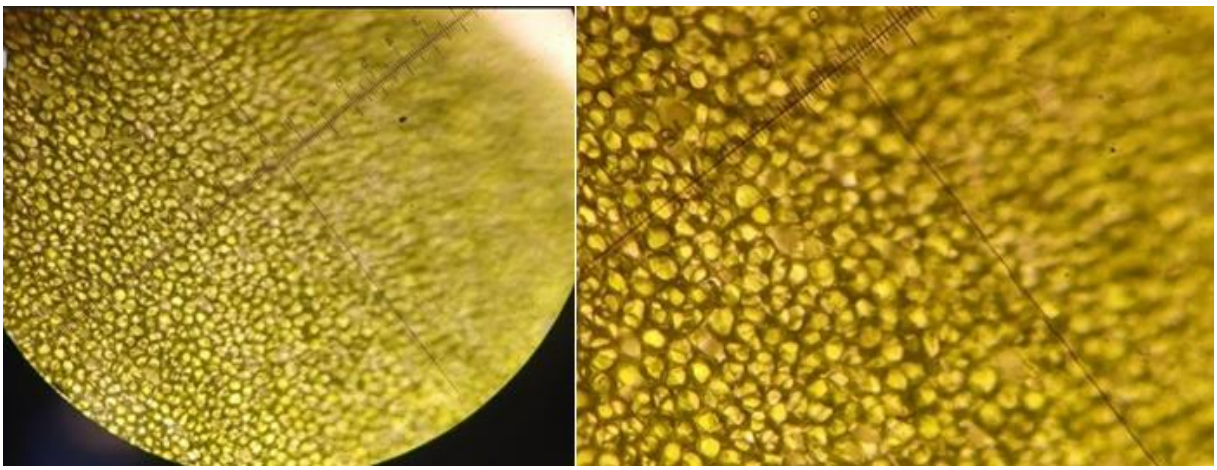
GİRİŞ

Su mercimeği (*Lemna minor*), küçük boyutlu ve basit morfolojik yapısı ile dikkat çeken, su yüzeyinde serbest halde gelişen bir makrofit türüdür (Şekil 1). Bitki genellikle 6–8 mm uzunluğunda, oval ya da eliptik formda tek bir yaprak (frond) ile karakterize edilir (Şekil 2,3) ve bu yaprak, su yüzeyinde serbest halde gelişerek fotosentetik aktivitenin temel organı olarak görev yapmaktadır (Sil, Gupta ve Neela, 2023) Bitkinin kök sistemi ise tek bir uzun kökten oluşmakta ve 2 cm'ye kadar uzayabilmekte (Şekil 4) ve kök uzunluğu, yetiştiği ortamın besin elementleri içeriği ile doğrudan ilişkili olup özellikle azot ve fosfor gibi temel besin maddelerinin konsantrasyonu arttıkça kök gelişiminin de paralel olarak uzadığı bildirilmektedir (Cedergreen ve Madsen, 2002; Steinberg, 1946).

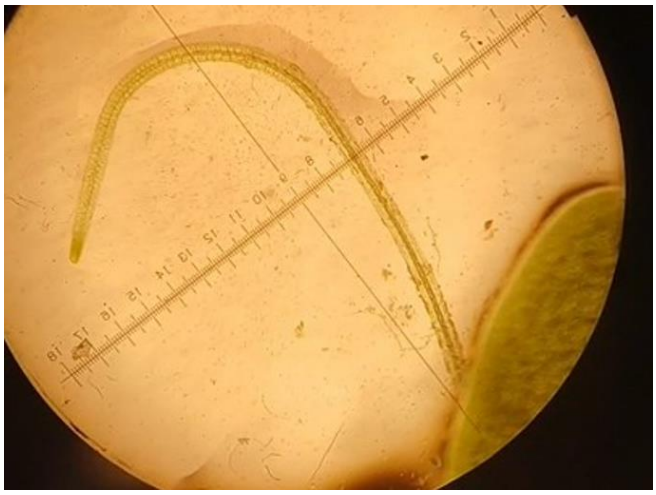
Şekil 1. Kapalı devre sistemde yetiştirilen *Lemna minor* (su mercimeği) örneklerinin su yüzeyinde oluşturduğu yoğun bitki örtüsü



Şekil 2. Işık mikroskobu altında gözlemlenen su mercimeği bitkisinin hücresel ve morfolojik yapısı



Şekil 3. Işık mikroskobu altında gözlemlenen *Lemna minor* (su mercimeği) yaprağının epidermis hücrelerinin yakın çekim mikroskobik görüntüsü



Şekil 4. Işık mikroskobu altında gözlemlenen su mercimeği bitkisinin kök ucu bölgesi

Minimal yapısına rağmen ekolojik değerlendirmeler ve biyoteknolojik uygulamalar açısından dikkate değer bir model organizma olarak öne çıkan su mercimeği özellikle hızlı büyüme kapasitesi, kolay kültüre alınabilmesi ve çevresel değişimlere yüksek duyarlılığı sayesinde ekotoksikoloji, su kalitesi değerlendirmeleri ve biyoteknoloji araştırmalarında yaygın olarak kullanılmaktadır (Goala, Bachheti, Kumar Arya ve Kumar, 2025;Vulpe, Toplicean, Agachi ve Datcu, 2025). Bu özellikleri, *Lemna minor*'u hem temel bilimlerde hem de uygulamalı araştırmalarda sürdürülebilir çözümler geliştirmek için önemli bir biyolojik araç haline getirmiştir.

Bitkinin büyüme hızı; besin elementlerinin (özellikle azot ve fosfor) miktarı, ışık şiddeti ve sıcaklık gibi çevresel faktörlere bağlı olarak değişkenlik göstermekle birlikte fotosentezin merkez pigmenti olan klorofil, bitkinin enerji üretim kapasitesini doğrudan şekillendirmekte ve çevresel koşullara bağlı olarak farklı düzeylerde bulunabilmektedir (Demmig-Adams ve ark., 2022). Klorofil miktarındaki azalma, fotosentetik kapasitenin baskılandığını ve metabolik stresin arttığını gösterirken; artış ise aktif fotosentez ve sağlıklı büyümenin göstergesi olarak kabul edilmektedir (Liebers ve ark., 2023). Bunun yanında karotenoidler, fotosentezde yardımcı pigmentler olarak görev yapmakta ve klorofilleri aşırı ışık hasarından korumakta ve antioksidan özellikleri sayesinde oksidatif stres koşullarında hücreleri koruyucu rol üstlenmeleri, karotenoid düzeylerini bitkinin ışık adaptasyonu ve stres yanıtlarının değerlendirilmesinde kritik bir parametre haline getirmektedir (Maslova, Markovskaya ve Slemnev, 2021).

Su mercimeği bitkisi olumsuz koşullarda büyüme hızını düşürür ve çözünür protein kaybı ortaya çıkabilir (Cooke, Oliver ve Davies, 1979). Protein kaybı, büyüme ve gelişmenin biyokimyasal temeli olduğundan, çevresel koşullara bağlı olarak protein düzeylerinde meydana gelen değişimler, bitkinin çevreye karşı metabolik adaptasyon kapasitesini ortaya koymaktadır. Bu bağlamda, *Lemna minor*'un pigment ve protein içeriklerinin belirlenmesi, hem fotosentetik kapasitenin hem de metabolik dayanıklılığın anlaşılması açısından büyük önem taşımaktadır.

ARAŞTIRMA ve BULGULAR

Bu çalışmada Tekirdağ Namık Kemal Üniversitesi Fen-Edebiyat Fakültesi Biyoloji Bölümü Sucul Omurgalı Deney Ünitesi'nde kapalı devre sisteminde yetiştirilen *Lemna minor* örneklerinin klorofil, pigment ve protein içerikleri analiz edilmiştir.

Klorofil ve Karotenoid İçeriğinin Belirlenmesi

Klorofil ekstraksiyonu ve tayini, Liu ve ark. (2018) tarafından bildirilen yönteme atıfta bulunularak gerçekleştirilmiştir. Analiz için su mercimeği örneğinin 0,1 g'ı toz haline getirilmiş ve klorofil

pigmentlerinin ekstraksiyonu amacıyla 10 mL çözücü karışımı (%5 aseton + %95 etanol, v/v) kullanılmıştır. Örnekler, 36 saat boyunca karanlık koşullarda inkübasyona bırakılmıştır. Ekstraksiyon sonrasında elde edilen süspansiyonlar spektrofotometre (UVmini-1240,SHIMADZU) ile 645 nm ve 663 nm dalga boylarında ölçülmüştür (Aghofack-Nguemezi, Tonfack, Neambo, Schoch ve Gräfe, 2006; Li ve ark. 2025; Martins, Rani-Borges, Queiroz, de Souza ve Pompêo, 2025).

Elde edilen absorbans değerleri aşağıdaki formüller kullanılarak hesaplanmıştır:

$$Klorofil\ a = (12{,}70 \times A_{663}) - (2{,}69 \times A_{665})$$

$$Klorofil\ b = (22{,}90 \times A_{645}) - (4{,}68 \times A_{663})$$

$$Karotenoid = 1000 \times A_{470} - (1{,}82 \times Klorofil\ a) - (85{,}02 \times Klorofil\ b) \div 198$$

A663, A645 ve A470 belirli bir dalga boyundaki optik yoğunluğa karşılık gelmektedir.

Burada klorofil-a, klorofil-b ve karotenoid miktarını ifade etmektedir. Sonuçlar mg/g biriminde değerlendirilmiştir.

Protein İçeriğinin Belirlenmesi

Toplam çözünür protein miktarı, Bradford yöntemi kullanılarak belirlenmiştir (Bradford, 1976). Analiz için 0,2 g taze bitki örneği, 1,5 mL 50 mM sodyum fosfat tamponu (pH 7,8) içerisinde homojenize edilmiştir. Kullanılan tampon çözeltisi, 1 mM EDTA ve %2 (a/h) polivinilpolipirrolidon (PVPP) içermektedir. Homojenizasyon sonrasında elde edilen ekstraktlar, 4 °C'de 15 dakika boyunca 10.000 rpm'de santrifüjlenmiş ve süpernatantlar toplam çözünür protein tayini için kullanılmıştır. Protein miktarının standartlaştırılması amacıyla, farklı konsantrasyonlarda (0; 0,2; 0,4; 0,6; 0,8 ve 1 mg mL^{-1}) sığır serum albümini (BSA) standartları hazırlanmıştır. Bradford reaktifi, 25 mg Coomassie Brilliant Blue G-250'nin 25 mL metanol ve 50 mL %85 (a/h) fosforik asit içerisinde çözülmesiyle hazırlanmıştır. Çözelti, 850 mL damıtılmış su ile tamamlanmış ve Whatman filtre kağıdı No.1'den süzülerek kullanıma hazır hale getirilmiştir. Analiz sırasında, 50 µL ekstrakt üzerine 1 mL Bradford reaktifi eklenmiş ve karışım oda sıcaklığında 5 dakika inkübe edilmiştir. Ardından absorbans değerleri spektrofotometre (595 nm) ile ölçülmüştür. Elde edilen veriler, standart eğriye göre değerlendirilerek toplam çözünür protein miktarı mg/g taze ağırlık cinsinden hesaplanmıştır.

Bu çalışmada *Lemna minor* örneklerinde gerçekleştirilen pigment ve protein analizleri, türün fotosentetik kapasitesinin ve biyoteknolojik potansiyelinin değerlendirilmesine önemli katkılar sağlamaktadır. Elde edilen sonuçlara göre klorofil-a düzeyi 188,99±11,58 mg/g, klorofil-b düzeyi 106,06±14,01 mg/g olarak belirlenmiş (Tablo 1); bu değerler, bitkinin yüksek fotosentetik aktiviteye sahip olduğunu göstermektedir. Klorofil-a ve klorofil-b miktarlarının yüksekliği, ışık enerjisinin etkin biçimde yakalanarak biyokimyasal süreçlere aktarılabildiğini ve bitkinin sağlıklı büyüme koşullarında bulunduğunu ortaya koymaktadır (Pavlović ve ark., 2014).

Karotenoid miktarının 16280,13±1430,04 mg/g gibi dikkate değer bir seviyeye ulaşması, *Lemna minor*'un ışık adaptasyonu ve oksidatif stres koşullarına karşı güçlü bir koruma mekanizmasına sahip olduğunu göstermektedir (Tablo 1). Karotenoidler, fotosentezde yardımcı pigmentler olarak klorofilleri aşırı ışık hasarından korumakta ve antioksidan özellikleri sayesinde hücresel metabolizmayı dengelemektedir (Hashimoto, Uragami ve Cogdell, 2016). Bu bulgu, türün çevresel stres faktörlerine karşı dayanıklılığını ve adaptasyon kapasitesini desteklemektedir.

Protein içeriğinin kuru ağırlığın %24,22±3,56'sını oluşturması, *Lemna minor*'un biyoteknolojik uygulamalarda sürdürülebilir bir protein kaynağı olarak değerlendirilebileceğini göstermektedir (Tablo 1). Protein düzeylerinin bu denli yüksek olması, bitkinin metabolik olarak aktif olduğunu ve büyüme ile gelişme süreçlerinin güçlü bir biyokimyasal temele dayandığını ortaya koymaktadır. Bu durum,

özellikle hayvan yemi, biyoteknolojik üretim süreçleri ve sürdürülebilir biyokütle kaynakları açısından *Lemna minor*'un önemini artırmaktadır.

Tablo 1. *Lemna minor* örneklerinde klorofil-a, klorofil-b, karotenoid ve toplam çözünür protein içerikleri (ortalama ± standart sapma, mg/g ve % kuru ağırlık protein)

Klorofil-a	Klorofil-b	Karotenoid	Protein
188,99±11,58	106,06±14,01	16280,13±1430,04	24,22±3,56

Elde edilen bulgular, literatürde bildirilen benzer çalışmalarla uyum göstermektedir. Daha önce yapılan araştırmalarda *Lemna minor*'un yüksek pigment ve protein içeriklerine sahip olduğu, bu nedenle ekotoksikoloji çalışmalarında model organizma olarak kullanılabileceği ve biyoteknolojik uygulamalarda alternatif bir biyokütle kaynağı olabileceği vurgulanmıştır. Bu çalışmada elde edilen veriler, söz konusu literatür bulgularını destekler nitelikte olup, türün hem ekolojik hem de biyoteknolojik açıdan stratejik bir öneme sahip olduğunu ortaya koymaktadır.

SONUÇ

Lemna minör bitkisinin yüksek klorofil ve karotenoid düzeyleri ile güçlü fotosentetik kapasiteye sahip olduğu, ayrıca yüksek protein içeriği sayesinde biyoteknolojik uygulamalarda sürdürülebilir bir kaynak olarak değerlendirilebileceği söylenebilir. Bu özellikler, türün hem çevresel değerlendirmelerde hem de endüstriyel biyoteknoloji çalışmalarında kullanımının genişletilmesi gerektiğini göstermektedir. Dolayısıyla, bu türün ekolojik ve biyoteknolojik araştırmalarda model organizma olarak kullanımının genişletilmesi, hem çevresel değerlendirmeler hem de endüstriyel biyoteknoloji açısından stratejik bir önem taşımaktadır.

KAYNAKÇA

Aghofack-Nguemezi, J., Tonfack, L. B., Neambo, H. K., Schoch, S., ve Gräfe, U. (2006). Effects of coconut oil and palm kernel oil treatments on ripening process in banana fruits. *Cameroon J. Exp. Biol*, *2*(1), 16-21.

Bradford, M. M. (1976). A rapid and sensitive method for the quantitation of microgram quantities of protein utilizing the principle of protein-dye binding. *Analytical biochemistry*, *72*(1-2), 248-254.

Cedergreen, N., ve Madsen, T. V. (2002). Nitrogen uptake by the floating macrophyte Lemna minor. *New phytologist*, *155*(2), 285-292.

Cooke, R. J., Oliver, J., ve Davies, D. D. (1979). Stress and protein turnover in *Lemna minor*. *Plant Physiology*, *64*(6), 1109-1113.

Demmig-Adams, B., López-Pozo, M., Polutchko, S. K., Fourounjian, P., Stewart, J. J., Zenir, M. C., ve Adams III, W. W. (2022). Growth and nutritional quality of Lemnaceae viewed comparatively in an ecological and evolutionary context. *Plants*, *11*(2), 145.

Goala, M., Bachheti, A., Kumar Arya, A., ve Kumar, V. (2025). A review on the role of duckweed (*Lemna spp.*) in the rejuvenation of aquatic bodies by pollutant remediation and recovery of valuable resources. *Environmental Monitoring and Assessment*, *197*(5), 1-13.

Hashimoto, H., Uragami, C., ve Cogdell, R. J. (2016). Carotenoids and photosynthesis. *Carotenoids in nature: Biosynthesis, regulation and function*, 111-139.

Li, L., Ye, S., Chen, F., Pan, Q., Yao, X., Tian, S., ... ve Lu, L. (2025). A Shading-Responsive bHLH Transcription Factor (CsPIF7) Promotes Theanine Biosynthesis in Tea Plants (*Camellia sinensis*). *Plant, Cell & Environment*, *48*(9), 7005-7016.

Liebers, M., Hommel, E., Grübler, B., Danehl, J., Offermann, S., ve Pfannschmidt, T. (2023). Photosynthesis in the biomass model species *Lemna minor* displays plant-conserved and species-specific features. *Plants*, *12*(13), 2442.

Liu, L., Li, Y., She, G., Zhang, X., Jordan, B., Chen, Q., ... ve Wan, X. (2018). Metabolite profiling and transcriptomic analyses reveal an essential role of UVR8-mediated signal transduction pathway in regulating flavonoid biosynthesis in tea plants (*Camellia sinensis*) in response to shading. *BMC Plant Biology*, *18*(1), 233.

Martins, T. F. G., Rani-Borges, B., Queiroz, L. G., de Souza, K. F., ve Pompêo, M. (2025). Toxicity of polyethylene microplastics combined with medroxyprogesterone on photosynthetic pigments of Lemna minor. *Aquatic Ecology*, *59*(1), 307-322.

Maslova, T. G., Markovskaya, E. F., ve Slemnev, N. N. (2021). Functions of carotenoids in leaves of higher plants. *Biology Bulletin Reviews*, *11*(5), 476-487.

Pavlović, D., Nikolić, B., Đurović, S., Waisi, H., Anđelković, A., ve Marisavljević, D. (2014). Chlorophyll as a measure of plant health: Agroecological aspects. *Pesticidi i fitomedicina*, *29*(1), 21-34.

Sil, S. K., Gupta, S., ve Neela, F. A. (2023). Anatomical features and antimicrobial activity of duckweed. *Bangladesh Journal of Botany*, *52*(1), 105-110.

Steinberg, R. A. (1946). Mineral requirements of Lemna minor. *Plant Physiology*, *21*(1), 42.

Vulpe, C. B., Toplicean, I. M., Agachi, B. V., ve Datcu, A. D. (2025). A Review on Uses of *Lemna minor*, a Beneficial Plant for Sustainable Water Treatments, in Relation to Bioeconomy Aspects. *Water*, *17*(9), 1400.

AZOLLA CAROLİNİANA'NIN PROTEİN, KLOROFİL VE KAROTENOİD İÇERİĞİNİN BELİRLENMESİ VE BİYOTEKNOLOJİK POTANSİYELİ

DETERMINATION OF PROTEIN, CHLOROPHYLL, AND CAROTENOID CONTENT IN *AZOLLA CAROLİNİANA* AND ITS BIOTECHNOLOGICAL POTENTIAL

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ÖZET

Azolla caroliniana, sucul ekosistemlerde hızlı büyüme kapasitesi, yüksek biyokütle üretimi ve atmosferik azotu fikse etme yeteneği ile öne çıkan bir su eğrelti otudur. Bu tür, köklerinde simbiyotik olarak yaşayan siyanobakteri *Anabaena azollae* sayesinde atmosferik azotu biyolojik olarak bağlayarak hem kendi gelişimini desteklemekte hem de bulunduğu ortama önemli miktarda azot kazandırmaktadır. Bu özellik, Azolla'yı özellikle tarımsal üretimde biyogübre olarak değerli kılmakta; pirinç tarlalarında doğal azot kaynağı olarak kullanımıyla verim artışı sağlanmaktadır. Yüksek protein içeriği sayesinde Azolla, hayvancılıkta alternatif yem katkısı olarak da öne çıkmaktadır. Kuru ağırlığının yaklaşık beşte birini oluşturan protein fraksiyonu, ruminantlar, kümes hayvanları ve balıklar için besleyici bir kaynak sunmaktadır. Bunun yanı sıra, klorofil ve karotenoid gibi pigmentlerin zenginliği, bitkinin fotosentetik kapasitesini artırmakla kalmayıp, antioksidan özellikleriyle hayvan beslenmesinde fonksiyonel katkılar sağlamaktadır. Ekosistem restorasyonu açısından bakıldığında, Azolla'nın hızlı büyüme ve yüksek fotosentetik etkinliği sayesinde karbon sekestrasyonu ve oksijen üretimi gibi ekosistem hizmetlerine katkıda bulunduğu görülmektedir. Ayrıca su yüzeyini kaplayarak ışık geçirgenliğini azaltması, bazı durumlarda alg patlamalarını kontrol altına almakta ve su kalitesinin korunmasına yardımcı olmaktadır. Bu çalışmada Tekirdağ Namık Kemal Üniversitesi Fen-Edebiyat Fakültesi Biyoloji Bölümü bünyesinde yer alan Sucul Omurgalı Deney Ünitesi'nde yetiştirilen azolla örneklerinde protein, klorofil ve karotenoid içerikleri belirlenmiştir. Kontrollü koşullarda yetiştirilen bitkilerden elde edilen biyokimyasal analizler sonucunda, klorofil-a düzeyinin 228,96±2,78 mg/g, klorofil-b düzeyinin 129,34±1,91 mg/g ve karotenoid miktarının 20864,48±1078,44 mg/g olduğu; ayrıca kuru ağırlığın %21,66±1,87'sini protein içeriğinin oluşturduğu saptanmıştır. Bu bulgular, *Azolla caroliniana*'nın yüksek klorofil-a ve klorofil-b içerikleri sayesinde güçlü bir fotosentetik kapasiteye sahip olduğunu, dikkate değer düzeydeki karotenoid miktarı ile antioksidan özellikler taşıdığını ve yaklaşık %21 oranındaki protein içeriğiyle sürdürülebilir hayvansal üretimde alternatif yem kaynağı olarak değerlendirilebileceğini göstermektedir. Sonuç olarak *Azolla caroliniana*, sürdürülebilir tarım

uygulamalarına katkı sağlayan ve çevresel biyoteknoloji alanında yenilikçi çözümler sunabilecek değerli bir biyolojik kaynak olarak dikkat çekmektedir.

Anahtar Sözcükler: *Anabaena azollae*, *Azolla caroliniana*, Klorofil, Karotenoid, Protein.

ABSTRACT

Azolla caroliniana is an aquatic fern notable for its rapid growth, high biomass production, and ability to fix atmospheric nitrogen in aquatic ecosystems. This species biologically fixes atmospheric nitrogen thanks to the cyanobacterium *Anabaena azollae*, which lives symbiotically in its roots, supporting its own development and contributing a significant amount of nitrogen to its environment. This feature makes Azolla particularly valuable as a biofertiliser in agricultural production, as its use as a natural nitrogen source in rice fields increases yields. Thanks to its high protein content, Azolla also stands out as an alternative feed additive in livestock production. The protein fraction, which constitutes about one-fifth of its dry weight, provides a nutritious source for ruminants, poultry and fish. In addition, the abundance of pigments such as chlorophyll and carotenoids increases the plant's photosynthetic capacity and provides functional benefits in animal nutrition through their antioxidant properties. From the perspective of ecosystem restoration, Azolla contributes to ecosystem services such as carbon sequestration and oxygen production due to its rapid growth and high photosynthetic efficiency. Additionally, by covering the water surface and reducing light penetration, it helps control algal blooms in some cases and helps maintain water quality. In this study, the protein, chlorophyll, and carotenoid contents of azolla samples grown in the Aquatic Vertebrate Experimental Unit of the Department of Biology at Tekirdağ Namık Kemal University Faculty of Arts and Sciences were determined. Biochemical analyses of plants grown under controlled conditions determined that the chlorophyll-a level was 228.96 ± 2.78 mg/g, the chlorophyll-b level was 129.34 ± 1.91 mg/g, and the carotenoid content was 20864.48 ± 1078.44 mg/g. Additionally, protein content constituted 21.66 ± 1.87% of the dry weight. These findings indicate that *Azolla caroliniana* has strong photosynthetic capacity due to its high chlorophyll-a and chlorophyll-b content, possesses antioxidant properties owing to its notable carotenoid levels, and, with a protein content of approximately 21%, can be considered an alternative feed source for sustainable livestock production. As a result, *Azolla caroliniana* stands out as a valuable biological resource that can contribute to sustainable agricultural practices and provide innovative solutions in environmental biotechnology.

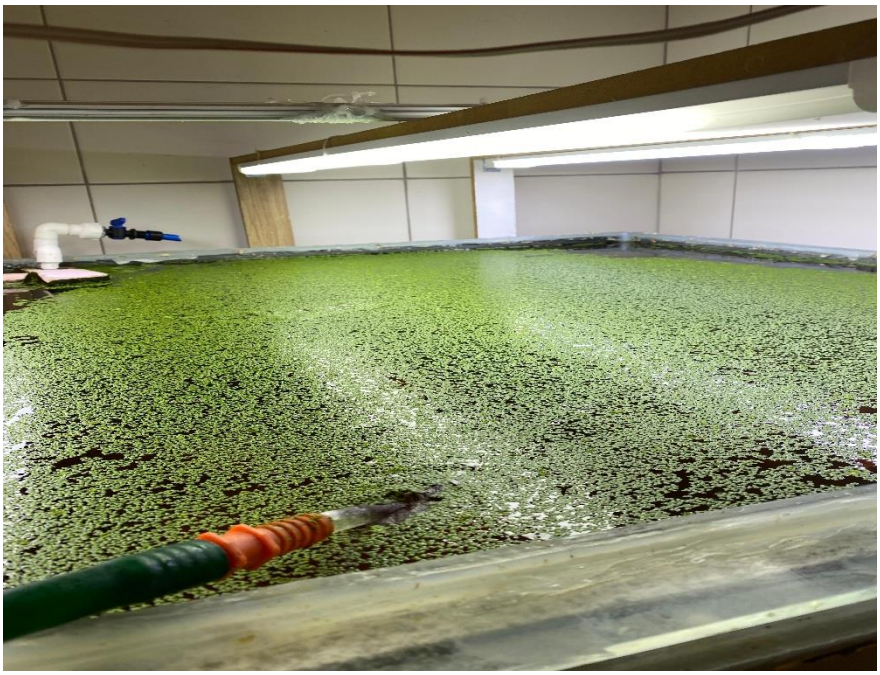
Keywords: *Anabaena azollae*, *Azolla caroliniana*, Chlorophyll, Carotenoids, Protein.

GİRİŞ

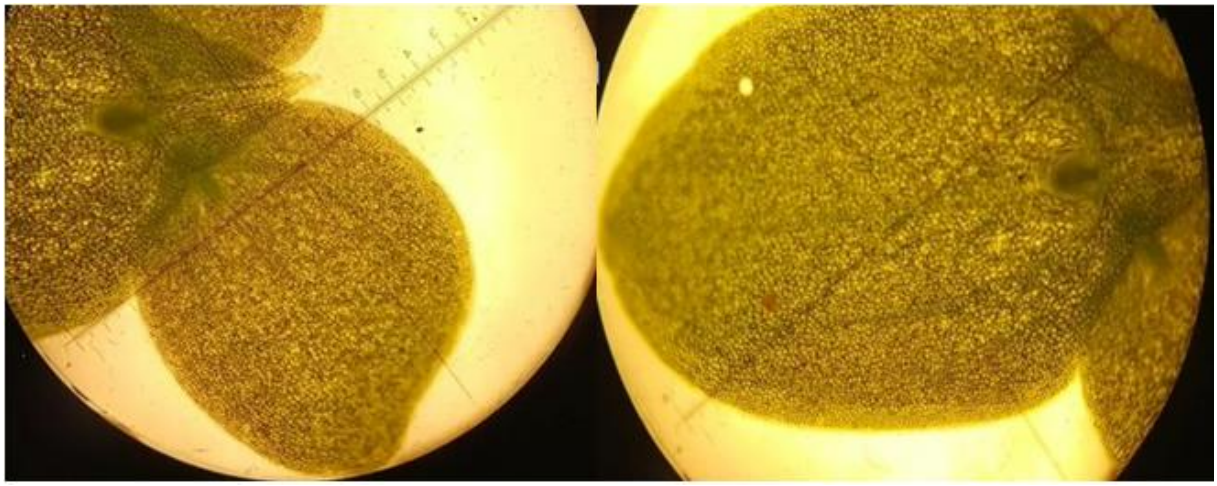
Yeşil altın olarak bilinen azolla, sucul ekosistemlerde hızla büyüyebilen, yüksek biyokütle üretim kapasitesine sahip ve atmosferik azotu biyolojik olarak bağlayabilen küçük su eğrelti otlarıdır (Vijayan, Deepthi ve Reshma, 2024) (Şekil 1). Bu özellikleri sayesinde, hem doğal ekosistemlerde hem de tarımsal üretim sistemlerinde dikkat çekici bir rol üstlenmektedirler. Özellikle *Azolla caroliniana*, köklerinde simbiyotik olarak yaşayan siyanobakteri *Anabaena azollae* ile kurduğu mutualistik ilişki sayesinde atmosferik azotu fikse ederek hem kendi gelişimini desteklemekte hem de bulunduğu ortama önemli miktarda azot kazandırmaktadır (Braun-Howland ve Nierzwicki-Bauer, 2018; Lechno-Yossef ve Nierzwicki-Bauer, 2002). Bu biyolojik süreç, Azolla'yı doğal azot kaynağı olarak değerli kılmakta ve özellikle pirinç tarımı gibi sucul tarımsal sistemlerde biyogübre olarak kullanımını yaygınlaştırmaktadır. *Azolla caroliniana*'nın üst epidermisi, ortalama 50 µm uzunluğunda tek hücreli papilliform trikomlarla karakterize olup bu yapılar hem türün mikroskobik tanımlanmasında ayırt edici bir morfolojik kriter sunmakta hem de epidermisin koruyucu işlevleri aracılığıyla çevresel koşullara adaptasyonunda rol oynamaktadır (Sârbu, Smarandache, Marinescu, Paraschiv, Mihai ve Velicu, 2017) (Şekil 2-3-4).

Azolla'nın tarımsal üretimdeki önemi yalnızca biyogübre potansiyeli ile sınırlı değildir. Yüksek protein içeriği sayesinde hayvancılıkta alternatif yem katkısı olarak da değerlendirilmektedir (Katole, Lende ve

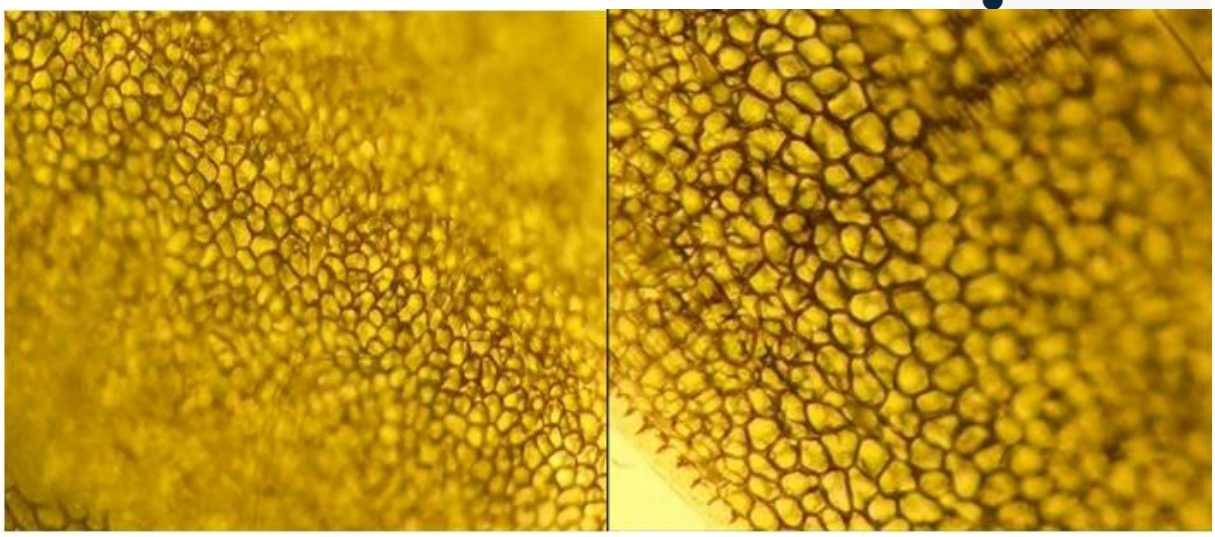
Patil, 2017; Yohana ve ark., 2023) (Şekil 5). Azolla sucul ortamlarda ağır metaller ve kirleticileri absorbe ederek suyun arıtılmasına katkı sağlar ve %25–33 oranındaki yüksek ham protein içeriği sayesinde hayvancılık ve su ürünleri yetiştiriciliğinde sürdürülebilir ve ekonomik bir yem kaynağı olarak değerlendirilebilir (Yang, Yang, Deng ve Ying, 2025). Bunun yanı sıra, tüm temel amino asitleri, demir, kalsiyum, magnezyum, potasyum, fosfor, manganez gibi mineralleri ve ayrıca önemli miktarlarda A vitamini öncüsü beta-karoten, B_{12} vitamini, klorofil, karotenoidler içermektedir (Rashad, 2021; Tadavi, Patil ve Kadam, 2017). Bu yönüyle Azolla, sürdürülebilir hayvansal üretimde hem besleyici hem de fonksiyonel bir yem katkısı olarak öne çıkmaktadır.



Şekil 1. *Azolla caroliniana* biyokütle üretimi için optimize edilmiş akuaponik sistem



Şekil 2. Azolla bitki yaprağının mikroskobik analizi: epidermis ve mezofil hücreleri



Şekil 3. Azolla bitki yaprak epidermis hücrelerinin mikroskobik görüntüsü: poligonal hücre düzeni

Şekil 4. Işık mikroskobu altında gözlemlenen azolla bitkisinin kök ucu bölgesi

Şekil 5. *Azolla caroliniana*'nın iç mekanda kurutulması sonrası elde edilen biyokütle görünümü

Son yıllarda sürdürülebilir tarım uygulamalarına yönelik artan ilgi, doğal kaynakların etkin kullanımını ve çevre dostu biyoteknolojik çözümleri ön plana çıkarmaktadır. Bu bağlamda Azolla, hem biyogübre hem de yem katkısı olarak çift yönlü bir değer taşımakta; aynı zamanda ekosistem hizmetleriyle çevresel sürdürülebilirliğe katkı sağlamaktadır (Kour ve ark. 2025). Ancak bu potansiyelin etkin şekilde değerlendirilebilmesi için Azolla'nın biyokimyasal bileşenlerinin ayrıntılı olarak incelenmesi gerekmektedir.

ARAŞTIRMA ve BULGULAR

Bu çalışmada, Tekirdağ Namık Kemal Üniversitesi Fen-Edebiyat Fakültesi Biyoloji Bölümü bünyesinde yer alan Sucul Omurgalı Deney Ünitesi'nde kontrollü koşullarda yetiştirilen *Azolla caroliniana* örneklerinde protein, klorofil ve karotenoid içerikleri belirlenmiştir. Elde edilen biyokimyasal veriler, türün fotosentetik kapasitesi, antioksidan özellikleri ve besleyici değerine ilişkin kapsamlı bir değerlendirme sunmakta; Azolla'nın sürdürülebilir tarım ve çevresel biyoteknoloji uygulamalarındaki potansiyelini ortaya koymaktadır.

Klorofil ve Karotenoid İçeriğinin Belirlenmesi

Klorofil ekstraksiyonu ve tayini, Liu ve ark. (2018) çalışmasında tanımlanan protokol esas alınarak gerçekleştirilmiştir. Analizlerde 0,1 g su mercimeği örneği öğütülerek ince partiküller haline getirilmiş ve pigmentlerin çözünmesi amacıyla 10 mL'lik çözücü karışımı (%5 aseton + %95 etanol, v/v) ile muamele edilmiştir. Hazırlanan örnekler, pigmentlerin tam ekstraksiyonu için 36 saat boyunca karanlık koşullarda bekletilmiştir. Ekstraksiyonun ardından elde edilen süspansiyonlar spektrofotometre (UVmini-1240, SHIMADZU) kullanılarak 645 nm ve 663 nm dalga boylarında ölçülmüş, böylece klorofil içerikleri hesaplanmıştır (Aghofack-Nguemezi, Tonfack, Neambo, Schoch ve Gräfe, 2006; Li ve ark. 2025; Martins, Rani-Borges, Queiroz, de Souza ve Pompêo, 2025).

Elde edilen absorbans değerleri aşağıdaki formüller kullanılarak hesaplanmıştır:

$$Klorofil\ a = (12{,}70 \times A_{663}) - (2{,}69 \times A_{665})$$

$$Klorofil\ b = (22{,}90 \times A_{645}) - (4{,}68 \times A_{663})$$

$$Karotenoid = 1000 \times A_{470} - (1{,}82 \times Klorofil\ a) - (85{,}02 \times Klorofil\ b) \div 198$$

A663, A645 ve A470 belirli bir dalga boyundaki optik yoğunluğa karşılık gelmektedir.

Burada klorofil-a, klorofil-b ve karotenoid miktarını ifade etmektedir. Sonuçlar mg/g biriminde değerlendirilmiştir.

Protein İçeriğinin Belirlenmesi

Toplam çözünür protein miktarının belirlenmesinde Bradford yöntemi (Bradford, 1976) esas alınmıştır. Analizlerde 0,2 g taze bitki materyali, 1,5 mL 50 mM sodyum fosfat tamponu (pH 7,8) içerisinde ezilerek homojenize edilmiştir. Kullanılan tampon çözeltisi, 1 mM EDTA ve %2 (a/h) polivinilpolipirrolidon (PVPP) içermektedir. Homojenizasyon sonrası elde edilen ekstraktlar, 4 °C'de 15 dakika boyunca 10.000 rpm'de santrifüjlenmiş ve üst faz (süpernatant) protein tayininde kullanılmıştır. Ölçümlerin standartlaştırılması amacıyla, farklı derişimlerde (0; 0,2; 0,4; 0,6; 0,8 ve 1 mg mL^{-1}) sığır serum albümini (BSA) çözeltileri hazırlanmıştır. Bradford reaktifi, 25 mg Coomassie Brilliant Blue G-250'nin 25 mL metanol ve 50 mL %85 (a/h) fosforik asit içerisinde çözülmesiyle hazırlanmış; çözelti 850 mL damıtılmış su ile tamamlanmış ve Whatman No.1 filtre kağıdından süzülerek kullanıma hazır hale getirilmiştir. Analiz sırasında 50 µL ekstrakt üzerine 1 mL Bradford reaktifi eklenmiş, karışım oda sıcaklığında 5 dakika inkübe edilmiş ve ardından absorbans değerleri spektrofotometrede 595 nm dalga boyunda ölçülmüştür. Elde edilen sonuçlar, BSA standart eğrisi

kullanılarak değerlendirilmiş ve toplam çözünür protein miktarı mg/g taze ağırlık cinsinden hesaplanmıştır.

Bu çalışmada *Azolla caroliniana* örneklerinde gerçekleştirilen pigment ve protein analizleri, türün fotosentetik kapasitesinin ve biyoteknolojik açıdan taşıdığı potansiyelin ortaya konulmasına önemli katkılar sağlamaktadır. Yapılan biyokimyasal ölçümler sonucunda klorofil-a içeriği 228,96±2,78 mg/g, klorofil-b içeriği ise 129,34±1,91 mg/g olarak saptanmıştır (Tablo 1). Bu değerler, bitkinin yüksek düzeyde fotosentetik pigment birikimine sahip olduğunu ve dolayısıyla güçlü bir fotosentetik aktivite sergilediğini göstermektedir.

Azolla caroliniana örneklerinde belirlenen karotenoid miktarının 20864,48±1078,44 mg/g gibi oldukça yüksek bir düzeye ulaşması, türün fotosentetik sisteminde ışık adaptasyonunu destekleyen ve oksidatif stres koşullarına karşı koruyucu bir mekanizma geliştirdiğini göstermektedir (Tablo 1). Karotenoidler, fotosentetik pigmentler arasında ışık hasadında yardımcı rol üstlenmelerinin yanı sıra, reaktif oksijen türlerinin (ROS) oluşumunu sınırlayarak hücresel düzeyde antioksidan etki sağlamaktadır (Maslova, Markovskaya ve Slemnev, 2021). Bu nedenle elde edilen yüksek karotenoid konsantrasyonu, Azolla'nın çevresel stres faktörlerine karşı dayanıklılığını artırmakta ve değişken ışık koşullarına uyum kapasitesini güçlendirmektedir. Bulgular, türün yalnızca biyokütle üretiminde değil, aynı zamanda ekosistem restorasyonu ve biyoteknolojik uygulamalarda da değerlendirilebilecek önemli bir adaptif avantaj taşıdığını ortaya koymaktadır.

Azolla caroliniana örneklerinde belirlenen protein içeriğinin kuru ağırlığın %21,66±1,87'sini oluşturması, türün biyoteknolojik uygulamalarda sürdürülebilir bir protein kaynağı olarak değerlendirilebileceğini açıkça ortaya koymaktadır (Tablo 1). Bu yüksek protein düzeyi, bitkinin metabolik olarak son derece aktif olduğunu ve büyüme ile gelişme süreçlerinin güçlü bir biyokimyasal altyapıya dayandığını göstermektedir. Protein fraksiyonunun bu denli yüksek olması, Azolla'nın yalnızca ekosistem hizmetleri açısından değil, aynı zamanda tarımsal ve endüstriyel uygulamalar açısından da stratejik bir öneme sahip olduğunu işaret etmektedir. Özellikle hayvan yemi formülasyonlarında alternatif besin kaynağı olarak kullanımı, biyoteknolojik üretim süreçlerinde hammadde potansiyeli ve sürdürülebilir biyokütle kaynaklarının geliştirilmesinde katkı sağlayabilecek bir unsur olarak öne çıkmaktadır (Anitha, Rajeshwari, Prasanna ve Shree, 2016; Katole, Lende ve Patil, 2017). Dolayısıyla elde edilen bulgular, *Azolla caroliniana*'nın hem tarımsal üretimde hem de çevresel biyoteknoloji alanında yenilikçi çözümler sunabilecek değerli bir biyolojik kaynak olduğunu desteklemektedir.

Tablo 1. *Azolla coroliniana* örneklerinde klorofil-a, klorofil-b, karotenoid ve toplam çözünür protein içerikleri (ortalama ± standart sapma, mg/g ve % kuru ağırlık protein)

Klorofil-a	Klorofil-b	Karotenoid	Protein
228,96±2,78	129,34±1,91	20864,48±1078,44	21,66±1,87

Tablo 1'de sunulan verilere göre, *Azolla caroliniana* örneklerinde klorofil-a ve klorofil-b içerikleri sırasıyla 228,96±2,78 mg/g ve 129,34±1,91 mg/g olarak belirlenmiştir. Bu yüksek pigment düzeyleri, türün güçlü bir fotosentetik kapasiteye sahip olduğunu ve ışık enerjisini etkin biçimde kullanabildiğini göstermektedir. Karotenoid miktarının 20864,48±1078,44 mg/g gibi dikkate değer bir seviyeye ulaşması, bitkinin oksidatif stres koşullarına karşı koruyucu bir mekanizma geliştirdiğini ve çevresel adaptasyon yeteneğinin yüksek olduğunu ortaya koymaktadır. Ayrıca toplam çözünür protein içeriğinin kuru ağırlığın %21,66±1,87'sini oluşturması, *Azolla caroliniana*'nın metabolik olarak aktif bir tür olduğunu ve sürdürülebilir biyokütle üretimi ile hayvansal beslenmede alternatif protein kaynağı olarak değerlendirilebileceğini göstermektedir. Bu bulgular, türün hem tarımsal hem de çevresel biyoteknoloji uygulamalarında çok yönlü bir potansiyele sahip olduğunu desteklemektedir.

SONUÇ

Türün metabolik olarak aktif bir yapıya sahip olduğunu ve sürdürülebilir biyokütle üretimi ile hayvansal beslenmede alternatif protein kaynağı olarak değerlendirilebileceğini göstermektedir. Bu özellikler, *Azolla caroliniana*'nın hem tarımsal üretimde biyogübre ve yem katkısı olarak kullanımını desteklemekte hem de çevresel biyoteknoloji uygulamalarında ekosistem hizmetlerine katkı sağlayabilecek değerli bir biyolojik kaynak olduğunu ortaya koymaktadır. Genel olarak, elde edilen veriler *Azolla caroliniana*'nın çok yönlü kullanım potansiyelini desteklemekte; türün sürdürülebilir tarım, hayvansal üretim ve çevresel iyileştirme süreçlerinde yenilikçi çözümler sunabilecek stratejik bir organizma olduğunu göstermektedir.

KAYNAKÇA

Aghofack-Nguemezi, J., Tonfack, L. B., Neambo, H. K., Schoch, S., ve Gräfe, U. (2006). Effects of coconut oil and palm kernel oil treatments on ripening process in banana fruits. *Cameroon J. Exp. Biol*, *2*(1), 16-21.

Anitha, K. C., Rajeshwari, Y. B., Prasanna, S. B., ve Shree, J. S. (2016). Nutritive evaluation of Azolla as livestock feed.

Bradford, M. M. (1976). A rapid and sensitive method for the quantitation of microgram quantities of protein utilizing the principle of protein-dye binding. *Analytical biochemistry*, *72*(1-2), 248-254.

Braun-Howland, E. B., ve Nierzwicki-Bauer, S. A. (2018). Azolla-Anabaena symbiosis: biochemistry, physiology, ultrastructure, and molecular biology. In *CRC handbook of symbiotic cyanobacteria* (pp. 65-117). CRC Press.

Katole, S. B., Lende, S. R., ve Patil, S. S. (2017). A review on potential livestock feed: Azolla. *Livestock Research International*, *5*(1), 1-9.

Kour, D., Ramniwas, S., Kumar, S., Rai, A. K., Singh, S., Rustagi, S., ... ve Ahluwalia, A. S. (2025). Azolla for agro-environmental sustainability. *Vegetos*, *38*(5), 1748-1759.

Lechno-Yossef, S., ve Nierzwicki-Bauer, S. A. (2002). Azolla-Anabaena symbiosis. *Cyanobacteria in symbiosis*, 153-178.

Li, L., Ye, S., Chen, F., Pan, Q., Yao, X., Tian, S., ... ve Lu, L. (2025). A Shading-Responsive bHLH Transcription Factor (CsPIF7) Promotes Theanine Biosynthesis in Tea Plants (*Camellia sinensis*). *Plant, Cell & Environment*, *48*(9), 7005-7016.

Liu, L., Li, Y., She, G., Zhang, X., Jordan, B., Chen, Q., ... ve Wan, X. (2018). Metabolite profiling and transcriptomic analyses reveal an essential role of UVR8-mediated signal transduction pathway in regulating flavonoid biosynthesis in tea plants (*Camellia sinensis*) in response to shading. *BMC Plant Biology*, *18*(1), 233.

Martins, T. F. G., Rani-Borges, B., Queiroz, L. G., de Souza, K. F., ve Pompêo, M. (2025). Toxicity of polyethylene microplastics combined with medroxyprogesterone on photosynthetic pigments of Lemna minor. *Aquatic Ecology*, *59*(1), 307-322.

Maslova, T. G., Markovskaya, E. F., ve Slemnev, N. N. (2021). Functions of carotenoids in leaves of higher plants. *Biology Bulletin Reviews*, *11*(5), 476-487.

Rashad, S. (2021). An overview on the aquatic fern *Azolla spp.* as a sustainable source of nutrients and bioactive compounds with resourceful applications. *Egyptian Journal of Aquatic Biology and Fisheries*, *25*(1), 775-782.

Sârbu, A., Smarandache, D., Marinescu, A. T., Paraschiv, A. M., Mihai, C., ve Velicu, A. M. (2017). Anatomical-histological observations conducted on aquatic ferns In the Danube Delta. *Journal of Plant Development*, *24*.

Tadavi, F. R., Patil, K. B., ve Kadam, R. L. (2017). Azolla: Nutritional importance in animal feed and it's composition. *Animal Research*, *50*(5), 721-724.

Vijayan, K. T. V., Deepthi, K. S., ve Reshma, C. V. (2024). Exploring the Multifaceted Benefits of Azolla: A Comprehensive Review of an Aquatic Fern's Biological and Practical Contributions. *International Journal of Ecology and Environmental Sciences*, *50*(5), 661-672.

Yang, Y., Yang, Y., Deng, S., ve Ying, Z. (2025). Role of Azolla in sustainable agriculture and climate resilience: a comprehensive review. *Frontiers in Plant Science*, *16*, 1661720.

Yohana, M. A., Ray, G. W., Yang, Q., Tan, B., Chi, S., Asase, A., ... ve Derrick, A. (2023). A review on the use of Azolla meal as a feed ingredient in aquatic animals' diets. *Aquaculture Research*, *2023*(1), 2633412.

EXAMINATION OF CULTURAL SENSITIVITY AND SOCIAL DEGENERATION IN THE CONTEXT OF PUBLIC HEALTH NURSING

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ABSTRACT

The health level of societies is shaped not only by the physical environment and biological elements, but also by cultural values and the integrity of the social structure. Cultural sensitivity plays a significant role in public health nursing by supporting the provision of services that accommodate diverse beliefs and lifestyles. Conversely, increasing value conflicts, weakening social ties, and the spread of misinformation highlight societal decay and negatively impact health behaviors. This situation makes the roles of community-based public health nurses even more critical, requiring approaches that consider cultural differences, strengthen trust, and protect against societal disintegration.

The aim of this review is to examine cultural sensitivity and societal decay within the context of public health nursing.

The literature shows that cultural sensitivity improves acceptance of health services, communication quality, and care outcomes. Culturally sensitive nursing practices increase health literacy, support treatment adherence, and strengthen community trust. Studies on societal decay indicate that value erosion, loss of solidarity, and the spread of misinformation negatively impact public health. These processes increase risky behaviors, making vulnerable groups particularly more defenseless. It is emphasized that culturally sensitive approaches by public health nurses play a protective role in mitigating the effects of societal disintegration.

Cultural sensitivity and social decay are two important issues that directly affect public health nursing. Culturally respectful practices increase the effectiveness of health services, while social decay leads to a loss of trust and communication problems. Therefore, public health nurses can support community health behaviors by strengthening cultural sensitivity and reduce the risks of social disintegration.

Key Words: Cultural sensitivity; social degeneration; public health nursing; community health; health behaviors; social values; preventive health services.

EXAMINATION OF XENOPHOBIA FROM THE PERSPECTIVE OF INTERCULTURAL NURSING

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ABSTRACT

The increase in global migration movements has significantly increased cultural diversity in healthcare services and strengthened the need for intercultural competence in nursing. In this context, xenophobia, which includes fear, prejudice, and exclusionary attitudes towards individuals of foreign origin, is seen as a significant obstacle negatively affecting access to healthcare services and the quality of care. Understanding the impact of xenophobia on nursing care processes is critical for the provision of equitable and inclusive care.

The aim of this review is to examine the phenomenon of xenophobia from an intercultural nursing perspective and to reveal its effects on care processes.

The literature shows that xenophobia leads to inequalities in access to healthcare services for immigrants and individuals of foreign origin. Research indicates that xenophobic attitudes in emergency departments and primary healthcare settings negatively affect communication, trust, and the right to receive care. Intercultural nursing theories (Purnell, Campinha-Bacote, Leininger) emphasize that cultural sensitivity is a fundamental element of professional care. Increasing nurses' level of cultural knowledge, empathy, and awareness reduces xenophobic tendencies. Studies in Turkey and Europe show that increasing workloads and communication barriers can increase the risk of xenophobia; however, intercultural education and experience strengthen inclusive care approaches.

Xenophobia is a significant social determinant affecting nursing care in healthcare settings with increasing cultural diversity. Improving nurses' cultural competence, raising awareness of prejudice, and supporting inclusive care policies in institutions are fundamental requirements in combating xenophobia. Such interventions will contribute to a more equitable and accessible care environment.

Key Words: Xenophobia; Intercultural Nursing; Cultural Competence; Migration and Health; Health Inequalities; Prejudice; Inclusive Care; Nursing Practices

ARTIFICIAL INTELLIGENCE APPLICATIONS IN DYSPHAGIA INTERVENTION: BIBLIOMETRIC ANALYSIS

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ABSTRACT

Dysphagia, or swallowing disorder, is a common health problem affecting quality of life in many disease groups. Failure to diagnose dysphagia in a timely and accurate manner leads to longer hospital stays and treatment, increased mortality rates, and higher healthcare costs. Artificial intelligence (AI) shows potential as a transformative tool in dysphagia intervention. This study aims to examine quantitative and qualitative trends regarding AI applications in dysphagia intervention using bibliometric analysis. Data were obtained from the Web of Science Core Collection database on December 8, 2025. The obtained data were analysed using VOSviewer software. When bibliometric data were searched using the keywords “dysphagia”, “swallowing disorder”, and “artificial intelligence”, 142 studies were identified. The analysis revealed that the most frequently used keywords in the publications were “dysphagia”, “artificial intelligence”, “deep learning” and “machine learning”. When the countries publishing were evaluated, it was determined that the countries with the most publications were the United States (n:35), China (n:31), and Japan (n:16), with the highest number of publications occurring in 2025 (n:41) and 2024 (n:34). When publication categories were evaluated, it was found that the most publications were in the field of clinical neurology (n:15). The author with the most publications related to the determined keywords was “Zixiao Li (n:7)”; the most cited authors were “Brigida Barberio, Nicola De Bortoli, Matteo Fassan, Matteo Ghisa, Santino Marchi, Mentore Ribolsi, Edoardo Savarino, Vincenzo Savarino, Michele Valmasoni, Pierfrancesco Visaggi (n:53)”. The author who contributed the most was “Yoshitaka Shimizu (n:33)”. Our bibliometric analysis of AI applications in the field of dysphagia shows that studies in this area are still limited and have gained momentum, particularly since 2022. It is believed that the results of this research will contribute to the design of research methodologies for AI applications in dysphagia intervention and will guide future research.

Key Words: Dysphagia; Swallowing Disorder; Artificial Intelligence; Bibliometric Analysis

INTRODUCTION

Dysphagia (swallowing disorder) describes a condition in which swallowing function is impaired due to dysfunction of the oropharynx and/or oesophagus for anatomical or physiological reasons (Nyabanga et al., 2021). Underlying causes can include many diseases such as stroke, neuromuscular diseases, traumatic brain injuries, and head and neck cancer (Lancaster, 2015). While dysphagia is more common in adults, it is also relatively common in the paediatric group. Although the exact prevalence of dysphagia is not clearly known, it is estimated that 2% to 20% of the world's population suffers from this disorder. Individuals with dysphagia are at increased risk of many complications, including decreased quality of life,

dehydration, malnutrition, aspiration pneumonia, admission to intensive care units, and even death (Lancaster, 2015; Thiyagalingam et al., 2021).

Differentiating the aetiology and making an early and accurate diagnosis plays a fundamental role in the prognosis of dysphagia. Assessment methods generally consist of complementary clinical assessment and instrumental review components. However, these assessments are considered subjective, and some reviews may encounter accessibility issues or lack standardised protocols (McCarty & Chao, 2021; Roden & Altman, 2013).

Artificial Intelligence (AI) comprises a range of technologies designed to perform tasks in a manner similar to human intelligence. Subfields of AI include Machine Learning (ML) algorithms that identify patterns and make predictions and Deep Learning (DL), which is considered more complex due to the use of layered neural networks. These technologies aim for a safer and more efficient approach in healthcare by contributing to the emergence of new hypotheses, discoveries, and task optimisation. In the context of dysphagia, AI offers new perspectives for identifying swallowing disorders and facilitating the rehabilitation process (Adkins et al., 2020; Thiyagalingam et al., 2021).

Bibliometric analysis uses quantitative methods such as mathematics and statistics to identify, evaluate, and track research in a particular field, thereby revealing the research structure and trends in a specific discipline (Guo et al., 2024). It can save time in future studies by providing researchers with a summary of the current literature. Bibliometric analysis is widely used in various branches of medicine and is increasingly accepted in identifying effective research within specific disciplines (Gondivkar et al., 2018). This research was conducted to identify and visualise articles published on artificial intelligence applications in dysphagia intervention, to reveal trends, and to provide researchers who will work on this topic in the future with a general overview based on the literature.

RESEARCH AND FINDINGS

Study Design

The Web of Science (WoS) database encompasses various disciplines, including fundamental principles such as data structuring, subject categorisation, citation analysis, international perspective, and scalability. It is the leading database used for bibliometric analysis (Birkle et al., 2020). Literature data related to the subject of this bibliometric study were obtained and retrieved from the main collection database in Web of Science (WoS). Searches were conducted using the keywords “dysphagia”, “swallowing disorder”, and “artificial intelligence”. As a result of the search, 142 studies were found. The obtained data were downloaded from the WoS database as .txt files. The analysis of the obtained data was performed bibliometrically using the “VOSviewer” program. Publication numbers by year, author, country, and keyword analysis of the published articles were performed.

Ethical Approval

Since this is a retrospective review of previously published research, no ethical committee approval was required.

Data Analysis

The data were analysed using bibliometric analysis techniques. The analysis of the studies was carried out in two stages, and many parameters were determined for the analysis. As the first stage, studies accessed from the WoS database were analysed using data such as publication years, document types, WoS categories, WoS index, and countries of publication; as the second stage, studies in the .txt file downloaded from the WoS database were analysed using the visual mapping method within the scope of co-author analysis, author citation analysis, and keyword analysis. To better understand the results, the data were graphically represented using VOSviewer software version 1.6.20 (van Eck & Waltman, 2010).

Findings

This study conducted a bibliometric analysis of 142 articles published between 2002 and 2025 on artificial intelligence applications in dysphagia intervention. It was determined that there were a total of 101 authors in co-authored articles. When publications were evaluated by year, the highest number of publications was in 2025 (n:41), followed by 2024 (n:34), and then 2023 and 2022 (n:26) respectively (Figure 1). Examining the publication types, the majority of publications consisted of articles (104), followed by 17 reviews, 12 conference papers, 6 conference abstracts, 2 early access publications, 2 editorial articles, 2 letters of recommendation, and 1 retracted publication (Figure 2).

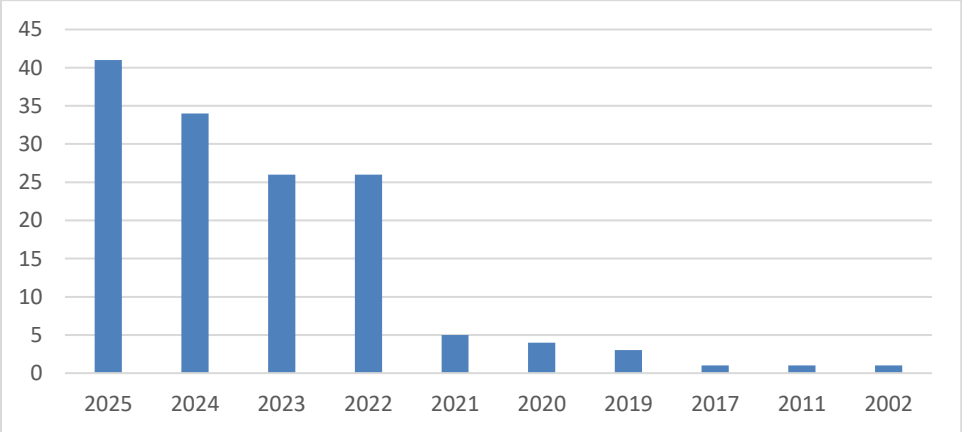

Figure 1. Distribution of studies by publication year

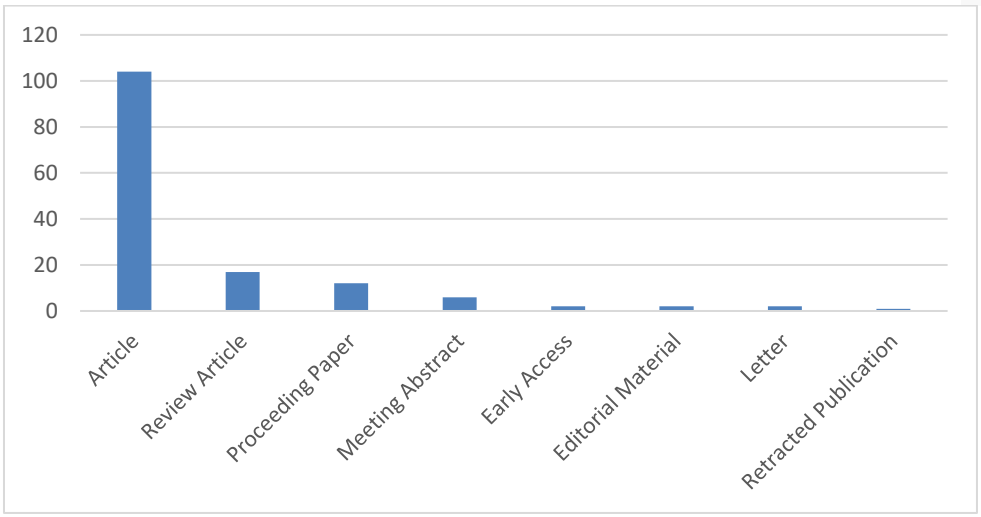

Figure 2. Publication type of studies

When the publication categories of studies on artificial intelligence applications in dysphagia intervention were evaluated, the category with the most studies was determined to be clinical neurology (n:15) (Figure 3). When the WoS index of the studies was examined, it was determined that 116 were within the scope of SCI-Expanded, 15 were within the scope of ESCI and CPCI-S, 6 were within the scope of SSCI, and 1 was within the scope of CPCI-SSH (Figure 4).

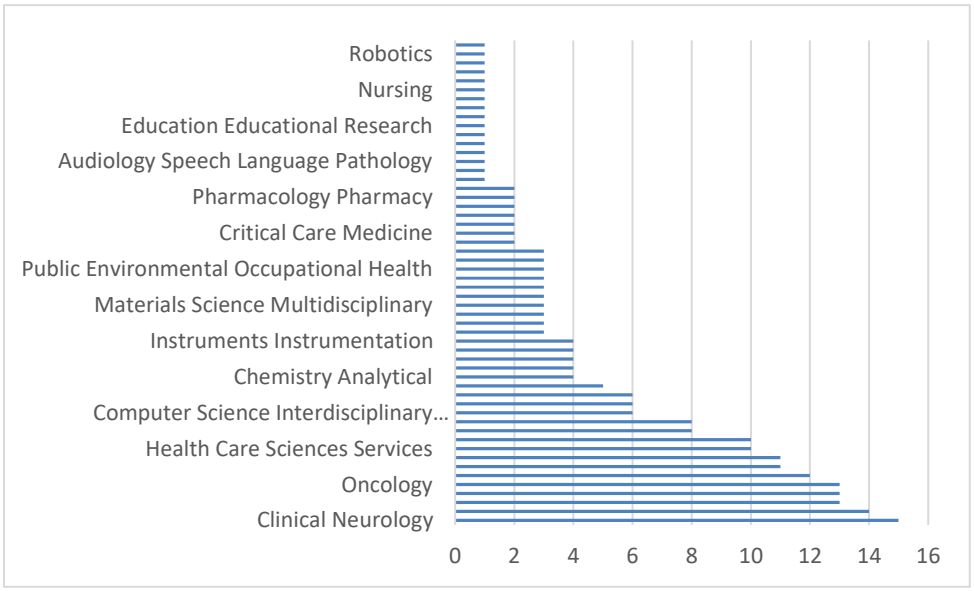

Figure 3. WoS categories of studies

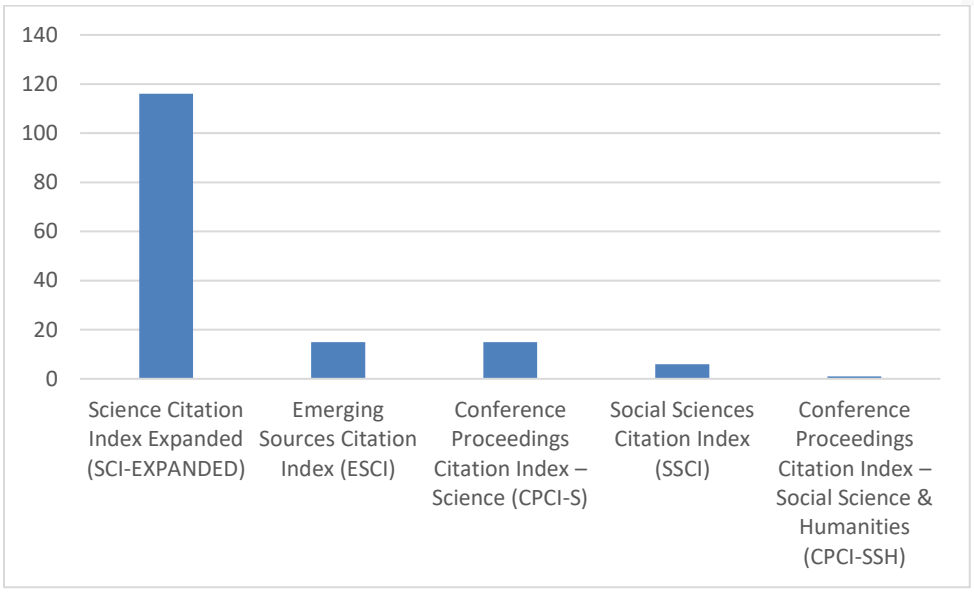

Figure 4. Wos index of studies

The analysis map according to the countries where studies on artificial intelligence applications in dysphagia intervention are carried out is given in Figure 5. According to the results of the analysis, the countries that publish the most are the USA (n:35), China (n:25), Australia (n:31) and Japan (n:16).

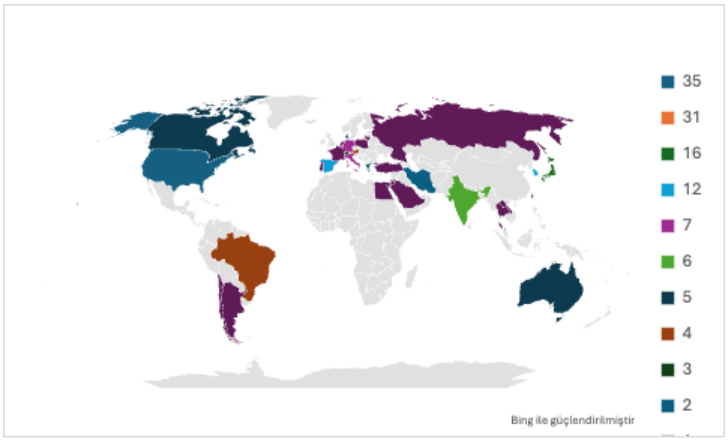

Figure 5. Broadcasting countries

The most published author on artificial intelligence applications in dysphagia intervention is "Zixiao Li (n:7)", the most cited authors are "Brigida Barberio, Nicola De Bortoli, Matteo Fassan, Matteo Ghisa, Santino Marchi, Mentore Ribolsi, Edoardo Savarino, Vincenzo

Savarino, Michele Valmasoni, Pierfrancesco Visaggi" with 53 citations, the most contributing author is "Yoshitaka" Shimizu (n:33)" (Figure 6, Figure 7, Figure 8).

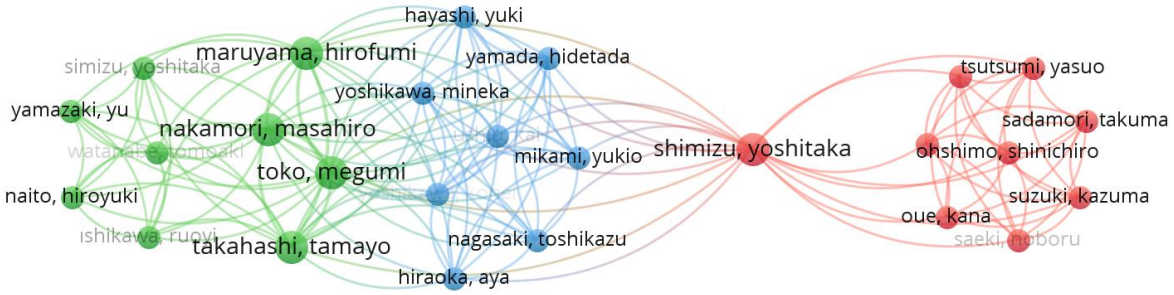

Figure 6. Co-author analysis

Figure 7. Top contributing authors

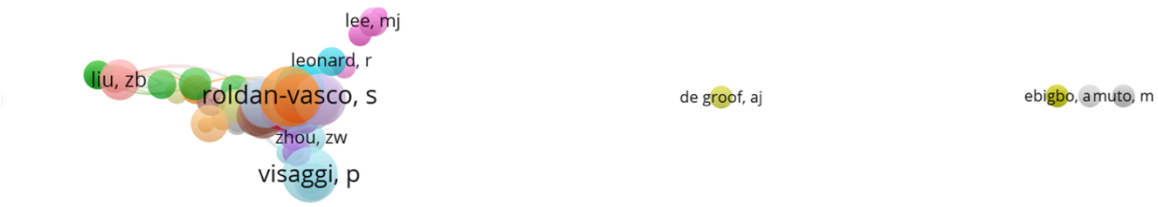

Figure 8. Most cited authors

When the keyword analysis was made for artificial intelligence applications in dysphagia intervention, it was found that the three most frequently used keywords were "dysphagia (n:29)", "artificial intelligence (n:23)", "deep learning (n:9)" and "machine learning (n:9)" (Figure 9).

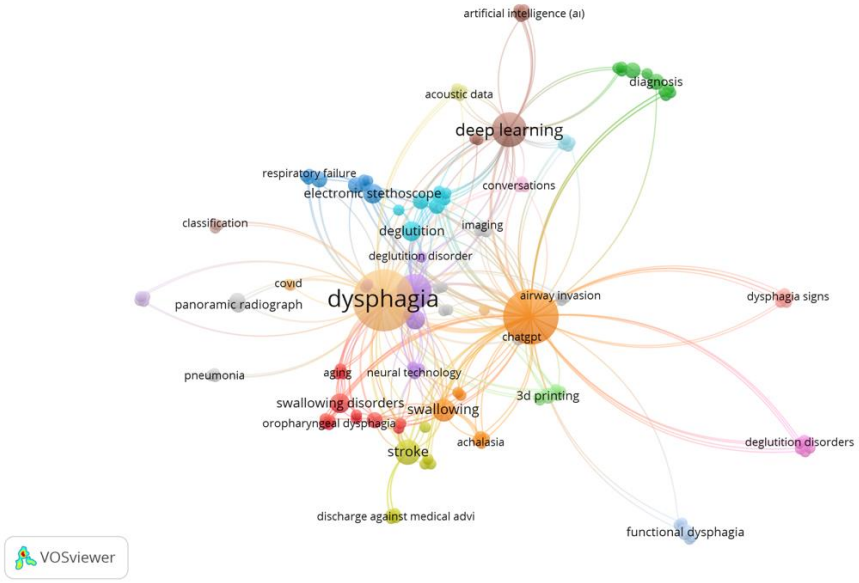

Figure 9. Keyword Analysis

CONCLUSION

Bibliometric analysis is a powerful tool used to explore the scientific literature on a specific topic (Alyanak et al., 2024).Through bibliometric analysis, a comprehensive overview of scientific fields that provide valuable information and guide scientific research can be obtained. The daily publication of new articles on various topics underscores the importance of this analysis. Citation analysis, a fundamental tool of bibliometrics, serves as an objective benchmark to assess the scientific impact of specific published studies on current research trends. In addition, citation analysis can be used to evaluate the impact of authors, journals, institutions, or countries (Gao et al., 2020). Articles with a high number of citations are generally an indicator of increased interest in a particular research area (Temel et al., 2022). Regardless of short-term trends, the citation index is used to determine the impact of an article (Berlinberg et al., 2019). To our knowledge, there are no existing citation analyses or other bibliometric studies on artificial intelligence applications in dysphagia intervention. This study systematically analyses artificial intelligence applications in dysphagia intervention and presents them with numerical and visual maps. The research results reveal the authors and countries with the most publications, the most frequently used keywords, and the highest citation rates.

The study examined 142 articles published between 2002 and 2025 and found that Clinical Neurology ranked first in the WoS publication category, with the highest number of publications occurring in 2025. The high number of publications in 2025 indicates a significant

increase in clinical and research interest in AI-based diagnosis and individualised therapy applications in dysphagia intervention, particularly in the last year. Furthermore, the high number of publications in the Clinical Neurology category suggests that research is focused on the clinical need for dysphagia accompanying neurological disease groups. When evaluating the countries with the most publications, the United States, China, and Japan were found to be the top three.

Regarding publication type, the most common type of publication was academic articles. This finding demonstrates that article-type publications are the most widely accepted format in the academic world for sharing research results and generating scientific knowledge. Published in scientific journals, articles enable research findings to reach the scientific community quickly and effectively (Norris, 2019).

The WoS Index shows that most publications are in the SCI index. This index is an important tool for measuring the impact factors of scientific journals and the effect of published articles on the academic community. Publishing in SCI-indexed journals is considered to indicate high quality and impact of research. Publishing in SCI journals is an important goal for researchers because it contributes to receiving more citations and reaching a wider audience for their work.

Regarding the specified keywords, the author with the most publications was "Zixiao Li", while the most cited authors were "Brigida Barberio, Nicola De Bortoli, Matteo Fassan, Matteo Ghisa, Santino Marchi, Mentore Ribolsi, Edoardo Savarino, Vincenzo Savarino, Michele Valmasoni, and Pierfrancesco Visaggi". The author who contributed the most was "Shimizu, Yoshitaka". This indicates that the author with the most publications did not maintain their top position in the ranking of most cited articles. Furthermore, it was observed that the most cited authors (e.g., Barberio, Brigida; De Bortoli, Nicola; Ghisa, Matteo; Visaggi, Pierfrancesco) were also among the authors with the highest overall linkage strength. This finding suggests that highly cited researchers are also more central to the co-authorship network.

Keyword analysis shows that artificial intelligence is integrated into dysphagia interventions, particularly with diagnostic and classification approaches based on "deep learning" and "machine learning". While the most frequently used terms, "dysphagia" and "artificial intelligence", reflect the clinical and technology-focused nature of the literature, the emergence of concepts such as "ChatGPT", "neural technology", and "airway invasion" indicates the beginning of new research trends in the field towards natural language processing and advanced neurological applications. These findings reveal that the dysphagia-AI intersection is still developing but is rapidly evolving into multifaceted sub-fields.

This study was conducted using the keywords "dysphagia", "swallowing disorder", and "artificial intelligence". Further research could enrich these keywords with additional concepts and search them in various databases such as PubMed, Embase, Scopus, SpringerLink, Google Scholar, and ScienceDirect. The analysis was performed using VOSviewer software. Future studies could utilise programmes like CiteSpace or SciMAT to enhance visualisation or observe differences between analysis programmes.

REFERENCES

Adkins, C., Takakura, W., Spiegel, B. M. R., Lu, M., Vera-Llonch, M., Williams, J. & Almario, C. V. (2020). Prevalence and Characteristics of Dysphagia Based on a Population-Based Survey. *Clinical Gastroenterology and Hepatology*, *18*(9), 1970-1979.e2. https://doi.org/10.1016/j.cgh.2019.10.029

Alyanak, B., Yıldızgören, M. T. & Bağcıer, F. (2024). Bibliometric and Altimetric Analysis of Research Relating to Percutaneous Electrolysis. *Muscle Ligaments and Tendons Journal*, *14*(01), 131. https://doi.org/10.32098/mltj.01.2024.11

Berlinberg, A., Bilal, J., Riaz, I. B. & Kurtzman, D. J. B. (2019). The 100 top-cited publications in psoriatic arthritis: a bibliometric analysis. *International Journal of Dermatology*, *58*(9), 1023–1034. https://doi.org/10.1111/ijd.14261

Birkle, C., Pendlebury, D. A., Schnell, J. & Adams, J. (2020). Web of Science as a data source for research on scientific and scholarly activity. *Quantitative Science Studies*, *1*(1), 363–376. https://doi.org/10.1162/qss_a_00018

Gao, Q., Zhang, C., Wang, J., Wei, Q., Wei, Q., Miyamoto, A., Zhu, S. & He, C. (2020). The top 100 highly cited articles on osteoporosis from 1990 to 2019: a bibliometric and visualized analysis. *Archives of Osteoporosis*, *15*(1), 144. https://doi.org/10.1007/s11657-020-0705-z

Gondivkar, S. M., Sarode, S. C., Gadbail, A. R., Gondivkar, R. S., Chole, R. & Sarode, G. S. (2018). Bibliometric analysis of 100 most cited articles on oral submucous fibrosis. *Journal of Oral Pathology & Medicine*, *47*(8), 781–787. https://doi.org/10.1111/jop.12742

Guo, B., Liu, M., Wang, Z. & Yan, Z. (2024). Research hotspots and frontiers in post-stroke dysphagia: a bibliometric analysis study. *Frontiers in Neurology*, *15*. https://doi.org/10.3389/fneur.2024.1343469

Lancaster, J. (2015). Dysphagia: its nature, assessment and management. *British Journal of Community Nursing*, *20*(Sup6a), S28–S32. https://doi.org/10.12968/bjcn.2015.20.Sup6a.S28

McCarty, E. B. & Chao, T. N. (2021). Dysphagia and Swallowing Disorders. *Medical Clinics of North America*, *105*(5), 939–954. https://doi.org/10.1016/j.mcna.2021.05.013

Norris, S. (2019). Bibliometrics and Research Evaluation: Uses and Abuses [Book Review]. *Journal of Librarianship and Scholarly Communication*, *7*(1). https://doi.org/10.7710/2162-3309.2286

Nyabanga, C., Khan, A. & Knotts, R. M. (2021). Oropharyngeal Dysphagia. In *Geriatric Gastroenterology* (pp. 1127–1143). Springer International Publishing. https://doi.org/10.1007/978-3-030-30192-7_40

Roden, D. F. & Altman, K. W. (2013). Causes of Dysphagia Among Different Age Groups. *Otolaryngologic Clinics of North America*, *46*(6), 965–987. https://doi.org/10.1016/j.otc.2013.08.008

Temel, M. H., Erdem, İ. H., Kul, A. & Bağcıer, F. (2022). Bibliometric analysis of the top 100 most-cited articles on the treatment of osteoporosis. *Archives of Osteoporosis*, *17*(1), 106. https://doi.org/10.1007/s11657-022-01141-6

Thiyagalingam, S., Kulinski, A. E., Thorsteinsdottir, B., Shindelar, K. L. & Takahashi, P. Y. (2021). Dysphagia in Older Adults. *Mayo Clinic Proceedings*, *96*(2), 488–497. https://doi.org/10.1016/j.mayocp.2020.08.001

van Eck, N. J. & Waltman, L. (2010). Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics*, *84*(2), 523–538. https://doi.org/10.1007/s11192-009-0146-3

AN EXAMINATION OF POSTGRADUATE THESES ON DYSARTHRIA

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ABSTRACT

Dysarthria is a motor speech disorder characterised by weakness, spasticity, and impaired coordination of the speech muscles, potentially affecting breathing, phonation, resonance, articulation, and the prosodic aspects of speech production. Dysarthria is considered the most common acquired primary communication disorder in clinical practice. The aim of this study is to review postgraduate dissertations in the national literature. Postgraduate theses in the field of dysarthria were searched in the Higher Education Council National Thesis Center database using the keywords “dysarthria”, “motor speech”, and “motor speech disorder”. Searching for “dysarthria” yielded four master's theses, searching for “motor speech” yielded three master's theses and one doctoral thesis, and searching for “motor speech disorder” yielded one master's thesis. After excluding duplicate studies, a total of eight postgraduate dissertations were included in the review. It was observed that 37.5% of the studies focused on disorders seen in the paediatric group, while 62.5% worked with the adult group. While 62.5% of the thesis studies focused on individuals with dysarthria, 12.5% examined the dynamic assessment of motor speech skills in children with speech sound disorders. It was found that 12.5% of the studies looked at therapy effectiveness, while 87.5% were assessment and norm studies. In conclusion, an examination of thesis studies on intervention in the field of dysarthria reveals a limited number of studies in the area of speech and language therapy. These studies encompassed a wide range of groups, from children to adults, and while seven studies focused on different patient groups, only one study examined treatment effectiveness. Accurate diagnosis of dysarthria and the effective determination of individualised therapy methods are critically important because they directly affect individuals' communication skills and quality of life. More studies examining valid, standardised assessment tools and evidence-based therapy approaches are needed in this area.

Key Words: Dysarthria; Motor Speech; Motor Speech Disorder; Thesis

INTRODUCTION

Dysarthria is a neuromotor disorder resulting from abnormalities in the speed, strength, stability, range, tone, or accuracy of movements necessary for speech control (Duffy, 2012). Speech disorders due to dysarthria affect articulation, phonation, breathing, nasality, and prosody, impacting the intelligibility, audibility, naturalness, and efficiency of spoken communication. Its severity ranges from the absence of speech (anarthria) or complete incomprehensibility to mild changes that are only noticeable to the speaker or through detailed speech assessment. In current usage, dysarthria does not encompass speech disorders resulting from structural abnormalities such as cleft palate or glossectomy. It is also distinct from speech apraxia, which, although neurological in origin, is conceptualised as a disorder of speech motor planning or programming (Duffy, 2012). Regardless of its severity, dysarthria can lead to negative impacts on self-identity, activity participation, and well-being, including social withdrawal and depression (Walshe & Miller, 2011).

Dysarthria is the most common acquired communication disorder, affecting 42% to 53% of individuals who have had a stroke, 56% of individuals with neuromuscular diseases such as myasthenia gravis and amyotrophic lateral sclerosis, up to 90% of individuals with Parkinson's disease (PD), and up to 65% of individuals who have experienced traumatic brain injury. Accordingly, dysarthria management accounts for approximately 14% of adult communication clinical services of speech and language pathologists (SLPs), and this percentage is expected to increase with the ageing population (Whillans et al., 2022).

The clinical management of dysarthria encompasses various treatment approaches aimed at maximising the individual's ability to effectively use speech communication. Intervention may include (1) a reparative approach aimed at reducing physiological impairment by improving the strength and movement precision or coordination of the affected speech muscles (Ray, 2002); (2) behavioural compensation, e.g., reducing speech rate to improve intelligibility (Martens et al., 2015); (3) assisted communication strategies (e.g., making eye contact, using speech repair strategies) (Duffy, 2012); and/or (4) providing assistive/alternative communication types to support verbal communication (Hanson et al., 2013). Traditionally, combinations of treatment methods are applied individually, with tasks appropriate to the nature and severity of dysarthria, as well as the individual's goals and preferences (Palmer & Enderby, 2007).

The aim of this study is to examine postgraduate dissertation studies on dysarthria intervention, revealing research trends, methodological approaches, focused individual groups, and key findings in this field.

RESEARCH AND FINDINGS

Materials and Methods

In this study, the document analysis data collection method was used. Document analysis is a scientific research method defined as the systematic acquisition, review, questioning, and analysis of various documents, considered as primary or secondary sources, that constitute the data set of the research (ÖZKAN, 2019). Postgraduate theses in the field of dysarthria were searched in the Higher Education Council National Thesis Center database using the keywords “dysarthria”, “motor speech”, and “motor speech disorder”. The sample of the research consists of 8 postgraduate theses between 2006 and 2025. The research data were examined within the scope of thesis type, year, author name, research aim, research type, sample characteristics, and research results. The data obtained from the postgraduate theses examined with document analysis were combined. The SPSS 22.0 package (IBM) program was used in the analysis of the data related to the theses included in the research. Descriptive statistics (number and percentage distribution) were used in the data analyses.

Findings

A search in the Higher Education Council National Thesis Center database yielded four master's theses with the search term "dysarthria", three master's theses and one doctoral thesis with the search term "motor speech", and one master's thesis with the search term "motor speech disorder". After excluding duplicate studies, a total of eight postgraduate theses were included in the study. The theses examined in the research were conducted between 2006 and 2025 and consisted of 7 master's theses (87.5%) and 1 doctoral thesis (12.5%). Information regarding the theses examined is presented in Table 1.

Table 1. Findings Regarding the Graduate Theses Examined

Author Aim Participant Outcome

Eyyup Kara

(Master's Thesis) (Eyyup Kara, 2006)

To establish as yet undefined standards for oral diadochokinesis (ODK), second formant transition, and voice tremor for the evaluation of motor speech disorders in Turkish-speaking adults; to determine Türkiye-specific normative values for the Motor Speech Profile parameters of the Acoustic Analysis Program. 103 healthy adult individuals, 20 adult individuals with neurological diseases Neurological diseases negatively affect ODK, F2 transition, and tremor parameters, reducing speech motor performance and intelligibility.

Aşena Karamete (Phd) (Aşena Karamete, 2021)

The aim was to perform a dynamic evaluation of motor speech skills in 82 Turkish-speaking children aged 3:00-6:11 with speech sound disorders, to identify children with childhood apraxia of speech (CAS) within this group, to determine the motor speech characteristics of the children, and to compare them with the group without a CAS diagnosis in terms of language, cognition, and motor speech skills. 82 children aged 3:00-6:11 with speech sound disorders The DEMSS-TR test demonstrated high validity and reliability for CAS diagnosis; it provided strong diagnostic evidence. Children diagnosed with CAS performed significantly lower on all tests compared to the other SSD group. Turkish-speaking children with CAS showed all the CAS characteristics accepted in the international literature.

Süleyman Kocaoğlu (Master's Thesis) (Süleyman Kocaoğlu, 2021)

Determination of Diadochokinetic Speed Normative Values in Turkish-speaking individuals aged 20-60 and Comparison with Different Types of Dysarthria 60 healthy individuals, 10 individuals with Dysarthria It was determined that diadochokinetic speed decreased with age but did not change according to gender. In the diadochokinetic speed data of the healthy group, /pa/ and /ta/ production were found to be similar, while /ka/ production was the lowest and /pataka/ production was the highest. The diadochokinetic speed of the dysarthric group was found to be lower than that of the healthy group.

Müzeyyen Karaman

(Master's Thesis) (Müzeyyen Karaman, 2021)

To perform acoustic and grammatical analyses of speech components in individuals with adult dysarthria and to determine the effect of these analyses on the patient's speech intelligibility 20 Individuals with dysarthria As the severity of dysarthria increased, the average turn length decreased, and patients used shorter sentences. In acoustic voice analyses, all parameters were found to be abnormal, and voice disorders due to dysarthria were observed. As the severity of dysarthria increased, speech intelligibility decreased significantly.

Ayşe Merve Arı

(Master's Thesis) (Ayşe Merve Arı, 2021)

To examine the voice characteristics of children with motor speech disorder and those with healthy development aged between 4-12 years and to compare these two groups. 30 children with motor speech disorder and 30 children with healthy development aged between 4-12 years. It was observed that voice perturbation and harmonic values were affected in children with motor speech disorder.

Aysu Papurcu (Master's Thesis) (Aysu Papurcu, 2023)

Investigation of the acoustic and perceptual characteristics of voice and speech in children with cerebral palsy (CP) with dysarthria after LSVT LOUD application 12 Individuals with CP with dysarthria The findings indicate that LSVT LOUD has an enhancing effect on the voice characteristics of children with CP.

Esra Erkaya Yalçın (Master's Thesis) (Esra Erkaya Yalçın, 2023)

Examination of voice characteristics, quality of life, depression levels, and speech intelligibility in adult individuals diagnosed with dysarthria. 21 adult individuals with dysarthria It was found that voice characteristics are generally affected in adult individuals diagnosed with dysarthria, speech intelligibility is significantly reduced, and quality of life decreases. These individuals have high levels of depression, and communication difficulties lead to social isolation and emotional problems.

Büşra Çınar (Master's Thesis) (Büşra Çınar, 2025)

To identify the effects of negative emotional stimuli on oral and laryngeal motor control.To examine the role of cognitive emotion regulation skills and personality traits in emotion-motor interaction. 35 female university students as volunteers. Negative emotional stimuli activated the sympathetic nervous system, resulting in increased speed of oral and laryngeal motor movements and the closing rate of vocal folds. As maladaptive cognitive emotion regulation skills and neuroticism personality traits became more dominant in individuals, an increase in reactivity and EGG-CQ, EGG-jitter, and F0 values was observed in the presence of negative emotional stimuli.

It was observed that 37.5% of the studies focused on disorders seen in the paediatric group, while 62.5% focused on the adult group (Table 2). 62.5% of the thesis studies focused on individuals with dysarthria, while 12.5% examined the dynamic assessment of motor speech skills in children with speech sound disorders (Table 3). It was found that 12.5% of the studies looked at therapy effectiveness, and 87.5% were assessment and norm studies (Table 4).

Table 2. Distribution of Studies by Age Group

Age Group Percentage (%)

Pediatric 37.5

Adult 62.5

Table 3. Clinical Focus of the Included Theses

Clinical Focus Percentage (%)

Dysarthria 62.5

Dynamic Assessment of Motor Speech Skills in Children with SSD 12.5

Individual with Neurological Disease 12.5

Healthy Individual 12.5

Table 4. Distribution of Studies by Research Type

Study Type Percentage (%)

Therapy Effectiveness 12.5

Assessment and Normative Studies 87.5

CONCLUSION

This study examined postgraduate dissertations on interventions in the field of dysarthria in Turkey. The dissertations identified current trends, focus areas, and areas for improvement. Analysis of the dissertations revealed that not all focused on individuals with dysarthria; some also worked with different groups, such as dynamic assessment of motor speech skills in children with speech sound disorders. Studies in the field of dysarthria and motor speech disorders were limited, focusing on assessment and norm studies, with only one study examining therapeutic effectiveness.

62.5% of the dissertations worked with adult groups. This is consistent with the literature indicating that dysarthria is most frequently associated with neurological diseases (stroke, Parkinson's disease, motor neurone diseases, etc.) (Duffy, 2012). The lower number of dissertations in the paediatric group can be explained by the heterogeneous nature of the disorder in this group of children and the more limited availability of assessment tools. The fact that the majority of the theses examined were assessment and norm studies demonstrates that accurate and differential diagnosis of dysarthria is critically important for clinical practice. However, the fact that only one thesis study examined therapy effectiveness is considered a significant limitation in terms of evidence-based practices.

In conclusion, the examination of thesis studies on interventions in the field of dysarthria reveals that there are a limited number of studies in the field of speech and language therapy. These studies cover a wide range of groups from paediatric to adult, and while seven studies focused on different patient groups, only one study examined therapy effectiveness. Accurate diagnosis of dysarthria and the effective determination of individualised therapy methods are extremely important, as they directly affect individuals' communication skills and quality of life. More studies examining valid, standardised assessment tools and evidence-based therapy approaches are needed in this area.

REFERENCES

AŞENA KARAMETE. (2021). Konuşma sesi bozukluğu olan 3:00-6:11 yaş arası çocukların motor konuşma becerisinin dinamik değerlendirmesi.

AYŞE MERVE ARI. (2021). Motor konuşma bozukluğu olan 4-12 yaş arası çocukların konuşma ve ses özelliklerinin değerlendirilmesi.

AYSU PAPURCU. (2023). Serebral palsili çocuklarda dizartri müdahalesinde LSVT LOUD terapi yönteminin etkililiğinin incelenmesi.

BÜŞRA ÇINAR. (2025). Farklı duygusal uyaranların ve kişilik özelliklerinin fizyolojik, ses ve motor konuşma parametrelerine etkisi.

Duffy, J. R. (2012). Motor Speech Disorders: Substrates, Differential Diagnosis, and Management.

ESRA ERKAYA YALÇIN. (2023). Dizartrili bireylerin ses özelliklerinin, yaşam kalitelerinin, depresyon düzeylerinin ve konuşma anlaşılırlıklarının incelenmesi.

EYYUP KARA. (2006). Yetişkinlerde, motor konuşma bozukluklarının değerlendirilmesinde oral diadokokinezi standartlarının Türkçe için oluşturulması.

Hanson, E. K., Beukelman, D. R. & Yorkston, K. M. (2013). Communication Support through Multimodal Supplementation:A Scoping Review. Augmentative and Alternative Communication, 29(4), 310–321. https://doi.org/10.3109/07434618.2013.848934

Martens, H., Van Nuffelen, G., Dekens, T., Hernández-Díaz Huici, M., Kairuz Hernández-Díaz, H. A., De Letter, M. & De Bodt, M. (2015). The effect of intensive speech rate and intonation therapy on intelligibility in Parkinson's disease. Journal of Communication Disorders, 58, 91–105. https://doi.org/10.1016/j.jcomdis.2015.10.004

MÜZEYYEN KARAMAN. (2021). Yetişkin dizartrik hastalarda konuşmanın dilbilgisel ve akustik özelliklerinin konuşma anlaşılırlığına etkisi.

ÖZKAN, U. B. (2019). Eğitim Bilimleri Araştırmaları İçin Doküman İnceleme Yöntemi. Pegem Akademi Yayıncılık. https://doi.org/10.14527/9786052417232

Palmer, R. & Enderby, P. (2007). Methods of speech therapy treatment for stable dysarthria: A review. Advances in Speech Language Pathology, 9(2), 140–153. https://doi.org/10.1080/14417040600970606

Ray, J. (2002). Orofacial myofunctional therapy in dysarthria: A study on speech intelligibility. International Journal of Orofacial Myology, 28(01), 39. https://doi.org/10.52010/ijom.2002.28.1.3

SÜLEYMAN KOCAOĞLU. (2021). Türkçe konuşan sağlıklı yetişkin bireylerde diadokokinetik hız normatif değerlerinin belirlenmesi ve dizartrik bireylerle karşılaştırılması.

Walshe, M. & Miller, N. (2011). Living with acquired dysarthria: the speaker's perspective. Disability and Rehabilitation, 33(3), 195–203. https://doi.org/10.3109/09638288.2010.511685

Whillans, C., Lawrie, M., Cardell, E. A., Kelly, C. & Wenke, R. (2022). A systematic review of group intervention for acquired dysarthria in adults. Disability and Rehabilitation, 44(13), 3002–3018. https://doi.org/10.1080/09638288.2020.1859629

REVEALING URBAN SPATIALITY OF THE ICONIC FANTASTIC LINEAR AXIS BETWEEN THE TRUMPHOLSTERY ARCH OF PARIS AND THE LOUVRE MUSEUM

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ABSTRACT

This article presents an urban spatial analysis of the area defined as the first arrondissement of Paris, located on the linear axis between the Arc de Triomphe and the Louvre Museum. This area, known as the first arrondissement of Paris, not only organizes iconic elements along a linear axis but also creates fantastical axes, creating profound urban serial perspectives along the line.

This linear, fantastic urban axis, which reaches from the triumphal arch to the Louvre museum, passses through the arches and obelisks in a very powerful and fluid manner, and finally enters the iconic historical Louvre museum.

Nowhere else in the world can such a strong urban axis be felt as strongly as the one between the Arc de Triomphe and the Louvre in Paris's first arrondissement. This axis creates a powerful linearity, occasionally rising and falling with gentle slopes. The Arc de Triomphe and the Place de Concorde obelisk overlap on this fine line, and this overlap sometimes accompanied by the elevated ramp at the entrance from the Jardin des Tuilories in Place de Concorde.

In addition to vertical overlapping and spatial depth, the juxtaposition of horizontal functions also occurs in an extremely dense manner along the axis, creating a spatial syntax. Horizontal spaces with different functions create spatial density at different scales. Consequently, on such a linear axis, different layers overlap, both vertically and horizontally, creating a series of perspectives.

This axis between the Arc de Triomphe and the Louvre in Paris's first arrondisement is not only remarkable for its continuity but also for its' fantastic natural formation. Equally powerful is the articulation of the secondary diagonal axes to the main linear axis and the diversity they create.

In terms of urban design, this linear axial organization between the Arc de Triomphe and the Louvre museum offers spatial diversity through cross-axial articulations. The study focuses on this linear axis, aiming to reveal the spatial design organized by this axis in urban design.

As Cliff Moughtin points out, urban design has three very clear parameters; squares, streets and buildings. Kevin Lynch, on the other hand, generalizes these parametes more broadly, stating that the components of urban design are; roads, focal points, landmarks, zones, and boundaries. Finally, Gordon Cullen draws attention to the continuity of urban design, to urban spaces and urban images as serial perspectives articulated in succession. According to Cullen, urban design consists of serial spatial designs, overlapping successively articulated and sometimes suprising.

This study attempts to uncover the spatial components of urban design on this fantastic linear axis between the Arc de Triomphe and the Louvre, one of the most powerful and fantastic urban axis in Paris and perhaps the world.

Keywords: Paris City Plan, Arc de Triomphe, Louvre Museum, Place de la Concorde, Jardin Des Tuileries, Urban Design, Spatial Design, Serial Perspectives.

PART-1: SPATIAL ANALYSES OF ICONIC FANTASTIC 1ST ABONDISSMENT OF PARIS

This article attempts to reveal the urban design characteristics of the area within and along the axis between the Arc de Triomphe and the Louvre Museum in Paris's 1st arrondissement, analyzes it using three important urban design theories. By examining the diverse spatial elements contained throughout this unique axis, which has become an iconic, popular and famous meeting place and recreational activity area, the urban spatial characteristics of the axis are investigated. Accordingly, the spaces located along this unique and fantastic axis are investigated. Spaces located along this unique and fantastic axis are analyzed based on the urban space theories of Cliff Moughtin, Kevin Lynch, and Gordon Cullen. The organizational forms of spaces along the axis are investigated by spatial design principles such as; spatial depth/density/interpenetration types, and the types of spaces are particularly emphasized in relation to important squares, streets, and green areas.

1.1.Problem Definition: What are the urban spatial characteristics of the axis that extend uninterruptedly from the Arc de Triomphe to the Louvre Museum in the 1st arrondissement of Paris?

1.2.Literature Review: The theory and conceptualization section of the article consists of Cliff Moughtin's 'Urban Design: Streets&Squares', Kevin Lynch's 'City Image', and Gordon Cullen's 'Townscape', which are considered masterpieces in the field of urban design, and the research and analyses are based on these theories.

1.3.Methodology: The article consists of original field analyses based on theorethical and conceptual literature reviews and on-site field analyses, observations made on site by the author, photographs and video recordings. All visuals and old maps used during the analyses section are entirely original, created from urban and spatial analyses and observations made by the author himself while walking along the axis and in the 1st arrondissement of Paris. (Figures 1-2-3-4)

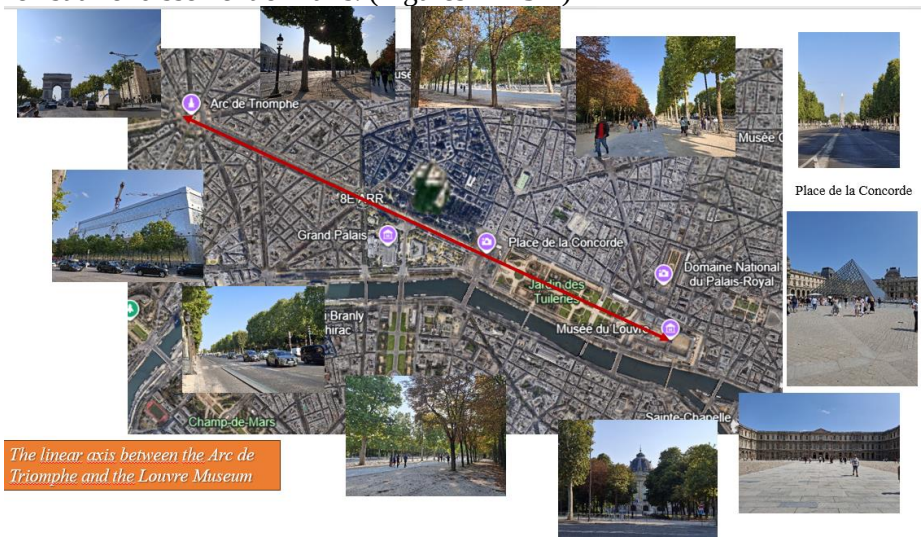


Figure 1. Iconic linear axis between the Arc de Triomphe and the Louvre Museum at the first arrondissement of Paris

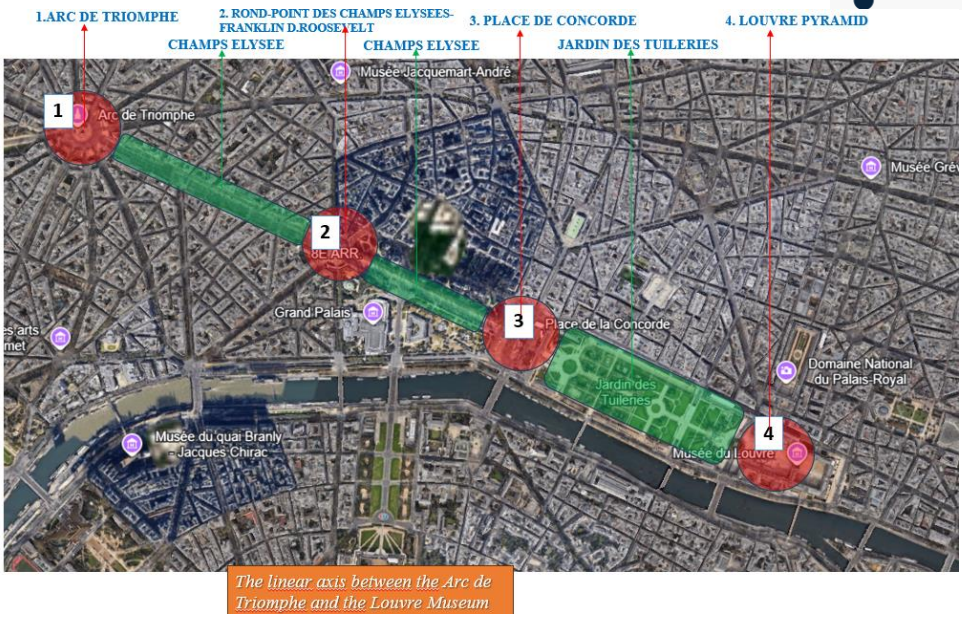


Figure 2. Landmarks on the Iconic linear axis between the Arc de Triomphe and the Louvre Museum at the first arrondissement of Paris

PARIS CITY'S URBAN INTERIORS ANALYSES OF THE 1.TH REGION: BETWEEN ARC DE TRIOMPHE AND MUSEE DU LOUVRE

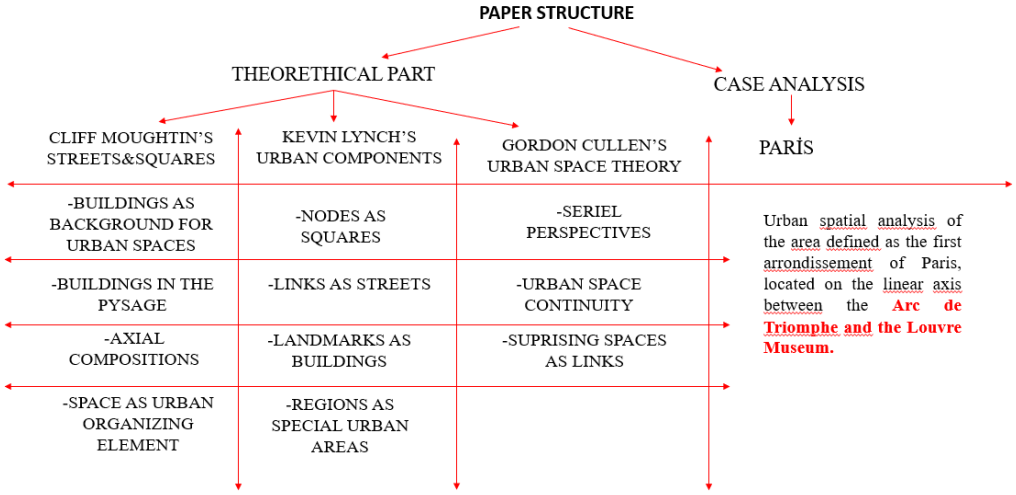


Figure 3. Exploration of the research's structure

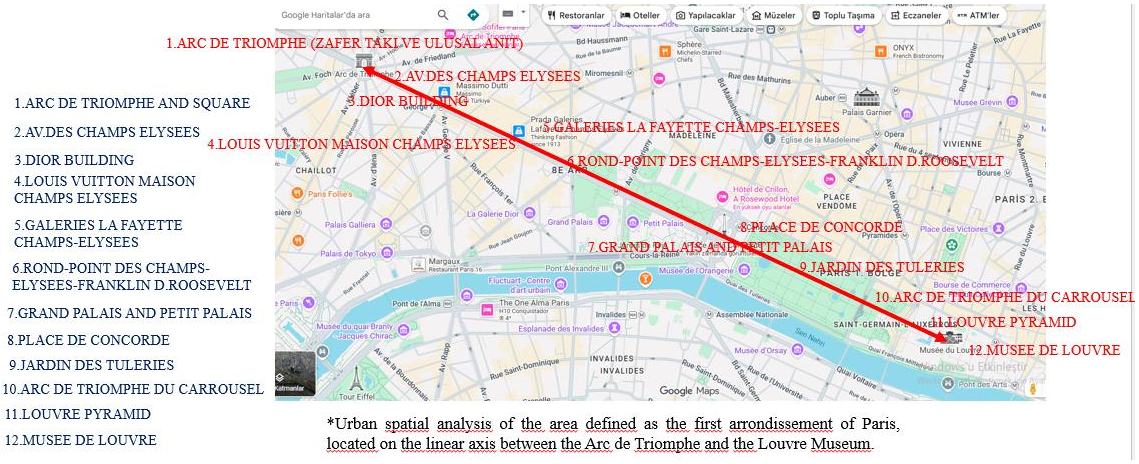


Figure 4. Urban spatial analyses of the area defined as the 1st arrondissement of Paris

PART-2: THEORETHICAL BACKGROUND

PARIS CITY'S URBAN INTERIORS ANALYSES OF THE 1.TH REGION: BETWEEN ARC DE TRIOMPHE AND MUSEE DU LOUVRE

This part explores theorethical part of the research with presenting mainly three academic studies on urban design topic respectively; i) Cliff Moughtin's 'Streets&Squares' book, ii)Kevin Lynch's 'City Image' book, iii)Gordon Cullen's 'Townscape' book.

2.1.CLIFF MOUGHTIN'S URBAN DESIGN:STREETS&SQUARES' THEORY

2.1.1. Buildings as Background for Urban Spaces: Accordingly Cliff Moughtin there are two quite distinct architectural concepts for the town or city. In the first concept the town or city is visualized as an open landscape into which buildings have been introduced as three-dimensional objects, pieces of sculpture sitting within a parkland. The second concept is of a town or city where public space, that is, the streets and squares appear to be carved from an original block of material. In the first concept, buildings are the positive solid elements and space is the general background against which they seen. In the second way of looking, the city space itself is the positive element with three-dimensional properties and the buildings are two-dimensional facades framing space. This figure-ground theory of Moughtin have been analysed on Paris's fantastic iconic linear axis, especially highlighting the Champs Elysees boulvard, which both sided buildings turn into walls and borders for the linear boulvard. Unity in urban design is also dependent upon the form of the layout adopted and the consistency with which it is developed. There are five board techniques for use in achieving unity in large-scale urban design projects. First, landscape can be used to unify an otherwise disprate group of buildings. Whether the city is composed of buildings sitting in space or of spaces formed within building mass, urban design aims at a cohensive and unified composition.(Moughtin,1992)

2.1.2.Buildings İn the Pysage: Accordingly Moughtin, the use of simple geometric shapes for buildings may lead to a unified composition. Such buildings need space around them so that they can be appreciated as unique compositions. The building standing in isolation within a landscape is appreciated in the same way as sculpture, that is, by walking round it and viewing from all sides.There are two basic forms taken by buildings designed to be seen in the round and appreciated as sculpture. The first is the informel model composed of free sculptural forms which give maximum flexibility for internal planning.With this theory, Arc de Triomphe and Musee de Louvre have been analysed as the buildings as that have simple geometric shapes, that are appreciated as sculptures in the iconic Paris axis.(Moughtin,1992)

Buildings have simple geometric volumes when placed together can present to the viewer a unified composition provided that certain conditions are met. The dynamic nature of the way building groups of this type are appreciated requires sufficient space around the buildings so that the ever-changing composition is seen from many viewpoints. In the Piazza Del Duoma there are three important religious buildings to be unified using only a combination of simple form and a strong architectural treatment. In the Piazza Del Duomo there are three important religious buildings; the cathedral, the baptistry and the campanile. The Piazza is quite unlike most other Italian squares, there is no attempt to create a sense of spatial enclosure. The site is so large compared with the ground coverage of the main buildings that the cathedral, baptistry and campanile stand out as plastic compositions on a broad grassy plane. The surrounding walls of the piazza are low in comparison with the principal buildings; they act as visual links between the three main compositional elements rather than enclosing walls. (Moughtin,1992)(Figure 5)

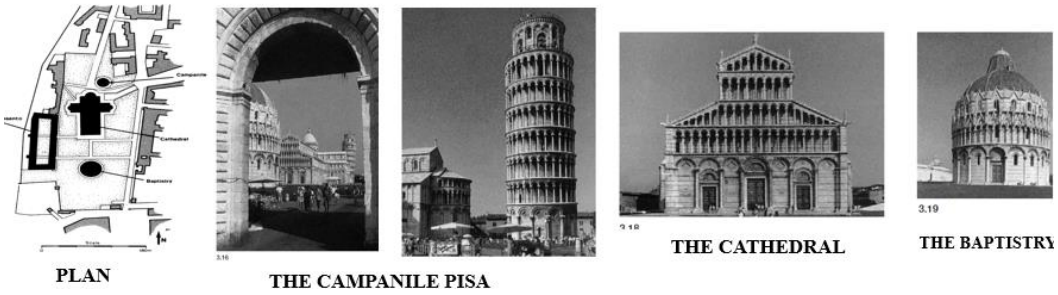


Figure 5. Buildings with simple geometric forms in the Piazza Del Duomo.

2.1.3.Axial Compositions: Buildings can be arranged about a series of axis and sub-axis. A strong axis as the organizing discipline for grouping buildings is a common method. With this generic layout form buildings and landscape elements are arranged symmetrically about an axis; unity being established through the presentation to viewer of controlled viewpoints along an axial vista. As a method of spatial planning it was common in the 19th century. In this design system, building elements within the building and externally on the grand scale of the city, face each other in such a way that their center lines coincide to form an axis. In this way the elements withing buildings, doors, windows, rooms and so on, all bear a spatial relationship to each other. This discipline, when extended beyond the bounds of the building, produced layouts where the buildings also bear a spatial relationship to each other determined by the Vista down the common axis.Minor axis at right angles to the main axis are introduced to relate buildings across the main direction of movement. Pope Sixtus V during the five years of his papacy bewteen 1585 and 1590 and with the assistance of his architect Domenico Fontana, transformed the face of mediaval Rome. The technique he used to create ordered development out of the chaos of the medieval city was the long vista. Using wide, straight roads he connected the seven main churches, the holy shrines which had to be visited by pilgrims in the course of a day. (Moughtin,1992)(Figure 6)

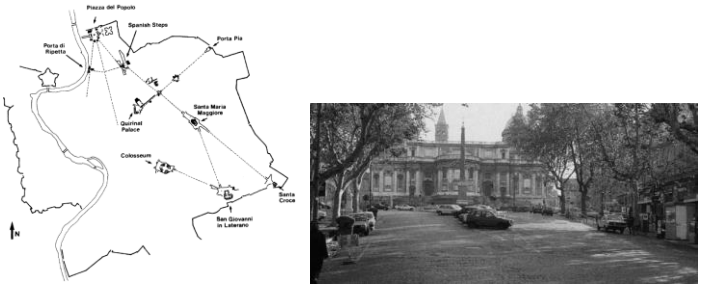


Figure 6. Rome and Sixtus V, S.Maria Maggiore

Using vista as the guiding principal for urban structuring Sixtus V set the pattern for Rome's future development. At the termination of his great vistas obelisks were raised and around these and other important nodes along the routes wonderful squares were later to develop. Urban structure disciplined by the vista is usually most successful when the uninterreupted view is no greater than 1.5 km. axess extending beyond this lenght require some added points of visual interest along the route. As Gibberd points out, vista or axial planning is not compatible with design for traffic speeds and densities of present day cities; the radial focal point system breaks down with modern road design because the line of the vista is now the path of rapid movement. (Cliff Moughtin,1992)

2.1.4. Space as the Organizing Concept in Urban Design: Sitte reversed current urban design dogma by emphasizing the square and the street as the elements of city development. In other words, according to his theory it is the spaces in the city which should receive the attention of the designers.This theory of urban design places emphasis on the outdoor rooms and corridors of the city; they are the volumes to be designed and the buildings are merely two-dimensional enclosures and walls of the spaces. Following Sitte's pattern of city development buildings are designed in such a way that the scene becomes more important as urban design while architecture is relagated to a subsidiary supporting role. There are two main ways in which buildings can be arranged in space. The buildings themselves can be the positive object designed as a three-dimensional mass, the figure in the composition, while the space in which

they stand is the ground. The alternative method advocated by Sitte is a reversal of this process. Space itself becomes the figure, the positive element, the volume to be designed and buildings are relegated to a supporting role, the ground. As the background of the urban scene the buildings are stage setting for the activities of daily life taking place within the spatial volumes they define. (Moughtin,1992)

2.2. KEVIN LYNCH CITY COMPONENTS THEORY

Kevin Lynch conducted a study; to find out, what people mentally extract from the physical reality of a city. In his examination, he found that there are **5 basic parameters / elements**, which people use to construct their mental image of a city, which are as follow: districts, edges, pathways, nodes, landmarks.(Glosh, M.2019)

Districts: A city is composed of component neighborhoods called districts. They consists of their centers,uptowns, midtowns,in-towns,suburbs,etc. They are distinct in form and extent,as well as, mixed in character.

Pathways: A city has a network of majOr pathways, while a district has a network of minor pathways. These are routes of circulation,which people use to move about.

Nodes: The centers of activities of a city are its nodes. They are generally distinguished by virtue of their active functions.

Landmarks: The prominent visual features of a city are its landmarks. They help people to orient themselves in the city and to identify an area. Some landmarks are very large and are seen at great distances, while some others are very small and can only be seen close up. (Glosh,M.,2019)

Images are interfaces that shape interaction, people and the environments they share (Burnett 1986). In urban space, there is always more than the eye can see and the ear can hear and no element perceived on its own, but in relation to its environment and the memory of past experiences (Lynch,1996). The combination of all these images that we perceive visually or visualize in our minds creates the image of the city in our minds. In addition, accordingly Kevin Lynch in his book 'image of the city', city components are defined as (Figure 7);

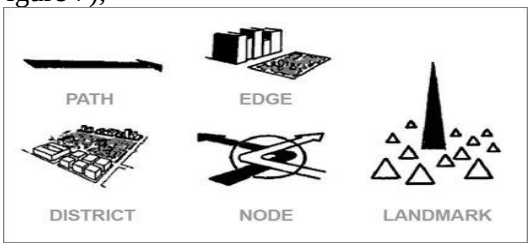


Figure 7. City Components

a.Traces-Links-Roads (paths): Roads, which Kevin Lynch refers to as tracks, are transportation axes that connect or separate regions within the city or pass between regions. Roads may be reserved for vehicular and pedestrain, vehicular only, or pedestrian only. According to these distinctions, their width, infrastructure and equipment features vary. While moving on these directional roads, people observe the city and perceive other environmental elements and establish their relationship with the whole. (Lynch,2010)

b.Nodes : Focal points are nodal points within the city plan. Nodal points, squares, intersections of transportation axes, bus terminals, train stations, city bus terminals, etc. While they can be transfer points, areas in the form of squares where crowds meet, gather, come together and at the same time disperse in different directions, also constitute important focal points (nodal points) and socializing places. Focal points as intersections of points where transportation breaks down, have a compelling importance for the city dweller and it is necessary to make decisions at intersections.(Lynch,2010)

Squares of all sizes within the city are not only transition areas for individuals, like streets and avenues, but they are also social living spaces for citizens as they are areas of gathering, accumulation, meeting and encountering. In this context, square areas are the only means of spatial organization for a variety of uses where urban centers with intense circulation and crowding in terms of both vehicle and pedestrian traffic.

c.Landmarks: Are icons that point to their location. The words 'landmark' which is the original expression of landmarks, has also been included in the urban design terminology in our language.

Landmarks are buildings or groups of buildings that effected the skyline and can be used as reference points. Landmarks consist of monumental elements such as; statues, clock towers, religious buildings, bridges, fountains, or structures and building groups with distinctive features in terms of architectural style.(Lynch,2010)

d.Edges: The elements that we call edges are the elements that surround and limit the public space and where the public space ends. These may be structural elements such as building facades or walls that form the interface between public and private spaces or natural theresholds such as streams, lakes or seashores. Boundaries, like roads, require continuity of form within lateral surfaces extending along them. (Lynch,2010)

e.Districts: Regions are city parts that form an integrity within themselves. It refers to areas that have similar characteristics to each other in terms of function, form, texture or content. While regions that have integrity within themselves such as; residential areas, commercial areas, industrial areas, and recreation areas, differ from each other in terms of function, historical city centers and development areas of the city differ from each other in terms of historical texture and the elements that amke up the urban texture. (Lynch,2010)

In similar context, Gordon Cullen developed another concept of the mental image of a city, through observation of various urban places and parameters / elements. Accordingly, he found that, there are also 3 more parameters to construct the mental image of a city, which are as follow: i)Serial Vision , ii)Place , iii)Content (Ghosh,M.,2019). Cullen , in his evaluation of the individual's experiences with urban space; he emphasized with urban space; he emphasized the scope of spaces and the importance of rapid vision-perception by taking advantage of the perspective of the street or the person on the street. (Çelikyay,2017)

PART 3: CASE ANALYSIS- PARIS 1.ST ARRONDISSEMENT, LOCATED ON THE LINEAR AXIS BETWEEN THE ARC DE TRIOMPHE AND THE LOUVRE MUSEUM.

This part consists of analysis of the area under three main headings;

i) Moughtin's space analysis,2)Spatial analysis, 3) Lynch's city components analysis,

This area, known as the first arrondissement of Paris, not only organizes iconic elements along a linear axis but also creates fantastical axes, creating profound urban serial perspectives along the line.

A. BUILDINGS AS BACKGROUND FOR URBAN SPACES
B. BUILDINGS IN THE PYSAGE
C. AXIAL COMPOSITIONS
D.SPACE AS THE ORGANIZING CONCEPT IN URBAN DESIGN

3.1.1. BUILDINGS AS BACKGROUND FOR URBAN SPACES FOR THE 1ST ARRONDISSEMENT OF PARIS

This figure-ground theory of Moughtin have been analysed on Paris's fantastic iconic linear axis, especially highlighting the Champs Elysees boulvard, which both sided buildings turn into walls and borders for the linear boulvard.

In Paris case, buildings on both sides transform walls for the urban space infront of them. The building facades on both sides of the boulvard, creates urban spaces for both circulations and extensions of ground floor cafes to the boulvard. These buildings with their facades makes the spatial border for urban space in front of them. (Figure 8)

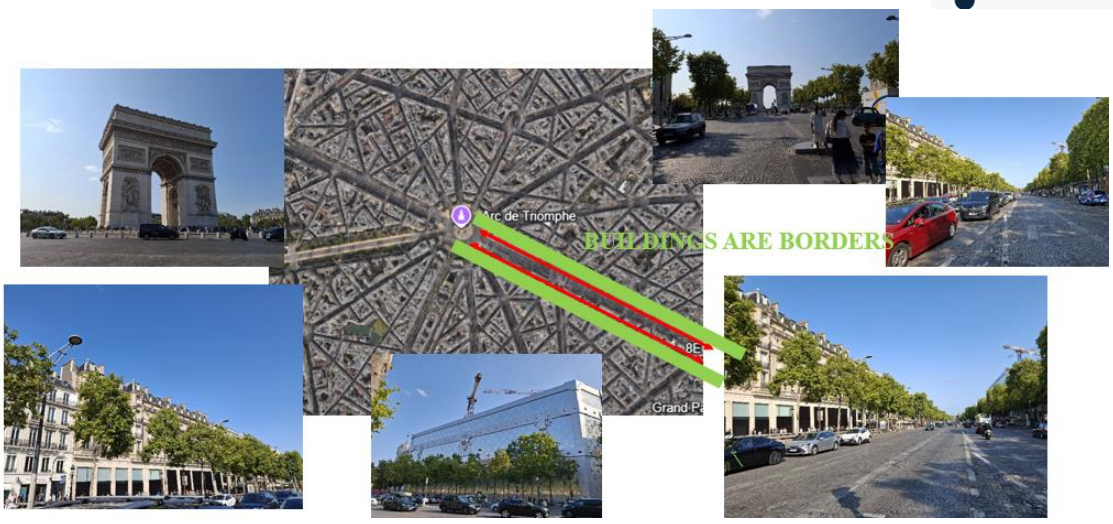


Figure 8. Buildings creating spatial borders for the urban spaces at Champs-Elysee boulvard

3.1.2. BUILDINGS IN THE PYSAGE AND BUILDIGN WITH SIMPLE GEOMETRICAL FORMS

As Sitte points out, the transformation of buildings into surfaces, walls or boundaries for urban spaces turn the figure-ground relationship into a positive principle in urban design. In this respect, buildings, thanks to their facades, continuity, and good alignment, create vibrant urban spaces. Especially in Paris, famous for its cafes, the sidewalks defined by building facades, with cafes extending outdoors, and the sidewalks on both sides of Champs Elysee, strongly defined by building facades, transform into urban spaces and pedestrian circulation as open and fluid versions of cafes. This alignment creates an aligned urban space in front of it.

On the other hand, buildings with simple geometric shapes within the urban landscape organize both the axis and the urban spaces around them in a 360-degree radius. As in the case of the Arc de Triomphe, this historic, simple rectangular monument has organized its surroundings as a circular intersection, an urban space. Similarly, the Louvre pyramid divides the large Louvre Museum courtyard into axis, and connects urban spaces by organizing them with smaller axis. And the Theatre du Rond Point, with its domes and simple form, similarly organizes its surroundings as a green urban space.(Figure 9)

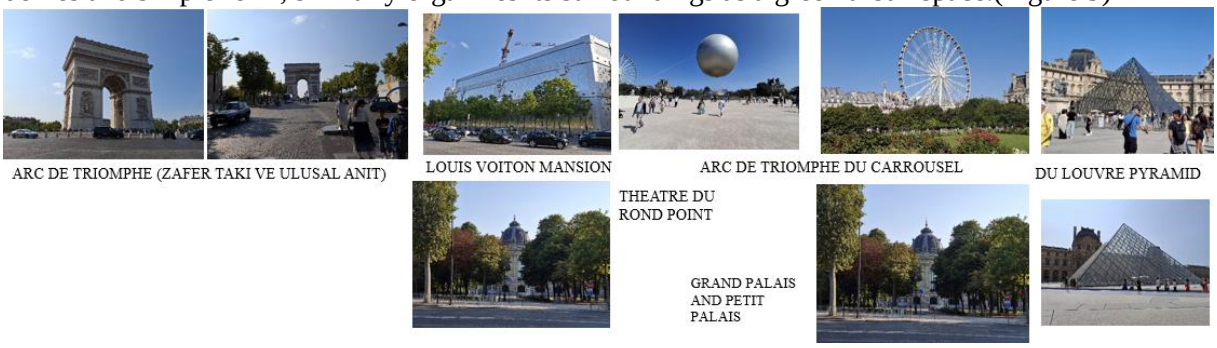


Figure 9. Buildings with simple geometric forms on the 1st arrondissement of Paris axis.

3.1.3.AXIAL COMPOSITIONS OF THE FIRST ARRONDISSEMENT OF PARIS

The study examines the iconic axis created by Paris's 1st arrondissement, focusing on how the linear axis between the Arc de Triomphe and the Louvre pyramid organizes urban design in a crucial area of Paris, and its effectiveness in creating urban circulation, focal points, and spaces.

This axis connects the city's most important squares; Arc de Triomphe square, the Place la de Concorde square, and the Louvre pyramid square, successfully organize a wide variety of acitivity spaces-pedestrian and vehicular circulation, promenades, photo taking, bicycle paths, cafe extensions on the sidewalks, parks, sqaures, and seating and recreation areas, all within a single linear axis. (Figure 10)

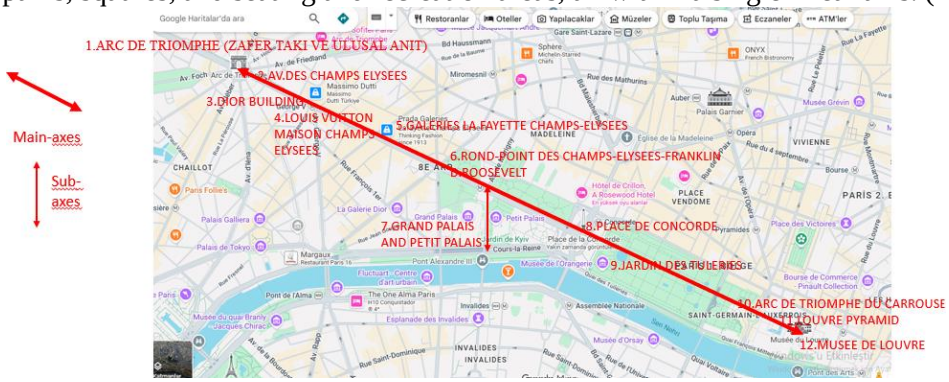


Figure 10. Iconic Linear axis of Paris 1st arrondissement

3.1.4.SPACE AS THE ORGANIZING CONCEPT IN URBAN DESIGN IN THE 1.ST ARRONDISSEMENT OF PARIS

At the most important three-dimensional element of spatial organization, urban spaces are located as iconic squares on this powerful axis. The organization of the axis includes three powerful squares, which overlap vertically to create a series of perspective. The linearity of the axis is so smooth and it openness so sufficient that,when viewed from a single point, all three squares overlap, creating spatial depth. This spatial depth in the 1st arrondissement of Paris is almost as successful, scaled, three-dimensional, physical and clear as what we are accustomed to seeing in interior spaces. Therefore, in this spatial design presented with the quality of an interior space, Arc de Triomphe, Place de Concorede, and Louvre Pyramid squares, regardless of the side from which they are viewed or where one stands on the axis, always overlap, creating a spatial depth as if they were a single square. In this respect, the squares here, as three dimensional volumetric elements, have a very strong ability to organize the urban design of this area.(Figure 11)

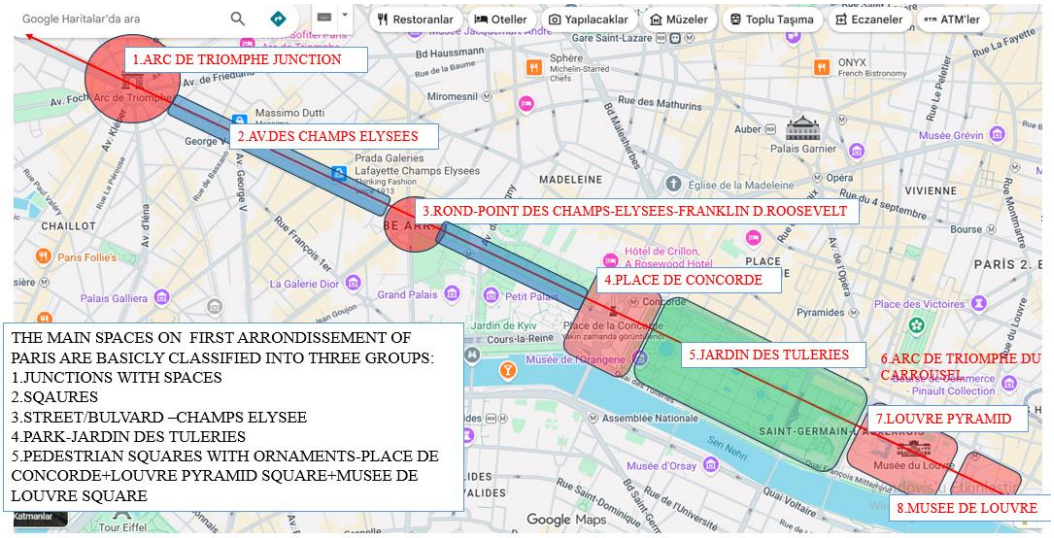


Figure 11. Main spaces on the 1st arrondissement of Paris linear axis

THE MAIN SPACES ON FIRST ARRONDISSEMENT OF PARIS ARE BASICLY CLASSIFIED INTO THREE GROUPS:

1.JUNCTIONS WITH SPACES
2.SQUARES
3.STREET/BULVARD –CHAMPS ELYSEE
4.PARK-JARDIN DES TUILERIES
5.PEDESTRIAN SQUARES WITH ORNAMENTS-PLACE DE CONCORDE+LOUVRE PYRAMID SQUARE+MUSEE DE LOUVRE SQUARE

The fourth topic in the urban design analyses of Paris's 1st arrondissment, the parameter of 'space' , was analyzed using maps and visuals of the area. 'Space' in urban design is one of the most important elements of urban design, functional and activity-based, at the human scale. Based on the urban spaces analyses conducted in Paris's 1st arrondissement, four different types of spaces were identified.

The Arc de Triomphe and Rond Point, with their circular forms, are vehicular squares and intersections formed by the intersection of 12 and 8 circular axes, respectively. The Arc de Triomphe , thanks to the iconic triumphal arch at its center, primarily creates an urban space around it and secondarily serves as a roundabout for vehicles.

The two intersections in the area exhibit harmony with their circular forms, connecting a very strong avenue consisting of both circulation and acitivity spaces. The first section between the Arc de Triomphe and Rond Point, creating a very vibrant urban acis. The Champs-Elysee boulevard consists of pedestrian circulation (sidewalks), cafes spilling out into the Street creating resting areas, a double-lane road in between, and a separate area in the middle where the iconic axis can be observed, photographed, and video making.

Therefore, the first section of the Champs-Elysee between the Arc de Triomphe and Rond Point intersections/squares exhibits a very lively, highly functional, human-scale, user-friendly, and acitvity-oriented spatiality.

The second section of the Champs-Elysees, starting from the other side of Rond Point Square, unlike the first, exhibits a natural spatiality. Walking platforms divided into different small linear axis and different paving materials create a spatial arrangement side-by-side, offering the user different experienced and alternatives within a relationship of spatial density.

The Champs-Elysee boulevard, an iconic axis in Paris's first arrondissement, offers two distinctly different types of urban spaces in its multi-functional design: one between Rond Point and the Arc De Triomphe, and the other between Rond Point and Place de Concorde. One section is more vibrant, featuring cafes, benches, and kiosks, creating a more urban atmosphere. The second section, towards Place de Concorde, emphasizes the boulevard's connection to nature. Sand paths and pavements are flanked by green gardens on either side, culminating in Place de Concorde. (Figure 12)

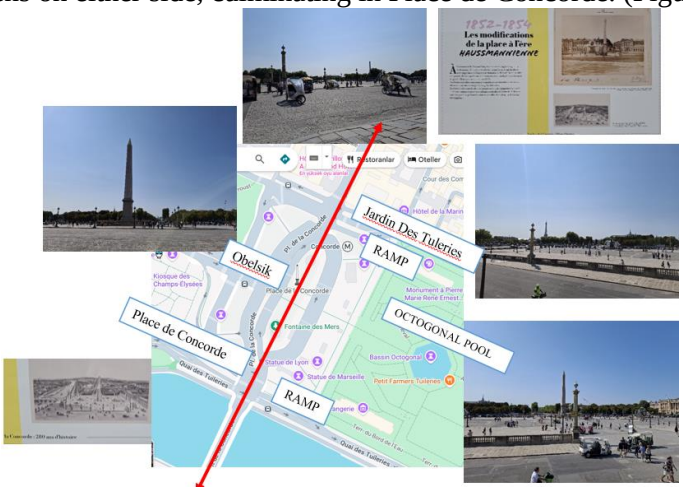


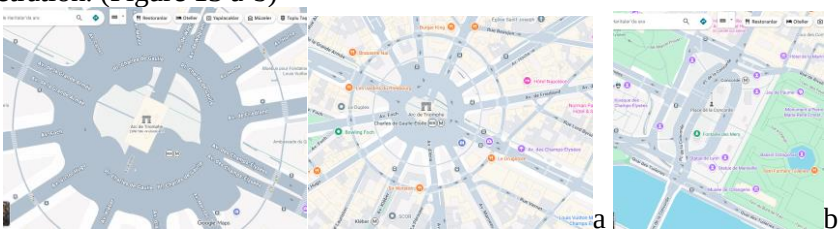
Figure 12. Place de Concorde as the entrance urban liminal space for the Jardin Des Tuileries.

Place de Concorde is the second largest sqaure in Paris, equally importnat as the Arc de Tiromphe. Place de Concorde serves both as an urban space and as a transitional space connecting the Arc de Triomphe to the Jardin des Tuilenes gardens. Access to the Jardin des Tuileries from the square is achieved through a difference in elevation.

Accessed by stairs from the sqaure, the Jardin des Tuileries' entrance descends via symmetrical ramps on both sides, leading to the iconic octagonal pool and the surrounding space. Thus, the gardens feature an entrance design composed of hills, descending from top to bottom.

Place de Concorde is particularly well-equipped, with a tall obelisk situated between two iconic, symmetrical fountains that conform to the rectangular form of the square.

With these characteristics, Place de Concorde is a high-quality urban space that serves as a gathering place, a square equipped with symmetrical iconic fountains and an obelisk, a transitional space in terms of its relationship with the Jardin des Tuileries gardens, and a point of observation, rest, and activity connecting the Arc de Triomphe and the Louvre Pyramid on the axis between these two squares, creating spatial interpenetration. (Figure 13 a-b)



a b

Figure 13. a) Arc de Triomphe , b) Place de Concorde

3.2.1.SPATIAL OVERLAPPING

The axis starting form the octogonal basin, the Place de Concorde obelisk, and finally the historic Arc de Triomphe, overlap and create depth on the linear axis. This linear axis creates an urban spatial analogy to the sequence of lines arranged one after another in painting. (Figure 14 a-b)

a b

Figure 14. a) Place de Concorde, b-c) Jardin Des Tuileries

3.2.2.SPATIAL DENSITY

Along the Arc de Triomphe axis, spatial density is revealed by the juxtaposition of different functions on the boulevard. This spatial density is manifested on the boulevard as follows: between the right and left sidewallks, a vehicle road, a central area for photography and observation, and again, a vehicle road, a controlled pedestrian walkway, a bicycle path, and a sidewalk.(Figure 15)

Figure 15. Champs-Elysee boulevard

The Champs Elysees boulevard is observed for its rhythmic arrangement of different acitivities side-by-side. Starting from the Arc de Triomphe, pausing at Place de le Concorde, and proceeding through the Jardin des le Tuileries gardens via numerous diagonal axes, this powerful, iconic Parisian 1st arrondissement axis features a particularly striking area in the middle of the boulevard dedicated to photography and observation of the Arc de Triomphe and Place de la Concorde.

Its' level with the road creates a spatial arrangement, characterized by a high density of people. This space is perhaps more harmonious and unique with this axis than any other activity could be possible.(Figure 16 a-b)

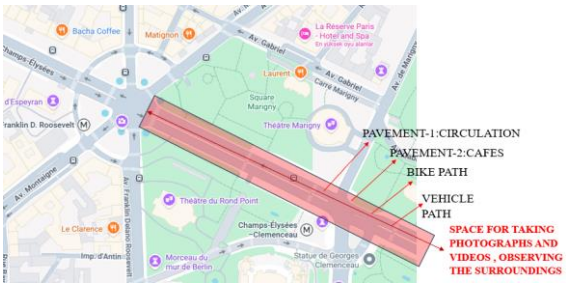


Figure 16. a) Spatial density on the Champs-Elysee boulevard

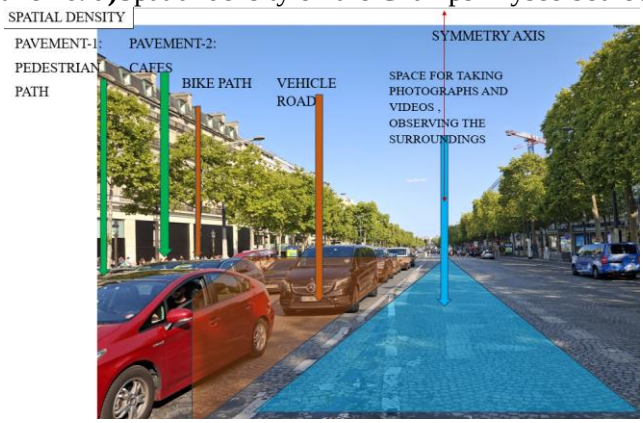


Figure 16. b) Spatial density on the Champs-Elysee boulevard**.**

3.2.3.SPATIAL INTERPENETRATION

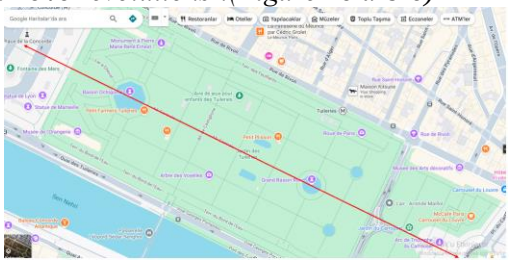
With these characteristics, Place de Concorde is a high-quality urban space that serves as a gathering place, a square equipped with symmetrcial iconic fountains and an obelisk, a transitional space in temrs of its relationship with the Jardin Des Tuileries gardens, and a point of observation, rest, acitivity connecting the Arc de Triomphe and the Louvre Pyramid on the axis between these two squares, creating spatial interpenetration.(Figure 17)

Figure 17. Spatial interpenetration and Place de Concorde as an in-between multifunctional space.

SPATIAL DENSITY-2: IN THE JARDIN DES TUILERIES, BETWEEN PLACE DE LA CONCORDE AND DU LOUVRE AND ARC DE TRIOMPHE DU CARROUSEL

'Completely burned down during the Commune (1871), the Palais des Tuileries was one of the main sites of French Revolution. On October 6, 1789, insurgent Parisian women forced Louis XVI to leave the Chateau de Versailles. After having been abandoned as the royal residence for more than a century,the old Palais des Tuileries and its gardens once again saw the king and his court return. Shortly afterwards, the Assemblee nationale relocated to a neighboring building, an indoor riding Academy called the 'Salle du Manege'.on August 10,1792,the Tuileries became the site of the fall of the monarchy: the palace was stormed and invaded into the palace itself, into a theater known as the 'Salle des Machines'. Every day, political life animated the streets of this neighbourhood: on the terrace of the Feullants club,deputes, journalists and citizens bumped into one another. Both of he revolutionary

Republican clubs, the Feuillants and Jaconins, were located nearby. The Louvre was also one of the hotspots of both the 1830 and 1848 revolutions'.(Figure 18 a-b-c)


a

b

c

Figure 18. Figure 18. a) The promenades of the Tuileries Palace, Jacques Rigound, b) View of the Place de la Concorde and the Champs-Élysées towards the second half of the 19th century. Anonymous, CCO Paris Musées/Musée Carnavalet-Histoire de Paris. Eiffel (**Source: open air exhibition at Place de Concorde in Paris, exhibition of historical development of the square, photos taken by Ayça Arslan)**

1763 The architect Gabriel completes the development of the Place Louis XV. Among the 28 participants in the competition, the projects of the architects Germain Boffrand, Jean de Lassurrance, and Pierre Contant d'Ivry emerge. The king then asks his chief architect, Ange-Jacques Gabriel, who had submitted a sketch, to create a synthesis of the elements he considers most interesting. Gabriel presents a first project in July 1753: structured by peripheral moats, the buildings on the north side form a backdrop for the statue, while preserving the perspective between the Tiliers and the Champs-Élysées. (Figure 19)

Figure 19. Photograph of the Place de la Concorde and its obelisk during the second half of the 19th century. CCO Paris Musees/Musee Carnavalet-Histoire de Paris. Eiffel (**Source**: open-air exhibition at Place de la Concorde in Paris, exhibition of the historical development of the square, photos taken by Ayça Arslan)

'1852-1854 LES modifications de la place e l'ere Haussmannıenne

1852-1854: Modifications to the Place de la République during the Haussmann Era

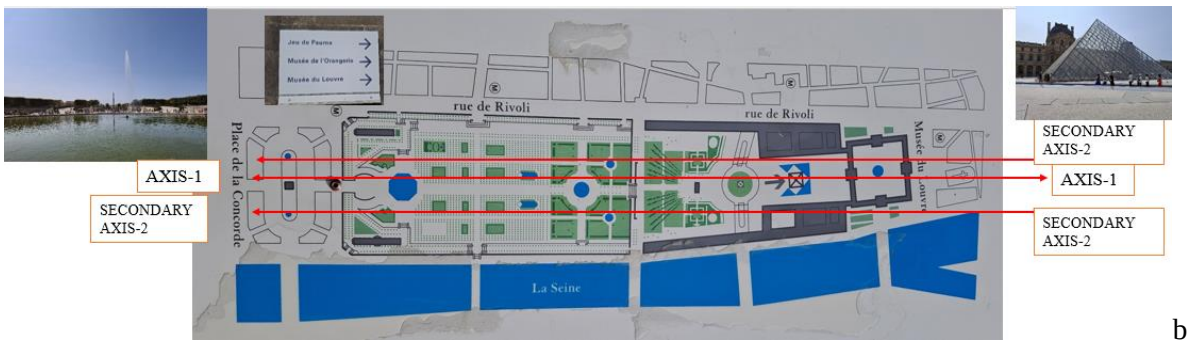
with the advent of the Second Empire, the moats, deemed dangerous and detrimental to the growing traffic on the square, were removed. The emperor asked Hittorff to resume his project ten years after its completion, despite the reservations of Prefect Haussmann, appointed in 1853. The moats were then filled in, and sidewalks were built in their place, except along the Tuileries Gardens.The balustrades were ultimately retained, but only on the inner side, as supports for the rostral columns and connecting elements between the sentry boxes bearing the statues of the cities. The polychrome paving was removed. In the summer of 2024, a new chapter in the long Olympic history is being written, with 25,000 people enjoying the urban park every day, a unique, temporary competition venue right in the heart of the city,

bringing together BMX Freestyle and breaking events in one place. A PLACE AT THE HEART OF THE PARIS SUMMER OLYMPIC AND PARALYMPIC GAMES'.

Concorde urban park, Olympic Games competition site as seen from the Eiffel Tower (**Source:** open air exhibition at Place de Concorde in Paris, exhibition of the historical development of the square, photos taken by Ayça Arslan)

At JARDIN DES TUILENES, urban spaces are very flexible and organized via main linear axis and cross axis that are distrubited on the main axial organization. This axial spatial organization of the Jardin Des Tuileries creates both spatial depth and integration on the main axis, and forms seriel space perspectives from place de Concorde to the Louvre Museum square.
Space quality is very high in the garden by flexble green seating chairs, groups of trees and pools that are placed in the grid organization repetitively. The unique chairs of the garden are very flexible, ensures many different sitting scenarios and are produce and reproduce the spaces in the Jardin des Tuleries by user desires. It is possible to watch diverse temporal urban scenes in the garden by the help of green chairs organizations. (Figure 20-21-22)

a



b

Figure 20. a-b-c) Jardin des Tuileries

In addition to socilizing spaces, the sculptures both on green zones and walking routes transforms garden into open air arts exhibition center of Paris.
It is observed that there is a high space quality in the Jardin Des Tuleries which carries urban spaces to urban interiors level by unique sitting chairs, trees, octoganol basins, walking routes designed within a space hierarchy by main axis and secondary axis, open exhitibiton spaces, book reading corners, relaxing areas, sun-bathing niches in the garden.(Figure 21)(Table 1)

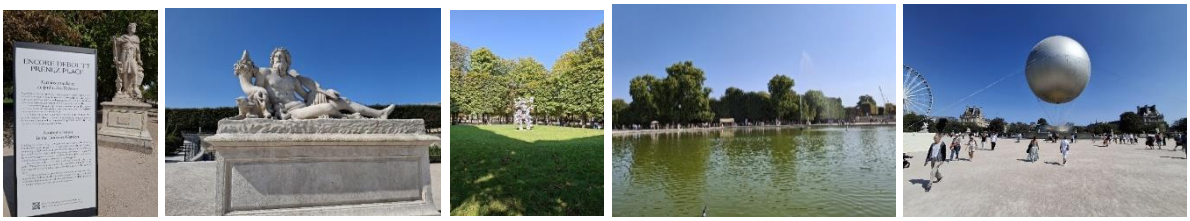


Figure 21. Jardin Des Tuileries , art objects in the garden

3.3.KEVIN LYNCH'S URBAN COMPONENTS: *nodes&links&icons&borders&zones*

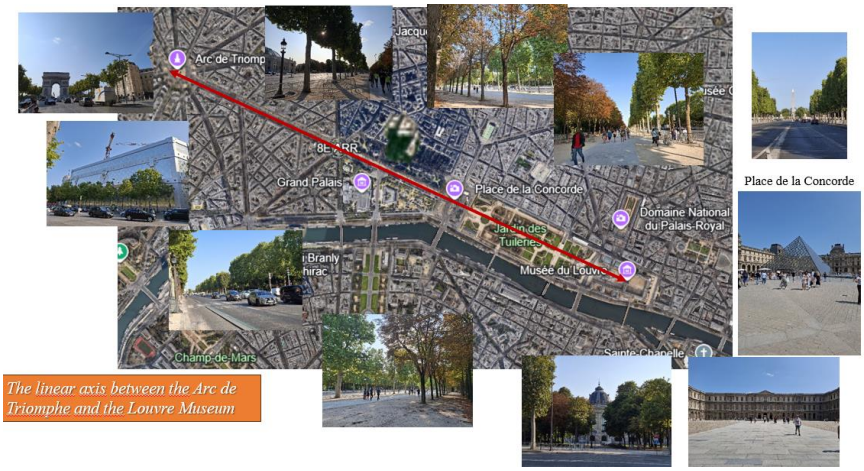


Figure 21. City components of 1st arrondissement of Paris

Table 1. City components of 1st arrondissement of Paris

nodes	links	icons	borders	zones
1.ARC DE TRIOMPHE JUNCTION	1.CHAMPS ELYSEES BULVARD	1.ARC DE TRIOMPHE	1.RAMPS AND STAIRS OF PLACE DE CONCORDE THAT SEPARATES	1.ARC DE TRIOMPHE REGION

			JARDIN DES TUREILES	
2.ROND-POINT DES CHAMPS-ELYSEES-FRANKLIN D.ROOSEVELT	2.MAIN AND SEOCNDARY AXIS IN THE JARDIN DES TUREILES	2.OBELISK IN THE PLACE DE CONCORDE	2.ALIGHNMENT OF BUILDINGS ON CHAMPSELYSEE BULVARD	2.JARDIN DES TULERIES-GREEN ZONE
3.PLACE DE CONCORDE SQUARE		3.LOUVRE PYRAMID	3.ALIGNMENT OF ROW OF TREES ON THE SECOND PART OF CHAMPS-ELYSEE BULVARD	3..MUSEUMS REGION
4.DU LOUVRE PYRAMID SQAURE		4.LOUVRE MUSEUM		4..SEINE RIVER REGION
5.LOUVRE MUSEUM SQAURE				
6.OCTOGONAL BASINS IN THE JARDIN DES TUREİLES				
7.ARC DE TRIOMPHE DU CARROUSEL				

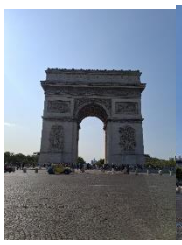
*ICONS (LANDMARKS)

*NODES

*LINKS

CHAMPS-ELYSEE BOULEVARD

*ZONES

 HISTORICAL ZONE

GREEN ZONE

SOCIALIZING ZONE

4.CONCLUSIONS

The article mainly aim to explore the urban design elements on the iconic and fantastical continous linear axis between the Arc de Triomphe and the Louvre Museum in Paris's 1.st arrondissement, using renowed urban design theories and spatial design parameters. The author's analysis, based on on-site observations along the axis in Paris, is examined through the academic publications and theories on urban design presented by the Moughtin-Lynch-Cullen's triology. Maps and on-site photographs were used as analytical tools in the research. As a result of the analysis, the spatial elements of urban design along the linear axis between the Arc de Triomphe and the Louvre Museum in Paris's 1.st arrondissement are presented below:

1.Cliff Moughtin's principles from his book 'Urban Design: Streets & Squares' were examined in the field, and it was observed that the figure-ground relationships, especially on the Champs-Elysee boulvard, buildings are aligned like walls and limiting elements for the urban spaces in front of the buildings, creating quality circulation and seating areas with cafes spilling out onto the boulvard.

2.It was observed that buildings with simple geometric shapes create focal points, such as; the Arc de Triomphe and the Louvre Pyramid, and spatiality organize their surroundings, transforming them into activity spaces and gathering places.

3.The principle of focusing urban spaces on landmarks along axes by establishing strong axes through the creation of urban landmarks. The arrangement of spaces along a single linear axis such as; Place de Concorde, Jardin Des Tuileries, the Louvre Pyramid, etc. Along the Arc de Triomphe -Louvre Museum axis, a strong and linear axis, has been revealed, demonstrating the importance of axis in creating urban spaces.

4.It has been determined that the way spaes organize their surroundings along the axis, based on the principle of 'space' as the creator of urban design, incorporate principles of spatial depth, spatial density, and spatial interpenetration.

5.Finally, it has been proven that Kevin Lynch's urban image elements are highly effective due to the preserve of highly iconic structures, squares, and gardens along this already iconic axis.

SOURCES

Moughtin,C. (1992). Urban Design : Street and Square. Architectural Press.
Krier,R.(2003).Urban Space. London: Academy Editions.
Trancik, R. (1990). Finding Lost Space: Theories of Urban Design.Van Nostrand Erinhold Company, New York.
Gehl, J. (1987). Life Between Buildings, Using Public Space. New York: Van Nostrand Reinhold.
Lynch K.(2016). Kent İmgesi. İş Bankası Kültür Yayınları
Ellin N.(1996). Postmodern Urbanism. Oxford,UK: Blackwell.
Özdemir B. & Ocakçı M. (2017). Kentsel Tasarım Kriterlerinin Mekânın Algısal Atmosferine Etkisi. Uluslar Arası Hakemli Tasarım ve Mimarlık Dergisi,11,ISSN:2148-4880.
Pardorokes,V. (1992). Kentsel Mekan Tasarım İlkeleri ve Mimari Oluşuma Etkileri. Yüksek Lisans Tezi.İTÜ,Fen Bilimleri Enstitüsü.
Tol,E.(1991).A Study On a Global Lexicon to Find A Medium For Urban Space Design Variables.Case Study: Dimensional Examination of Constant and Universal Urban Values. Department of Architecture Middle East Technical University. September 1991.
Ghosh,M.(2019).Urban Designintroduction, history,characteristics,parameters.August 2019. Encyclopedia of Design. Bloomsbury. pgs:364-69.
Çelikyay,S., 2017,'Kent İmgelerinin Kamusal Alanı Tariflemedeki Rolü', Kamusal Alanların Mekansal Organizasyonu, (s.19-41). Karınca Matbaacılık Yayıncılık.)

ETIOLOGY AND PATHOGENESIS OF DIABETES MELLITUS

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Annotation. Currently, diabetes mellitus is increasing at a high rate globally, particularly among women.During the study, changes associated with diabetes mellitus in patients admitted to the Endocrinology Hospital were investigated. Our research observed that complications were more frequent in women after menopause.

Introduction. Today, diabetes mellitus holds the first place in terms of frequency among the pathologies of the endocrine system. Despite a number of research works being conducted on the pathogenesis and treatment of diabetes and certain successes being achieved, this disease continues to increase rapidly all over the world. The number of people afflicted with diabetes mellitus is also increasing every year in our country.

Materials and Methods. During the execution of the research work, patients with diabetes mellitus were observed. The individuals included in the study were selected from those admitted to the Endocrinology Hospital. Our work was not to monitor the course of treatment, but rather to inform the patients about the prevention of pancreatic diseases and the avoidance of complications.

Result. High levels of blood sugar were observed in the individuals studied. It was found that in some of these individuals, diabetes mellitus is hereditary, as it was detected in their family members and close relatives. In some others, it developed after a fright/shock. For a portion of them, the disease is associated with leading an unhealthy lifestyle. The highest blood glucose indicator in these individuals was 400 mg%. After receiving treatment, it decreased to 180 mg%. The lowest indicator observed was 190 mg%. Timely detection of the disease will make it possible to reduce the frequency of complications, improve the overall survival rate, and enhance the effectiveness of treatment in patients with diabetes mellitus.

Keywords: diabetes mellitus, nutrition,insulin, glucose, carbohydrate.

MECHANICAL BEHAVIOURS OF UNIDIRECTIONNAL COMPOSITES LAMINATED

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ABSTRACT

The aim of our work is to characterize the elastic behavior of a unidirectional glass fiber reinforced composite laminate with a 60% volume fraction of epoxy resin matrix E. The determination of the elastic constants of the specifically orthotropic composite laminate is estimated using the rule of mixtures, and macro-mechanical studies have allowed us to determine the evolution of elastic constants based on fiber orientation and calculate the variation of thermo elastic quantities according to fiber orientation. Under the combined effect of mechanical stresses and temperature variations, the overall thermomechanical deformations of the unidirectional laminate will be determined by introducing longitudinal and transverse thermal expansions of the composite.

Keywords: Unidirectional composite laminate, thermo elastic behavior, fiber orientation

CRIMPING TOOL WEAR AND TEAR ANALYSIS

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Abstract
This paper represents an investigation into spare parts longevity in the context of automotive production. By systematically examining the accuracy of the crimping process, our research unveils the potential for cost reduction by pushing the limits of the usage of crimping tooling, while maintaining production efficiency and quality. Preliminary findings reveal encouraging prospects, but underscore the necessity for further examinations, maintenance strategies, and the development of predictive models. Through the tests described in this paper and the obtained results, it has been concluded that the limits imposed by the procedure can be extended (thus reducing production interruptions and associated costs). Extending these limits cannot be determined by a universally applicable rule, therefore, additional analyses are necessary, analyses that will be the subject of further research.
Keywords: crimping process, spare parts lifetime, anvil, crimper, value engineering

1. Introduction

The automotive industry faces relentless competition, evolving market demands, and stringent regulations, which drive the constant quest to cut production costs while upholding product quality and performance. This drive has given rise to the practice of value engineering, focusing on enhancing product efficiency while minimizing expenses [1], [2].

Within this context, a critical factor to consider is the longevity of spare parts used in specialized machinery. These often-overlooked components wield significant influence over cost-efficiency and productivity within automotive plants.

This paper aims to evaluate cost reduction possibilities in an electrical harness production plant by investigating the lifespan of spare parts employed in the crimping process. The crimping process is fundamental to electrical and electronic assembly, vital for creating reliable wire-to-connector connections in various industries, including automotive manufacturing.As the crimping tool’s active parts endure wear and tear during regular use, they require replacement, impacting overall project costs. Standard maintenance protocols given by the crimping equipment suppliers typically recommend active part replacement when wear or damage is detected. Internally, work instructions dictate replacement after ½ years or at 200000 crimps (strokes). While efforts have been undertaken, there are presently no accurate methods for predicting the failure of spare parts [3], [4].

Our objective is to conduct tests to assess the validity of the 200000-stroke reference point for active part replacement and explore alternative methods for determining replacement, potentially extending

the tooling's lifespan. We hypothesize that significant differences in spare parts wear exist among various crimping tools, which may necessitate a reconsideration of the current internal instructions.
This study aims to advance the current state of the field by introducing novel insights based on empirical analyses, thus opening up space for an integrated body of knowledge. By meticulously examining the accuracy of the crimping process in automotive production, our research not only extends the established boundaries but also suggest cost-effective methodologies to minimize production interruptions and expenses. This work's paramount contribution lies in its revelation of unexplored opportunities for enhancing longevity in spare parts, thereby fortifying the foundation for more efficient and economical manufacturing practices. The imperative necessity to optimize maintenance strategies and develop predictive models is underscored, highlighting the indispensable relevance of this research in steering the industry towards more robust and forward-thinking methodologies.

2. Methodology

The machine used for this study is a Schaefer eps 2000 (Fig. 1), used alternatively with two different crimping tools (applicators) from TE. The two critical tooling inserts within an applicator are the wire crimper and the anvil, commonly known as the active parts or spare parts (Fig.2).
The wear of the applicator active parts can be determined indirectly by examining the results of a crimp. In the context of this investigation, we have evaluated two distinct applicator types belonging to the same family (designated App_01 and App_02). We have used a cable with cross section 0.35mm2 type FLRY-A and two terminals with the same material (CuNiSi).

Figure 1. Schaefer eps 2000 crimping machine

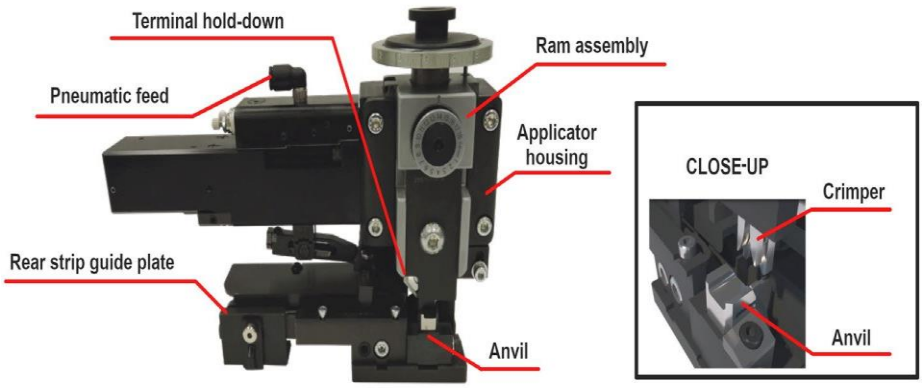


Figure 2. Crip tooling: applicator parts and close-up of inserts

Our initial step involved recording the baseline value, as documented by the strokes-meter of each applicator. Given the extended duration of the testing, we introduced a protocol for measurement intervals, set at either every 5 working days or when the cumulative strokes reached 60000, depending on whichever milestone occurred first. At each of these designated points in time, we conducted assessments and measurements of the quality of the crimps, recording the results in a table. If the measured parameters were off scale, the experiment stopped and the final value on the meter was recorded. If no deviation was found after twenty iterations of testing, provided that the limit of 200000-strokes has been exceeded, the experiment was also stopped and the value on the meter recorded.
Evaluating the crimp quality is a method commonly used in the industry [5]-[7] and consists of specific steps and measurements, such as visual inspection: correct crimp (Fig. 3) or incorrect crimp (Fig. 4), cross section analysis (Fig. 5) and others.In essence, a quality crimp ensures that the wire maintains the right shape and size without any excess material, deformities, or damage that might lead to connection failures [8].

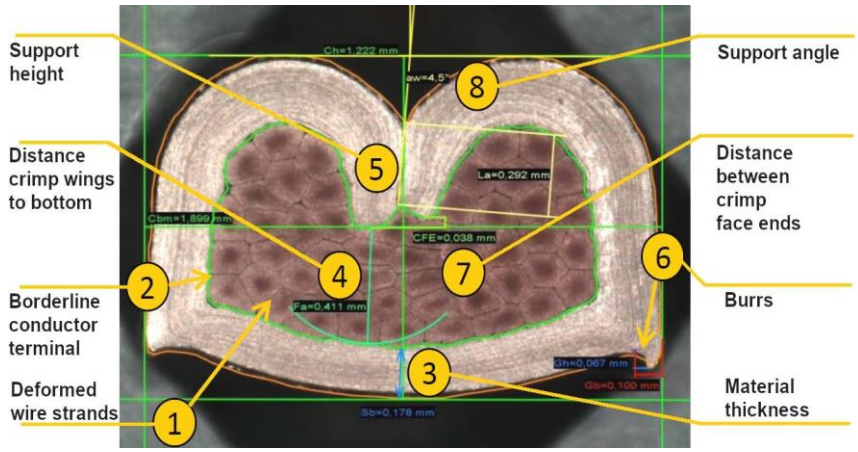


Figure 3. Microsection of the crimp, showing measurable parameters

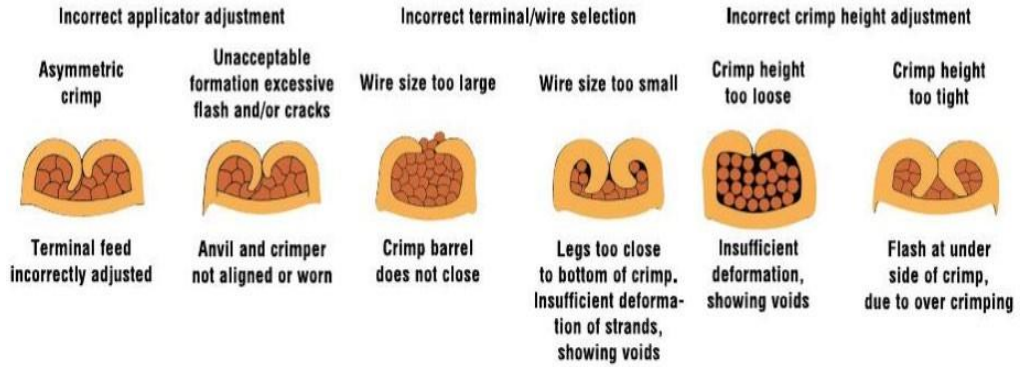
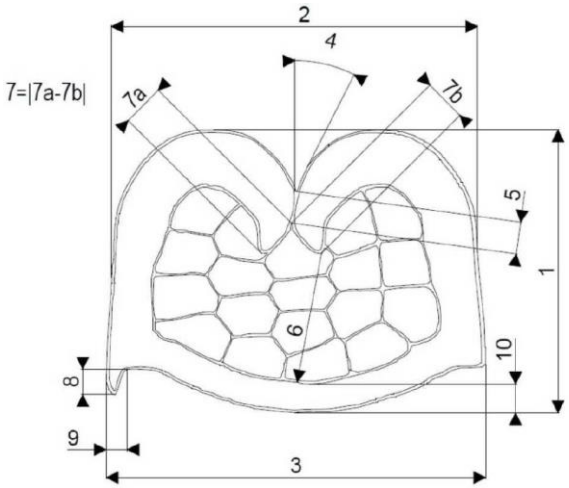


Figure 4. Incorrect crimp quality
A high-quality crimp should achieve the necessary area reduction without causing issues like flash (burr), over-crimping, under-crimping, or bending, respecting the nominal intervals for given value measurements (Fig. 5).

We applied the previously outlined methods to evaluate the crimp's quality and generated a dataset of values that were analyzed in Minitab software. The most significant parameters in our study are wire crimp height (CH), wire crimp width (CW), burr height (Gh) and burr width (Gb). Especially the latest two are indicative of spare parts wear or damage.



Ref. nr.	Measured parameter
1	Capability study_wire crimp height (CH)
3	Capability study_wire crimp width (CW)
NA	Pull-force
4	Support angle (Aw)
5	Support height
6	Edge end distance (Fa)
7	Distance Crimp edge-end (CFE)
8	Burr height (Gh)
9	Burr width (Gb)
10	Base thickness (b)

Figure 5. Crimp cross section measurable parameters

3. Data analysis and discussion

The dataset presented in Table 1 was collected through a series of test iterations focusing on the resulted crimps of two applicators, App_01 and App_02, with the aim of drawing insights and conclusions about their active parts wear and tear.

In line with our study's design, we concluded the experiment for App_01 after twenty recorded instances, even though the achieved crimps remained within the specified range (Fig. 6, 7). The initial meter reading of App_01 was 9308462, and the final reading reached 10163418, resulting in a cumulative total of 854956 strokes performed for quality crimps.

Nr. Crt.	Strokes number	Capability study wire crimp height CH 0.76 ±0.03 mm	Capability study wire crimp width CW 1.40+0.15 mm	Burr height Gh ≤0.20 mm	Burr width Gb ≤0.10 mm
1	9308462	0.7580	1.4070	0.0000	0.0000
2	9336012	0.7730	1.4210	0.0000	0.0000
3	9362092	0.7630	1.4640	0.0000	0.0000
4	9381825	0.7770	1.4540	0.0000	0.0000
5	9404857	0.7770	1.4510	0.0000	0.0000
6	9441572	0.7730	1.4450	0.0540	0.0000

Nr. Crt.	Strokes number	Capability study wire crimp height CH 0.76 ±0.03 mm	Capability study wire crimp width CW 1.40+0.15 mm	Burr height Gh ≤0.20 mm	Burr width Gb ≤0.10 mm
7	9479197	0.7810	1.4500	0.0000	0.0000
8	9519222	0.7550	1.4280	0.0400	0.0770
9	9544204	0.7670	1.4360	0.0500	0.0500
10	9569809	0.7730	1.4440	0.0000	0.0000
11	9630170	0.7740	1.4420	0.0000	0.0000
12	9690192	0.7560	1.4230	0.0260	0.0880
13	9750445	0.7780	1.4280	0.0000	0.0000
14	9777968	0.7650	1.4250	0.0000	0.0000
15	9822351	0.7730	1.4440	0.0000	0.0000
16	9882407	0.7640	1.4620	0.0000	0.0000
17	9931873	0.7600	1.4320	0.0330	0.0980
18	9956797	0.7790	1.4380	0.0000	0.0000
19	10051447	0.7840	1.4410	0.0800	0.0330
20	10163418	0.7860	1.4390	0.0210	0.0880

Table 1. App_01 Tests iterations and measured values of parameters

Remarkably, the cumulative number of strokes, which reached 854956, greatly exceeded the reference point of 200000 strokes as per the recommended spare parts exchange. This significant surplus in the number of strokes observed suggests a potential for extending the operational lifespan of the equipment.

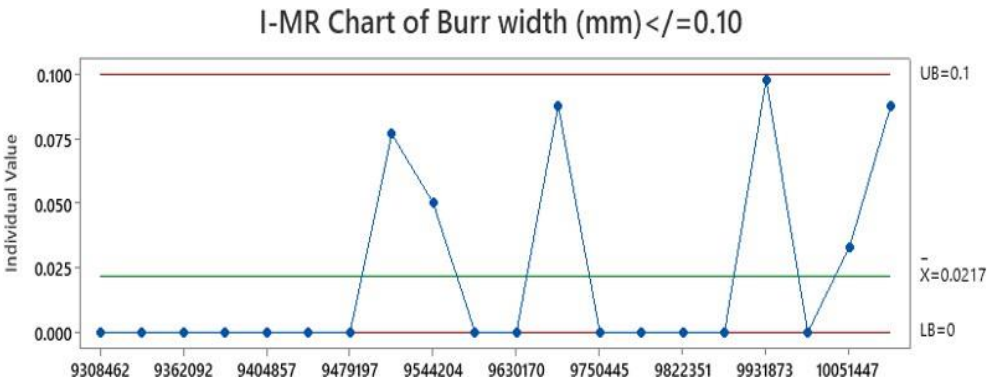


Figure 6. Control chart of the burr width for App_01

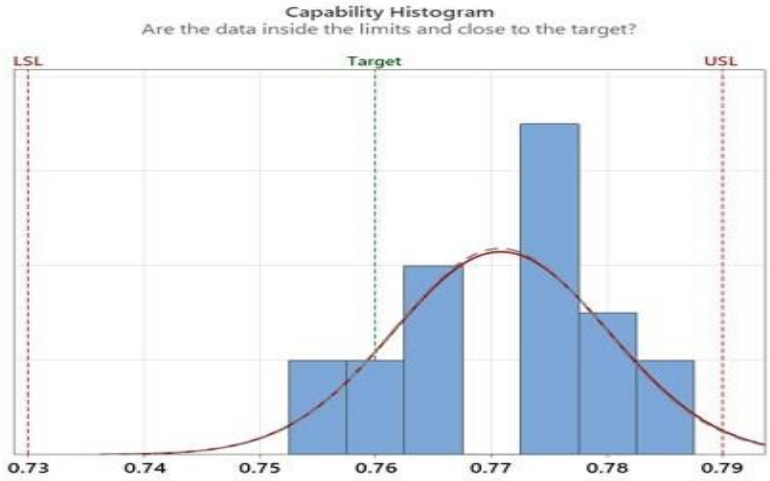


Figure 7. Histogram analysis of crimp height for App_01

Concerning App_02, the experiment was concluded after sixteen iterations (see Table 2) due to an observed defect.

Nr. Crt.	Strokes number	Capability study wire crimp height CH 0.78 ±0.02 mm	Capability study wire crimp width CW 1.07+0.11 mm	Burr height Gh ≤0.20 mm	Burr width Gb ≤0.10 mm
1	2299978	0.7800	1.0990	0.0000	0.0000
2	2312128	0.7970	1.1400	0.0000	0.0000
3	2325693	0.7750	1.1620	0.0000	0.0000
4	2336993	0.7650	1.1350	0.0000	0.0000
5	2358030	0.7730	1.1510	0.0000	0.0000
6	2380845	0.7850	1.1490	0.0000	0.0000

7	2397279	0.7970	1.1630	0.0000	0.0000
8	2406379	0.7880	1.1520	0.0340	0.0520
9	2429907	0.7970	1.1400	0.0000	0.0000
10	2447082	0.7730	1.1510	0.0000	0.0000
11	2471040	0.7650	1.1400	0.0000	0.0000
12	2485118	0.7970	1.1630	0.0000	0.0000
13	2491843	0.7710	1.1380	0.0210	0.0370
14	2505343	0.7840	1.1620	0.0000	0.0000
15	2522143	0.7980	1.1750	0.0000	0.0000
16	2553490	0.7860	1.1480	0.0640	0.1050

Table 2. App_02 Tests iterations and measured values of parameters

The deviation from the anticipated values was identified through the measurement of the burr width (Fig. 8). While the measurements for crimp height and width remained within acceptable ranges (Fig. 9), the observed deviation in burr width suggests a potential concern regarding the wear and tear of the anvil (as depicted in Fig. 10).

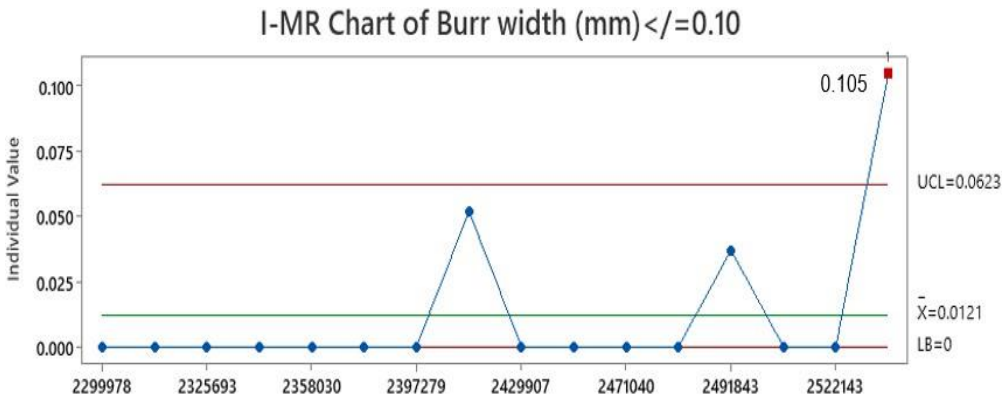


Figure 8. Control chart of the burr width for App_02

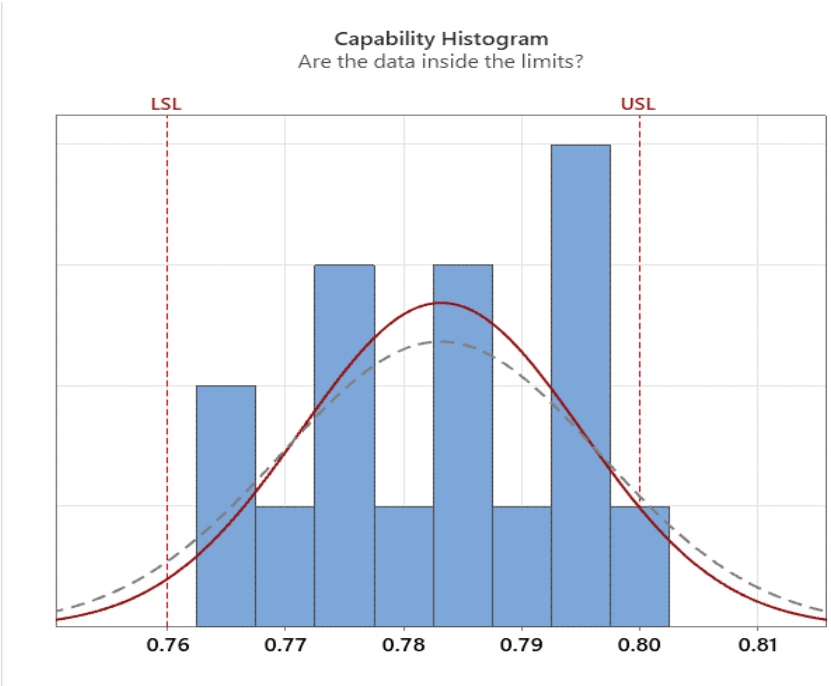


Figure 9. Histogram analysis of crimp height for App_02

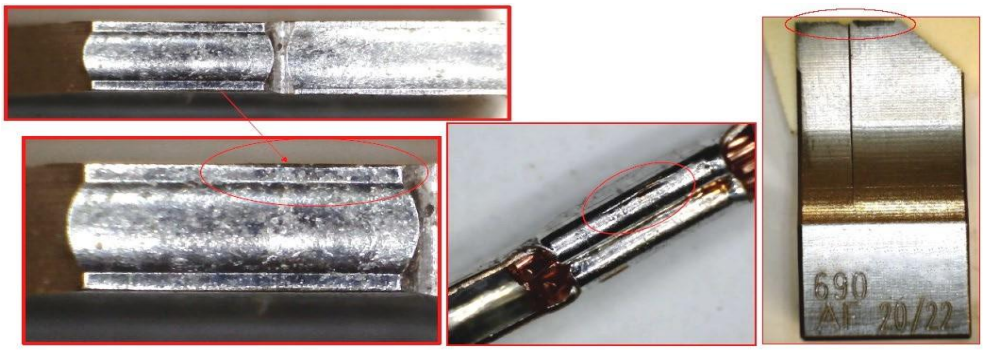


Figure 10. Damage on the anvil and the resulted crimp

The initial meter reading for App_02 stood at 2299978, while the final reading marked 2553490, reflecting a total of 253512 strokes. This cumulative stroke count, totaling 253512, surpassed the recommended spare parts exchange threshold of 200000 strokes, but not to the same extent as in case of App_01.

In light of our hypothesis that substantial variations in spare parts wear may exist among different crimping tools, the surplus of strokes, exceeding the recommended maintenance threshold, underscores the potential validity of our hypothesis. This outcome suggests that there may indeed be significant differences in wear patterns among these tools, necessitating a reevaluation of the existing internal maintenance instructions, while also stressing the need for further study in an attempt to be able to predict the lifespan of the spare parts.

4. Conclusions

Analyzing spare part longevity indicates potential for cost reduction in automotive production. While our initial findings are encouraging, it is evident that further testing is imperative to ascertain the complete lifecycle of these spare components.

Regular maintenance schedules and monitoring of spare part lifetimes can further enhance cost reduction efforts. A proactive approach in this regard is essential for enhancing production efficiency and cost-effectiveness.

Moreover, introducing a predictive model capable of simulating tests and extrapolating insights from empirical results represents a progressive avenue. Such a model could furnish valuable predictive tools, further refining cost-reduction strategies and potentially revolutionizing the management of spare parts in the automotive production process.

This study's significance lies in its immediate applicability within the automotive industry, where the delicate balance between cost reduction, quality maintenance, and operational efficiency is paramount. The potential implementation of these findings

could significantly impact production processes, leading to tangible reductions in costs and notable improvements in efficiency. However, the need for continued research is evident, beckoning further analyses and the development of predictive tools to refine maintenance strategies and deepen our understanding of spare parts management. Ultimately, this study not only identifies critical avenues for cost reduction but also lays the groundwork for the proactive, predictive methodologies that will shape the future of automotive production, establishing itself as a cornerstone in the ongoing evolution of the field.

References

1 Rachwan R., Abotaleb I., Elgazouli M., The Influence of Value Engineering and Sustainability Considerations on the Project Value, *Procedia Environmental Sciences*, 34, 2016, pp. 431-438, https://doi.org/10.1016/j.proenv.2016.04.038

2 Behncke F., Maisenbacher S., Maurer M., Extended Model for Integrated Value Engineering. *Procedia Computer Science*, 28, 2014, pp. 781-788, https://doi.org/10.1016/j.procs.2014.03.093

3 Mocellin K., Petitprez M., Experimental and Numerical Analysis of Electrical Contact Crimping to Predict Mechanical Strength, *Procedia Engineering*, 81, 2014, https://doi.org/10.1016/j.proeng.2014.10.274

4 Morgado L., Teixeira A., Sá, J. Pinto Ferreira L., Almeida F.D., Analysis and Development of a Failure Prediction Model for Electrical Terminals Used in the Automotive Industry, *Procedia Manufacturing*, 51, 2020, pp. 207-214, https://doi.org/10.1016/j.promfg.2020.10.030

5 Jongwuttanaruk K., Thavornwat C., Optimization of Mechanical Crimping in the Terminal Crimping Process Using a Response Surface Methodology, *Advances in Materials Science and Engineering*, Article ID 6508289, 2022, https://doi.org/10.1155/2022/6508289

6 Dragomir F., Manescu T., Gillich G.-R, Korka Z. Tufisi C., Influence of vibration and environmental factors on a crimped assembly resistivity, *Vibroengineering Procedia*, 51, 2023, pp. 173-178, https://doi.org/10.21595/vp.2023.23681

7 Castro T.A.M., Campilho R., Optimising a Specific Tool for Electrical Terminals Crimping Process, *Procedia Manufacturing*, 11, 2017, pp. 1438-1447, https://doi.org/10.1016/j.promfg.2017.07.274

8 SAE International, *Performance Specification for Cable-to-Terminal Electrical Crimps. SAE/USCAR-21*, 4th SAE International, U.S. and Canada, 2020. https://global.ihs.com/doc_detail.cfm?document_name=SAE%20USCAR%2D21&item_s_key=00407431.

IMPLEMENTATİON OF ARTİFİCİAL INTELLİGENCE İN DATABASE SYSTEMS

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ABSTRACT

The rapid development of digital technologies has significantly transformed the role of databases in contemporary information systems. With the exponential growth of data volumes, the integration of Artificial Intelligence (AI) into database management and analytics has become a key factor for achieving efficiency, accuracy, and automation in decision-making processes. This paper discusses the conceptual and practical aspects of implementing AI within modern database environments, focusing on intelligent data processing, automated optimization, and predictive analytics.

Traditional database systems are evolving toward intelligent data platforms capable of learning from historical records, adapting to patterns, and providing real-time insights. AI-driven algorithms—such as machine learning, natural language processing, and deep learning—are increasingly used to enhance query optimization, anomaly detection, data classification, fraud detection, and user behavior analysis. These capabilities significantly reduce manual workload and improve system performance. Furthermore, AI enables automated index tuning, dynamic workload management, and smart caching, which increases the reliability and scalability of database systems.

The paper also explores challenges associated with AI integration, including data quality, model transparency, ethical considerations, and computational complexity. Despite these challenges, AI-enhanced databases offer substantial opportunities for organizations seeking to transition to advanced digital infrastructures. By combining structured and unstructured data with AI, enterprises can harness deeper analytical insights, support evidence-based decision-making, and create adaptive, self-managing data ecosystems.

Overall, the implementation of artificial intelligence in database systems represents a revolutionary step toward autonomous and intelligent data management. It transforms databases from passive data containers into active engines capable of learning, predicting, and optimizing, thereby shaping the future of data-driven innovation.

Keywords: Database Systems ,Artificial Intelligence (AI),Machine Learning,Predictive Analytics,Data Integration,Data-driven Decision Making.

A COMPREHENSİVE REVİEW OF KEY FACTORS INFLUENCiNG EMPLOYEE RETENTiON

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Abstract

This review paper explores the key factors influencing employee retention in contemporary organizations, emphasizing the growing importance of strategic human resource practices in maintaining a stable and committed workforce. Drawing from recent academic literature, industry reports, and empirical studies, the review synthesizes insights on the major determinants of retention, including compensation, work–life balance, organizational culture, leadership style, career development opportunities, job satisfaction, and employee engagement. The analysis reveals that retention is a multidimensional challenge shaped by both intrinsic and extrinsic motivators, where supportive leadership, meaningful work, and opportunities for growth play equally significant roles alongside competitive pay and benefits. The review also highlights the increasing relevance of psychological well-being, flexible work arrangements, and recognition practices, especially in the post-pandemic work environment. Findings indicate that organizations adopting holistic retention strategies—integrating culture-building, transparent communication, and continuous learning—are better positioned to minimize turnover and enhance long-term performance. Additionally, the paper identifies gaps in current research, particularly regarding the role of HR analytics, generational differences, and digital workplace expectations in shaping retention outcomes. Overall, this review underscores the need for organizations to adopt data-driven, employee-centered approaches to effectively retain talent in an evolving labor landscape.

Keywords: employee retention, human resource management, job satisfaction, organizational culture, leadership, employee engagement, turnover reduction

RACING AGAINST THE MACHINE: BRIDGING STUDENTS' SKILLS GAP IN THE DIGITAL ERA

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ABSTRACT

Technological advancements are evolving faster than students' ability to acquire the skills required to keep pace with innovation in their fields of expertise. While every sector is undergoing digital transformation, education is experiencing one of the most profound impacts, particularly in the processes of teaching and learning. This study explores the extent to which students in higher education and secondary schools are prepared to adapt to ongoing technological changes that increasingly shape their academic routines. The research investigates students' digital competencies, their use of technology for academic purposes, and their perceptions of the challenges that accompany the digital shift.

A structured survey was conducted among university students and final-year high school pupils, in Tirana, to assess their preparedness for a technology-driven learning environment. On the other hand, the study highlights the barriers to digital learning, particularly the risk of deepening educational inequalities among students with varying levels of technological access and digital skills. By analysing students' suggestions for the effective integration of digital learning within educational environments, the research aims to identify key strategies for fostering inclusive, equitable, and future-oriented education systems.

Keywords: digital literacy, learner, Education 4.0, future skills, technological adaptation

INTRODUCTION

The twenty-first century has witnessed a rapid acceleration of technological change, transforming every aspect of human activity, including the way knowledge is produced, distributed, and acquired. The use of information and communication technologies in education can play a crucial role in providing new and innovative forms of support to teachers, students, and the learning process more broadly (World Bank Group, 2022). Education systems, traditionally structured around static learning models, are now challenged to adapt to digital transformation at an unprecedented pace. Technologies such as artificial intelligence, virtual learning environments, and digital collaboration platforms have redefined the boundaries of teaching and learning, creating both opportunities and challenges for students and educators alike. While technological innovation promises to enhance access, flexibility, and interactivity in education, it also requires a new set of digital skills and competencies that not all students possess to the same extent. The challenges and obstacles encountered by students across various educational institutions often bring into question the very attainment of the Sustainable Development Goals. As recognised in the Incheon Declaration, the achievement of SDG 4 is dependent on opportunities and

challenges posed by technology. Technology appears in six out of the ten targets in the fourth Sustainable Development goal on education. These references recognize that technology affects education through five distinct channels, as input, means of delivery, skill, tool for planning, and providing a social and cultural context. There are often bitter divisions in how the role of technology is viewed, however. These divisions are widening as the technology is evolving at breakneck speed. The 2023 GEM Report on technology and education explores these debates, examining education challenges to which appropriate use of technology can offer solutions (access, equity and inclusion; quality; technology advancement; system management), while recognizing that many solutions proposed may also be detrimental (UNESCO, 2023). This paper explores the eagerness of students to face these rapid technological shifts by analysing their digital literacy, usage of technology, perceptions regarding the benefits and barriers of digital learning, and in the end initiating certain strategies for bridging the skills gap. The research focuses on both university students, studying in the field of geography, and final-year high school pupils, at "Isa Boletini" High School, Vora - Tirana, aiming to identify the gap between the pace of technological change and students' ability to adapt effectively. Moreover, the study examines the main factors that influence students' digital preparedness and how unequal access to technological tools may reinforce educational disparities. Findings imply that technology access reduces academic disparity raised by socioeconomic differences. Therefore, policymakers could ensure technology access with sufficient training to address educational inequality-related challenges (Forhad. A.R, 2022). By investigating these interrelations, the research seeks to contribute to the broader academic debate on how education systems can bridge the digital divide and ensure that students are equipped not only with knowledge, but with the adaptive capacities required in a technology-driven world and the labour market nowadays.

LITERATURE REVIEW

Technology has transformed economies throughout history, fundamentally altering production possibilities and processes, consumption patterns, as well as the rewards for the different kinds of skills that workers bring to the labour market. Modern technologies such as machine learning and robotics are set to continue this trend, perhaps at an unprecedented speed and scale (Graetz. G *et al*, 2022). The relationship between technological innovation and education has been a central topic in contemporary academic discourse, particularly as digital transformation continues to reshape learning environments. Digital competencies represent students' ability to use technology and digital media interactively to enhance their learning experiences. Given their growing importance, there is a need to develop instruments that can be used in different contexts to measure them (Mejías-Acosta. A *et al*, 2024). Digital competence constructs not only technical proficiency but also cognitive, social, and ethical dimensions of technology use. This implies that students' readiness for technological change extends beyond mere familiarity with digital tools, it also includes the ability to critically evaluate information, collaborate in virtual contexts, and adapt to continuous innovation. Referred to UNESCO (2023) the Covid-19 global pandemic significantly increased the digital transmission of knowledge, making digital competencies crucial for participation in society, including lifelong learning and employment opportunities. On the other hand, the rise of Education 4.0, closely aligned with the Fourth Industrial Revolution, has further emphasized the integration of technology into teaching and learning. With Industry 4.0 and Work 4.0 entering the world, modern education is undergoing transformations in terms

of educational practices, skillsets and competencies, teaching and learning methodologies (including flipped classroom, blended learning, self-regulated learning, project-based learning, inquiry-based learning, student-centred pedagogy), digital tools used at all educational levels, as well as barriers and challenges. This string of changes is covered by the new buzzword "Education 4.0" (Tikhonova E *et al,* 2023). According to Puncreobutr (2016), Education 4.0 requires a paradigm shift from traditional content-based instruction to competency-based learning, where digital literacy, creativity, and problem-solving become core educational outcomes. However, numerous studies (e.g., Helsper & Eynon, 2010; van Laar et al., 2017) have shown that a considerable digital divide persists among students, both in access to technology and in the quality of digital skills acquired. Such disparities often reflect broader social inequalities and institutional differences in educational infrastructure. Research also points to the pedagogical challenges that accompany digital transformation. Some other authors argues that technology alone cannot guarantee effective learning unless supported by innovative teaching strategies and equitable access policies. Aesaert *et al.* (2015) emphasize the role of teachers and educational institutions in fostering digital competence through continuous professional development and curriculum redesign. Digital technologies can be used to support the inclusion of diverse student groups in education in a number of ways including enhancing accessibility of educational content, increasing personalisation and providing distance learning opportunities, as was the case during the Covid-19 pandemic. However, persistent digital inequalities can undermine digital equity and inclusion and equity and inclusion in education generally, particularly for the most disadvantaged students. This paper explores the themes of digital equity and inclusion, and maps some of the policies and practices adopted in OECD countries for the equitable and inclusive use of digital tools in education (Gottschalk. F *et al,* 2023). Overall, the literature suggests that while technological change creates vast opportunities for learning innovation, it simultaneously exposes vulnerabilities within educational systems. Students' digital readiness is thus contingent on an ecosystem of factors, including institutional support, socio-economic background, and pedagogical innovation, that determine how effectively technology enhances, rather than exacerbates, learning inequalities.

METHODOLOGY

The study is entirely based on a fieldwork approach, conducted through a questionnaire comprising both closed and open-ended questions, and on the other hand, combined with in-depth interviews. The survey is designed to capture demographic variables, access to digital devices, frequency and purpose of technology use in learning, and students' self-assessment of their digital skills. Additionally, it includes open-ended questions to collect qualitative insights on the perceived challenges and recommendations for improving digital learning environments. The selection of respondents was based on random sampling, but based on students within the age group of 17–24 years. The surveys were conducted during October 2025, with a total of 172 respondents. The questionnaire had an approximate duration of 7 minutes and was administered partly online (via Google Forms) and partly through face-to-face interviews. The questionnaire consisted of 9 questions, of which 7 were closed-ended (including general profile questions of respondents, questions with the option "yes" or "no", and multiple - choice questions), and 2 were open-ended questions allowing respondents to express their opinions on the subject matter. The questionnaire represented a combination of qualitative and quantitative data collection, aimed at gathering, analysing, processing, and comparing the information obtained. The

focus was on the theoretical perspectives by empirically examining how students perceive and respond to the technological challenges of contemporary education.

RESULTS

The assessment and measurement of students' acquired skills can be observed through various projects in which they engage during the academic year, however, it remains challenging to grasp the true extent of the new competencies required for the labour market. The findings are derived from fieldwork and in-depth interviews conducted with pupils and university students. The surveyed participants represent a diversity of ages, genders, educational levels, and access to different technological resources. The respondents represent a heterogeneous sample of students. Around 70% of the respondents are female, and 30% are male. The significant predominance of females besides the higher willingness of this category to engage in completing the questionnaire. The age range is between 17 to 24 years old. The survey included final-year pupils from "Isa Boletini" High School (29%) and university students from the Department of Geography (71%). Based on general survey questions administered to pupils and students, the findings indicate that only 60% of respondents have consistent access to the internet and are able to use it throughout the day, whereas 40% experience limited connectivity due to irregular or infrequent access. This finding highlights a significant digital divide among pupils and students, suggesting unequal opportunities for accessing online learning resources. The limited internet access among 40% of respondents may hinder their academic engagement and digital skill development, posing challenges to educational equity and inclusion.

A. What is the reality between knowledge and the use of technology?

A.1. Assessing students' digital competence: Are students ready?

The data presented below highlights the distribution of devices through which respondents most frequently access the Internet. A significant majority of 72% of participants reported using smartphones as their primary device, indicating a strong preference for mobile connectivity. Laptops are the second most common device, utilized by 20% of respondents, while desktop computers and tablets are considerably less popular, with only 5% and 3% usage, respectively.

Table 1 - Through which device do you most frequently access the Internet?

Device	**Percentage**
Desktop computer	5
Laptop	20
Tablet	3
Smartphone	72

Source: Questionnaire results

These findings have important implications for digital content delivery and educational strategies. Given the dominance of smartphones, platforms and services targeting this population should prioritize mobile-friendly interfaces and responsive design. Conversely, the minimal use of desktops and tablets indicates that traditional computer-based approaches may not reach the majority of users effectively. Understanding these preferences allows educators, developers, and policymakers to tailor digital

experiences to the most commonly used devices, ensuring accessibility and engagement across different user groups. Students' self-assessment of their digital skills highlight their confidence in various online learning activities. The highest reported skill is navigating the internet for learning purposes, with 70% of respondents indicating competence in this area. A slightly lower proportion of students feel capable of using digital tools for learning (60%) or learning independently at their own pace in a digital environment (58%). Collaboration in a digital environment is assessed as the least confident skill, with 57.5% of students reporting proficiency.

Table 2 - Students' self-assessment of digital skills

Students' self-assessment of digital skills	**Percentage**
Navigate on the internet for learning purposes	70
Use digital tools for learning	60
Collaborate in a digital environment	57.5
Learn in a self-paced mode in a digital environment	58

Source: Questionnaire results

These results demonstrate that while students are generally comfortable with accessing information online, there is slightly less confidence in applying digital tools and collaborating virtually. The data points to the need for targeted training and support in collaborative digital practices, as well as structured guidance for self-paced learning. Understanding students' perceived strengths and weaknesses in digital skills can help educators design more effective instructional strategies and foster the development of competencies necessary for successful participation in a digitally mediated learning environment.

A.2. Patterns of technology use in academic contexts

The frequency with which students employ digital technologies, for various learning activities, reported that the highest activity is searching the internet to find new information, with 75% of students indicating regular use. Consulting digital resources follows at 65%, suggesting that students frequently rely on online materials to support their learning. Activities that involve more active engagement, such as using creation tools for educational purposes or collaborating in virtual learning environments, are slightly less common, with 55% of students reporting participation in each of these activities.

Table 3 – Digital technology use for learning activities

Usage for learning activities	**Percentage**
Searching on the internet to find new information	75
Consulting digital resources	65
Using creation tools for education	55
Using virtual learning environments collaboration	55

Source: Questionnaire results

Referred to this data, students predominantly use digital technology as a tool for information retrieval rather than for creative or collaborative purposes. While the majority are comfortable accessing digital resources, fewer students engage in productive or interactive digital activities, highlighting an area for

pedagogical improvement. Educators could consider strategies to encourage the integration of creative tools and virtual collaboration into regular learning practices, thereby enhancing students' digital competence and their ability to participate effectively in collaborative and technology-enhanced educational environments.

Table 4 reflects pupils' and students' perceptions of digital learning and its role in educational processes. A majority of respondents (65%) consider that the integration of digital tools facilitates the learning process, suggesting a general acknowledgment of the efficiency and accessibility that technology provides in academic contexts. Similarly, 62.5% of participants report that digital learning encourages productivity, indicating that technology is perceived not only as a supportive instrument but also as a motivator for completing learning tasks. Engagement in learning is recognized by 57.5% of students, reflecting a somewhat lower, though still significant, positive perception regarding the motivational and interactive potential of digital platforms.

Table 4 . How do pupils and students perceive the use of digital learning?

Perception of the use of digital learning	**Percentage**
Facilitate the learning process	65
Engage in learning	57.5
Urge productiveness	62.5

Source: Questionnaire results

These findings highlight that while students generally value digital tools for enhancing efficiency and output, there remains a slight gap in perceiving technology as fully engaging. This nuance points to the importance of pedagogical strategies that not only integrate digital resources but also actively foster interactive and participatory learning experiences. By aligning digital tool usage with student-centered instructional design, educators can better harness the potential of technology to simultaneously support learning, stimulate engagement, and promote productive academic practices.

A.3. Barriers in the transition to digital learning

In the context of frequency, the most reported challenge is the lack of adequate digital learning materials, indicated by 63.5% of respondents. Insufficient internet access is also a significant obstacle, affecting 54.2% of students, while nearly half (49.4%) identify limitations in physical infrastructure as a constraint. Additionally, 44.1% of students perceive their own digital skills as a barrier, whereas 31% consider the digital competence of teaching staff to be insufficient.

Table 5- Students' perceptions of digital learning challenges

Barriers to digital learning	**Percentage**
Lack of digital learning materials	63.5
Insufficient internet access	54.2
Insufficient physical infrastructure	49.4
Digital skills of students	44.1
Digital skills of teaching staff	31

Source: Questionnaire results

While technical infrastructure and access remain critical issues, the data also reveals the importance of addressing human and institutional factors, including digital literacy among both students and educators. Addressing these barriers requires a comprehensive approach that combines investment in resources, improvements in connectivity, and targeted training to enhance digital competencies, ensuring a more equitable and effective transition to technology-enhanced education.

A. 4. Overcoming digital inequalities: Students' overview

Students' recommendations for promoting digital inclusion and enhancing the integration of technology within higher education curricula are presented to the data below. The most frequently suggested measure is the improvement or completion of physical infrastructure, identified by 39% of respondents, highlighting the continued importance of adequate facilities in supporting digital learning. Increasing internet access is considered a priority by 21.3% of students, reflecting ongoing connectivity challenges. Other recommendations include the increased use of digital tools during lectures (14.2%) and the provision of digital learning materials (13.2%), which emphasize the need for both pedagogical and resource-based interventions. Training for students and teaching staff is suggested by 12.1% of respondents, pointing to the recognition of human capacity as a key factor in effective digital integration. Less frequently mentioned measures include raising awareness regarding digital learning (5%) and implementing a well-planned blend of digital and traditional learning approaches (4%).

Table 6 - Students' recommendations for effective digital integration in education

Suggestions to overcome digital inequalities	**Percentage**
Improvement/completion of physical infrastructure	39
Increase in internet access	21.3
Increased use of digital tools during lectures	14.2
Provision of digital learning materials	13.2
Training of students and pedagogical staff	12.1
Raise of awareness regarding digital learning	5
Well-planned blend of digital and traditional learning	4

Source: Questionnaire results

Based on data, it can be underlining that student perceive digital inclusion as a multidimensional challenge, requiring simultaneous attention to infrastructure, connectivity, pedagogy, and capacity-building. Addressing these recommendations could facilitate a more equitable and effective learning environment, ensuring that all students benefit from technology-enhanced education. Moreover, the emphasis on blended learning approaches, although less frequently cited, points to a growing awareness of the importance of integrating digital tools with traditional methods to optimize learning outcomes and engagement.

B. Strategies for bridging the skills gap

Bridging the skills gap in the digital era requires a multifaceted approach in which educational institutions play a pivotal role as centers for cultivating new competencies and equipping students with the knowledge and tools needed to navigate rapidly evolving technological environments. Integrating digital practical courses and interactive learning platforms further enhances students' hands-on skills, fostering problem-solving, creativity, and collaboration in technology-rich contexts. Based on in-depth interviews, with students, it can be distinguished that strengthening of university - industry partnerships facilitate the alignment of academic curricula with labour market demands and provides students with opportunities for practical experience and exposure to real-world challenges. Educational institutions should encourage collaborative projects, internships, and mentorship programs that connect students directly with industry practitioners, promoting experiential learning and the practical application of digital skills. The integration of emerging technologies, such as virtual laboratories, simulation software, and online collaborative platforms, can further enhance learning outcomes by providing realistic scenarios in which students can experiment and innovate safely. Moreover, embedding a mindset of continuous improvement and adaptability within the curriculum ensures that students not only acquire current technical skills but also develop critical thinking, problem-solving, and digital adaptability - competencies that remain relevant despite the rapid evolution of technology.

Equally important is the promotion of digital literacy and the broader culture of lifelong learning, enabling graduates to continuously update their skills and adapt to emerging technologies throughout their professional careers. Additionally, adopting best international practices allows universities to benchmark their educational strategies against global standards, ensuring the incorporation of innovative pedagogical approaches, effective use of digital tools, and a student-centered learning environment. Promoting digital literacy and lifelong learning is essential to prepare graduates for continuous professional development in an ever-evolving technological landscape. Furthermore, adopting best international practices provides valuable models for innovation, collaboration, and the creation of a more future-oriented educational system. These strategies create a robust framework for addressing the digital skills gap, preparing students not only for current professional demands but also for future technological transformations, while simultaneously strengthening the synergy between academia, industry, and society.

DISCUSSION

Analysis of the data indicates that smartphones are the predominant device through which students access the internet, with 72% of respondents relying primarily on mobile devices. This preference for mobile devices reflects the need for digital learning strategies to prioritize accessibility, portability, and responsive design in educational platforms. Students' self-assessments reveal that a majority feel confident navigating the internet for learning purposes and using digital tools for educational activities. However, slightly fewer students report proficiency in collaborative digital tasks and self-paced learning in online environments, suggesting that while basic digital literacy is relatively strong, higher-order competencies related to collaboration and autonomous digital learning require further development. These patterns are corroborated by students' reported usage of digital technologies for learning activities, where information retrieval through internet searches and consultation of digital resources dominate, whereas active engagement through creation tools and virtual collaboration is less frequent.

Students' perceptions of the benefits of digital are generally positive. The majority believe that digital tools facilitate the learning process and encourage productivity, while a slightly lower proportion associate digital learning with increased engagement. This highlights a nuanced view in which students recognize efficiency gains and the potential to support learning outcomes but may not fully perceive the motivational or interactive potential of technology. Despite these positive perceptions, several barriers impede effective digital learning. The lack of digital learning materials, insufficient internet access, and inadequate physical infrastructure were identified as key obstacles, alongside limitations in students' own digital skills and those of teaching staff. These findings underscore that digital learning challenges are multifaceted, encompassing not only technological and infrastructural issues but also human and institutional factors. Addressing these barriers requires coordinated interventions involving resource provision, training programs, and capacity-building initiatives for both students and educators. Students' recommendations for improving digital inclusion emphasize the importance of infrastructure development and increased internet access, while other suggestions, such as the provision of digital learning materials, the increased use of digital tools during lectures, and training for students and pedagogical staff, highlight the need for comprehensive support that combines material, technological, and human capacity aspects. Less frequently cited measures, such as raising awareness regarding digital learning and implementing a well-planned blend of digital and traditional learning, indicate emerging recognition of the potential benefits of blended pedagogical approaches. To generalize, the data underline a clear link between students' digital skills, their usage patterns, perceptions of digital learning, and the barriers they face. While students demonstrate competence in basic digital tasks and recognize the advantages of technology-enhanced education, the effective integration of digital tools is constrained by infrastructural limitations, connectivity issues, and gaps in both student and teacher digital literacy. Addressing these challenges requires a holistic approach that combines investment in physical and digital infrastructure, targeted training programs, incorporation of interactive and collaborative learning platforms, and the adoption of best international practices. Such strategies are essential for bridging the digital skills gap, promoting equitable access to technology-enhanced learning, and fostering a culture of lifelong learning that equips students to meet current and future demands in a rapidly evolving digital environment.

CONCLUSION

The findings of this study highlight the critical role of digital skills and technology integration in contemporary higher education. Students demonstrate a relatively high level of competency in basic digital tasks, particularly in navigating the internet for learning purposes and consulting digital resources. At the same time, their engagement with more advanced or collaborative digital tools remains moderate, and a range of infrastructural, connectivity, and institutional barriers continues to limit the full potential of technology-enhanced learning. These results emphasize the need for a comprehensive approach to digital education, one that simultaneously addresses access, skills development, and pedagogical strategies. Addressing the digital skills gap and promoting inclusive digital learning requires coordinated efforts from universities, policymakers, and industry partners. Strategies should include enhancing physical and technological infrastructure, increasing internet accessibility, providing digital learning materials, and implementing training programs for both students and teaching staff. Additionally, fostering a culture of lifelong learning and adopting international best practices can ensure

that students not only acquire essential digital competencies but are also prepared to adapt to ongoing technological changes. Ultimately, the integration of these measures can contribute to more equitable, effective, and engaging learning experiences, equipping graduates with the skills necessary to thrive in a dynamic digital economy.

LITERATURE

Aesaert. K, Braak. J, Nijlen. D, Vanderlinde. R. (2015). *Primary school pupils' ICT competences: Extensive model and scale development*, Computers & Education, Volume 81, https://doi.org/10.1016/j.compedu.2014.10.021

Forhad. A. R. (2022). *Access to Technology and Educational Disparity*. Conference: Tenth Pan-Commonwealth Forum on Open Learning. DOI: 10.56059/pcf10.6153

Gottschalk. F & Weise. C. (2023). *Digital equity and inclusion in education: An overview of practice and policy in OECD countries*. OECD Education Working Papers No. 299.

Graetz. G, Restrepo. P, Skans. O.N. (2022). Technology and the labor market. Labour Economics, Volume 76. https://doi.org/10.1016/j.labeco.2022.102177

Helsper. E. J & Rebecca Eynon. R. (2010). *Digital Natives: Where Is the Evidence?*. British Educational Research Journal 36(3). DOI: 10.1080/01411920902989227

Laar. E, Deursen. A, Dijk. J, Haan. J. (2017). *The relation between 21st-century skills and digital skills: A systematic literature review*. Computers in Human Behavior. Volume 72. ISSN 0747-5632. https://doi.org/10.1016/j.chb.2017.03.010

Mejías-Acosta. A, D'Armas Regnault. M, Vargas-Cano. E, Cárdenas-Cobo. J & Vidal-Silva. C. (2024) *Assessment of digitalcompetencies in higher education students: development and validation of ameasurement scale*. Front. Educ. 9:1497376

Puncreobutr, V. (2016). *Education 4.0: New Challenge of Learning.* St. Theresa Journal of Humanities and Social Sciences, 2, No. 2.

Tikhonova E., & Raitskaya L.(2023). *Education 4.0: The Concept, Skills, and Research*. Journal of Languageand Education, 9(1), 5-11. https://doi.org/10.17323/jle.2023.17001

UNESCO. (2023). *Digital Competencies and Skills*. https://www.unesco.org/en/digital-competencies-skills?hub=752

UNESCO. (2023). *Technology in Education: A tool on whose terms?*. Global Education Monitoring Report. https://www.unesco.org/gem-report/en/publication/technology

World Bank Group. (2022). *Education Technology or "EDTECH"*. Education Newsletter. https://www.worldbank.org/en/topic/edutech

ANTIMICROBIAL ACTIVITY EVALUATION OF Zn(II) AND Cu(II) COMPLEXES WITH SCHIFF BASE; N-SALICYLIDENE-1-NAPHTHYLAMINE

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ABSTRACT

The Schiff base derived from condensation of Salicylaldehyde and 1-naphthylamine and its Zn(II) and Cu(II) complexes were synthesized and characterized using physical and analytical processes such as; infrared spectral analyses,, magnetic susceptibility, elemental analyses and Uv-visible spectral analyses, Solubility test, melting point/decomposition and conductivity measurement,. The Schiff base and its metal complexes were screened for antimicrobial activity. The sharp melting point 102 ^{o}C indicated the purity of the Schiff base. The decomposition temperature range 212 – 218 ^{o}C indicated good stability of the complexes. The molar conductance values range 9.69 – 13.0 $\Omega^{-1}cm^{2}mol^{-1}$ indicated the complexes as non-electrolytes. The –Ve BM magnetic moment value indicated Zn(II) complex as diamagnetic; while 1.82 BM magnetic moment value indicated Cu(II) complex as paramagnetic. The infrared spectral analyses results suggested that the Schiff base behave as a bidentate ligand coordinates to the metal ion via azomethine nitrogen and phenolic oxygen. The elemental analyses results revealed slight differences between observed and calculated percentages of Carbon, Hydrogen, and Nitrogen in all the synthesized compounds showing a good agreement with their proposed structures. The antimicrobial activity of the Schiff base and its corresponding metal complexes were carried out using agar well diffusion method against two pathogenic bacterial strains; *Salmonella typhi and Streptococcus pneumoniae* and two fungal isolates; *Aspergillus fumigatus and Rhizopus stolonifer*. The results revealed that the Schiff base and its corresponding metal complexes exhibited moderate antimicrobial activity when compared with the standard drugs (Gentamycin and Nystatin), the activity increases by increasing concentration, also the metal complexes showed higher activity than free ligand due to chelation.

Keywords: Schiff base, Complexes, Salicylaldehyde, 1-naphthylamine, Antibacterial activity.

BANK LOANS, LENDING CONDITIONS AND THE DEVELOPMENT OF SMALL AND MEDIUM-SIZED ENTERPRISES IN ALBANIA: DETERMINING FACTORS, OBSTACLES AND MACROECONOMIC IMPLICATIONS DURING THE PERIOD. 2018–2024.

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ABSTRACT.

Small and medium-sized enterprises (SMEs) represent the core of economic development, job creation, and the establishment of a healthy competitive market in emerging economies. Albanian small and medium enterprises constitute more than 95% of the total number of registered companies and are the backbone of the private sector. Our national small and medium enterprises still face difficulties in accessing external finance, especially bank credit, which has been a major challenge for them. The paper, as a result of collaboration between the researchers, is meant to: inspect the factors that affect the availability of loans to small and medium enterprises in Albania by analyzing the indicators: Impact of Interest Rates, Loan Quality (NPL Ratio), and Economic Sentiment Indicator (ESI) on credit flows over a 7-year period from 2018 to the end of 2024. The authors of the given paper have taken the secondary data as their base for research, which has been procured from the databases of different official institutions at both national and international levels, among which are: Bank of Albania, INSTAT, and Eurostat. The writers of the article have carried out the implementation of the linear regression techniques by the econometric software for their analysis. The seven-year period empirical model indicates that: interest rates are the main factor which influences lending to SMEs, loan quality affects the decision of lending to be of a long-term nature, and macroeconomic sentiment has a significant impact on credit changes. The policy recommendations are aimed at the enhancement of credit guarantee schemes, digital lending platforms, and non-bank financing channels.

Keywords: Small and medium-sized enterprises (SMEs), Credit Constraints, Bank Lending in Albania, Interest Rates, SME policy; Microfinance; Fintech.

1. INTRODUCTION.

Small and medium enterprises represent the heart of the Albanian economy since they make up more than 95% of the active companies and contribute to more than two-thirds of the private-sector workforce (INSTAT, 2024). While they have a significant role, SMEs have been running short of money since banks are still their main source of financing, and only a few have been the developments in alternative financing options (EIB, 2016). Small and medium enterprises (SMEs) typically face higher interest rates and shorter loan maturities due to less complete financial records, limited collateral, and a perception of higher risk. Some recent research papers have revealed that microfinance institutions and FinTech platforms might be a potential source of funding that could replace bank financing, thus enabling SMEs to have access to a more liberal credit line (Pjetri, 2025). It is essential to know factors that influence

bank loans to SMEs such as interest rates, quality of the portfolio, and macroeconomic sentiment before engaging in the policy-making process that is directed at energizing SMEs growth and supporting economic development.

2. LITERATURE REVIEW.

2.1 Importance of Small and medium-sized enterprises in Economic Development in Albania.

Small and medium enterprises are main contributors for a more diverse economy, new business activities, and creative ideas (Ayyagari, 2007). SMEs in Albania, according to the latest data, are the major contributors to the GDP and employment, thus they are considered the main driving force of the private sector (INSTAT, 2024). On the other hand, because of their limited size and lack of easy access to formal credit, they are exposed to financial shocks more than other sectors (Shahini, 2016).

2.2 Small and medium-sized enterprises financing challenges.

One of the factors that continue to limit the growth of small and medium enterprises is access to finance. Credit rationing is a result of information asymmetries that exist between lenders and borrowers (Stiglitz, 1981). Small and medium-sized enterprises frequently do not have audited financial statements and assets that can be used as collateral, which leads to higher costs for screening and risk premiums. In Albania, besides these factors, an underdeveloped financial infrastructure and weak legal enforcement further deepen these constraints (Beck, 2006).

2.3 The bank lending process, the non-performing loan lending process, and lending conditions in small and medium-sized enterprises.

The quality of banks' loan portfolios, as reflected in non-performing loan (NPL) ratios, has a significant impact on lending behavior. A rise in NPLs leads to a decrease in banks' lending activities, particularly long-term credit (Berger, 2004). Researcher Tushaj also identifies the problem in his article from the same point of view (Tushaj, 2021). Elevated interest rates make borrowing more expensive and thus the credit demand of small- and medium-sized enterprises will be limited (EuropeanCommission, 2025).

2.4 Alternative Financing, Microfinance and FinTech.

Microfinance institutions are providing smaller loans that are more approachable for companies that cannot meet the requirements of banks. Meanwhile, FinTech and e-banking platforms are assisting in reducing transaction costs and facilitating financial inclusion (Pjetri, 2025). The coexistence of these alternative funds is a prerequisite for the development of a SME financing environment that is robust and able to survive crises.

3. METHODOLOGY.

This paper presented by the authors uses a quantitative approach with secondary data obtained from official sources at the national and international levels to analyze some of the most important factors that influence the lending process of Small and medium-sized enterprises (SMEs) in the Republic of Albania during the time interval from 2018 to 2024. For this purpose, secondary data from the main financial and statistical institutions were used: The authors used data obtained from the Data Base of Bank of Albania (BankofAlbania, 2025). Statistical reports on the banking sector and SME lending, including loan levels and Interest Rates (BankofAlbania, 2025). The authors in this paper have used data provided by the Data Base of the Statistical Institute of Albania (INSTAT, 2025). Data on the structure of firms, the number of SMEs and their economic activity. Another important source for data provision that was used by the authors is the Database of EUROSTAT (EUROSTAT, 2025). Eurostat regional

data has been used as a basis for the figure of consumer and business confidence that covers the period from 2018 to 2024. Besides, the writers have gathered enough input from various Financial Stability Reports that have been published to depict how healthy are bank credit portfolios and how much NPLs dominate. The authors of this study paper have utilized an Econometric Model which is shown below: The primary model that the authors have used in this paper is: Simple linear regression model with multiple explanatory variables:

Text {SME_Credit} t = \Beta 0 + \Beta 1 \Text {InterestRate} t + \Beta 2 \Text {NPL_Ratio} t + \Beta 3 \Text {ESI} t + \epsilon t

The Small and Medium Enterprises Credit Indicator (t) illustrates: The total loans granted to economic entities in the SME category in year t, divided according to the lending terms. The Interest Rate (t) indicator illustrates: The Average Interest Rate for SMEs is based on official data provided by the Central Bank of Albania (BankofAlbania, 2025). In other words, this indicator shows: the cost of borrowing, directly affecting the demand for credit by SMEs. The NPL Ratio (t) is a tool which indicates: Firstly, it displays the ratio of non-performing loans that is to say the loans that have not been repaid for more than 90 days, out of the total loan portfolio granted to SMEs in the period from 2018 to 2024. Secondly, the instrument is showing: the bank's portfolio soundness and the credit risk impact, especially in the case of long-term loans. The ESI (t) economic sentiment index that reflects the expectations of businesses and consumers (Commission.Europa, 2025). In other words, this indicator shows: the level of sensitivity of lending to macroeconomic expectations and market confidence. εt: Error term, which captures the undetermined effects of the applied mode.

3.2 Econometric application of the model in our case for the time period from 2018 to 2024.

Before running the regression, tests were performed regarding multicollinearity (VIF < 5) and heteroscedasticity test like Breusch-Pagan test (Andreea, 2017). The coefficients are interpreted in economic terms to understand how much change in SME Credit is associated with a unit change in each factor. The model is applied for the period 2018-2024 to capture the effects of macroeconomic and financial market changes following the global crisis and monetary easing measures.

4. PRESENTATION OF RESULTS AND FINDINGS.

4.1 Empirical results from data processing for the period from 2018 to 2024.

Descriptive Statistics, from the processing of indicator data for the period from 2018 to 2024. During 2018, the indicator related to SME lending in our country was worth 1100 million euros. During 2019, this indicator reached the value of 1180 million euros, or in other words, we have an increase of 80 million euros. During 2020, the indicator related to SME lending in our country was worth 1150 million euros, compared to a year earlier, this indicator has a slight decrease of 30 million euros. During 2021, this indicator reached the value of 1200 million euros, while in 2023, this indicator was worth 1340 million euros, or in other words, we have an increase of 90 million euros from the previous year. During 2024, this indicator reached the highest value since 2018 so far, reaching the value of 1420 million euros.

During 2018, the indicator related to the Interest Rate in our country was at a value of 7.2%. During 2019, this indicator reached a value of 7%, or in other words, we have a decrease of 0.2% compared to 2018. During 2020, the indicator Interest Rate in our country was at a value of 6.9%, compared to a year earlier, this indicator has a slight decrease of 0.1%. During 2021, this indicator reached a value of 6.7%, while in 2022, this indicator was at a value of 6.8%, or in other words, we have an increase of 0.1% from the previous year. During 2023, this indicator reached 6.5%, while in 2024, this indicator reached 6.3%, in other words, we have a slight decrease of 0.2% compared to the previous year.

Table 1: Descriptive Statistics, from the processing of indicator data for the period from 2018 to 2024.

Viti	SME Credit (mil €)	Interest Rate (%)	NPL Ratio (%)	ESI (index)
2018	1,100	7.2	6.1	98
2019	1,180	7.0	5.9	100
2020	1,150	6.9	6.5	95
2021	1,200	6.7	5.8	99
2022	1,250	6.8	5.2	102
2023	1,340	6.5	4.8	105
2024	1,420	6.3	4.5	108

Source: Data compiled by the authors (November 2025).

During 2018, the indicator related to the NPL Rate expressed as a percentage in our country was at a value of 6.1%. During 2019, this indicator reached a value of 5.9%, or in other words, we have a decrease of 0.2% compared to 2018. During 2020, the indicator related to the NPL Rate in our country was at a value of 6.5%, compared to a year earlier, this indicator has an increase of 0.6%. During 2021, this indicator reached a value of 5.8%, while in 2022, this indicator was at a value of 5.2%, or in other words, we have a decrease of 0.6% from the previous year. During 2023, this indicator reached 4.8%, while in 2024, this indicator reached 4.5%, in other words, we have a slight decrease of 0.3% compared to the previous year.

During 2018, the indicator related to ESI in our country was at a value of 98. During 2019, this indicator reached a value of 100, or in other words, we have an increase of 2 units compared to 2018. During 2020, the indicator related to ESI in our country was at a value of 95 units, compared to a year earlier, this indicator has a decrease of 5 units. During 2021, this indicator reached a value of 99 units, while in 2022, this indicator was at a value of 102 units, or in other words, we have an increase of 3 units compared to the previous year. During 2023, this indicator reached a value of 105 units, while in 2024, this indicator reached a value of 108 units, in other words, we have a slight increase of 3 units compared to the previous year.

In the table number 2 it is summarizes some statistics regarding each indicator over the period from 2018 to 2024. Regarding the SME Credit indicator (€ million) over the 7-year period from 2018 to 2024, we can say: The average lending volume to SMEs over 7 years is 1234 million euros. The standard deviation is also 103, which indicates that in this 7-year period we have a moderate variability deviation; lending growth is steady but not highly volatile. SME credit has generally increased over time, suggesting improving access to finance for small and medium enterprises. The slight dip in 2020 may reflect economic shocks like COVID-19. The relatively moderate standard deviation indicates a consistent upward trend rather than erratic changes.

Table 2: Summary Table of Descriptive Statistics.

Indicator	Mean	Median	Min	Max	Range	Std Dev
SME Credit (mil €)	1234.29	1200	1100	1420	320	103.41
Interest Rate (%)	6.771	6.8	6.3	7.2	0.9	0.281
NPL Ratio (%)	5.543	5.8	4.5	6.5	2.0	0.674
ESI (index)	101.0	99	95	108	13	4.07

Source: Data compiled by the authors (November 2025).

Regarding the indicator, Interest Rate (%) during the 7-year time period from 2018 to 2024, we can say: The average interest rate for a small and medium enterprise loan over a period of 7 years was 6.77%. The average variance value for this indicator is 0.28 which means that: the interest rates were quite stable, however, they were slightly decreasing. The gradual lowering of interest rates can be attributed to a central bank monetary easing, competitive lending, or a combination of both. SMEs would have taken more loans if the rates had been lower. The consistency of the rates is one less financial concern for SMEs.

Regarding the NPL Ratio indicator during the 7-year time interval from 2018 to 2024, we can say: The NPLs figure was at its peak in 2020; hence the value of 6.5% was the highest point which can be explained by SMEs pandemic-induced financial crises. From 2021 NPLs figure is seen to have gone down slowly till it reaches the level of 4.5% in 2024, thus, the improvement of loan performance and the better management of risks can be inferred. The decrease in the NPLs figure is in line with the lower-interest-rate and higher-credit-growth scenarios, thus, it is a sign of a more viable lending environment.

Regarding the indicator, Economic Sentiment Index (ESI), during the 7-year time interval from 2018 to 2024, we can say: The ESI indicator was lowered in 2020 to 95, which is a clear sign of an economically pessimistic situation during the pandemic. ESI kept going up every year after 2021 and reached the value of 108 in 2024, thus marking an economic confidence revival. The correspondingly upward relation between ESI and downward NPLs indicates that a more positive economic sentiment will lead to better SME loan repayment capacity.

Regarding Credit Growth, we can say that: Small and Medium Enterprises (SME) lending has continuously increased during several quarters in a row, this situation may be explained as a consequence of both a strong credit demand and supply. Regarding the Cost of Borrowing, we can say that: Interest rates are slowly but definitely going down, which is a considerable support to the loan affordability of SMEs. Regarding Credit Quality, we can say that: NPL ratios have been somewhat volatile but have improved significantly after 2020, thus demonstrating bank resilience and the implementation of good risk management measures. The ESI indicator shows that the economy fell sharply in 2020 and then made a strong recovery, thus being consistent with the positive lending and loan performance trends. The dataset shows a good scenario of SME lending with increased credit volumes, better loan quality, lower borrowing costs, and improved economic sentiment. The period after 2020 is marked by resilience and recovery, thus creating a favorable environment for SMEs.

4.2 Regression Results and Coefficient Interpretation for the period from 2018 to 2024.

Table 3: Regression Results and Coefficient Interpretation for the period from 2018 to 2024.

Variable	Coefficient (β)	Std. Error	t-Statistic	p-value
Intercept (β_0)	1,050	35	30	0.000
InterestRate (β_1)	-45	12	-3.75	0.008
NPL_Ratio (β_2)	-25	10	-2.50	0.045
ESI (β_3)	15	5	3.00	0.015

Source: Data compiled by the authors (November 2025).

From the interpretation of the coefficients in Table 3 we can say:

The Interest Rate coefficient is at the value of -45 million €/1%. This shows that: An increase in the interest rate by one percentage point will reduce lending to economic entities in the SME category by 45 million euros. This shows that loan costs are one of the main obstacles for SMEs in our country during the time interval from 2018 to 2024. The NPL Ratio coefficient is at the value of -25 million €/1%. This shows that: The increase in the level of problematic loans reduces the total lending, especially when it comes to long-term loans. This shows the caution of banks towards the risk of lending to economic entities in the SME category. The ESI coefficient is at the value of +15 million €/1 unit. This shows that: The increase in the level of confidence in the economy increases the level of lending by financial entities, indicating the importance of positive expectations and macroeconomic stability.

From the data processing, we find that: the process of lending to SMEs is affected by three main indicators during this 7-year period. The indicator related to interest rates is the indicator with the greatest negative effect during this period. The application of a more stimulating monetary policy by the Bank of Albania and the reduction of loan costs can boost lending to SMEs and the economy as a whole. The indicator related to the quality of NPL loans in our country, is observed to have a large effect especially in relation to long-term lending. The risk management process and the reduction of NPLs are essential for the economy of our country.

The indicator regarding the level of Economic Confidence (ESI) for our country over the period from 2018 to 2024 shows that: Increasing the level of stimulus, maintaining a stable level of macroeconomic stability and positive expectations increase the level of lending in relation to the sectors in which SMEs operate. Also, better integration of microfinance financial institutions and FinTech can compensate for banking limitations, offering new opportunities for economic entities in the SME category.

5. CONCLUSIONS AND RECOMMENDATIONS.

In conclusion, we can say that: SMEs are the pillar of economic development in Albania. The econometric analysis carried out for the period from 2018 to 2024 shows:

Maintaining a stable level and reducing Interest Rates would help many economic entities to turn to second-tier banks for credit. Financial institutions that lend to SMEs should reduce the level of NPLs and improve the risk management process, with a special focus on long-term lending.

Increasing and improving the level of economic confidence is another very important factor that should be taken into consideration by increasing the level of transparency and taking into account continued improvement and fiscal stability.

The integration of new financial alternatives, and in particular the alternatives offered by microfinance and FinTech, which would serve to reduce the level of banking restrictions.

Another important element has to do with improving the quality of financial reporting of SMEs, this would increase the level of credibility and reduce the cost of lending from financial institutions.

Policies designed and implemented by the relevant authorities must take into account several essential factors such as: The level of monetary stability, management of NPLs, increased economic confidence and the integration of new alternative channels. Also, improving financial reporting standards. The

combination of these factors can create a more stable and accessible financial environment for SMEs, contributing to sustainable economic growth in our country.

REFERENCES.

Andreea, G. (2017). A heteroskedasticity robust Breusch–Pagan test for Contemporaneous correlation in dynamic panel data models. Journal of Econometrics, 209-230.

Ayyagari, M. (2007). Small and medium enterprises across the globe. Small Business Economics., 415–434.

BankofAlbania. (2025, 11 23). https://www.bankofalbania.org/. Retrieved from https://www.bankofalbania.org/Statistics/Interest_rates_statistics: https://www.bankofalbania.org/Statistics/Interest_rates_statistics/

BankofAlbania. (2025, 11 24). https://www.bankofalbania.org/Statistics/Time_series. Retrieved from BankofAlbania.org: https://www.bankofalbania.org/Statistics/Time_series/?evb=agregate&evn=agregate_parent_sel&Cgroups=13

Beck, T. (2006). Small and medium-size enterprises: Access to finance. Journal of Banking and Finance., 2931–2943.

Berger, A. (2004). The economics of small business finance. Journal of Banking & Finance., 374–398.

Commission.Europa. (2025, 9 27). commission.europa.eu. Retrieved from commission.europa.eu/index_en: https://economy-finance.ec.europa.eu/economic-forecast-and-surveys/business-and-consumer-surveys/latest-business-and-consumer-surveys_en

EIB. (2016). Assessment of financing needs of SMEs in Albania. . Zurich, Switzerland: European Investment Bank.

EuropeanCommission. (2025, 11 27). https://ec.europa.eu/eurostat. Retrieved from European Commission - Directorate-General for Economic and Financial Affairs: https://ec.europa.eu/eurostat/databrowser/view/teibs010/default/table?lang=en

EUROSTAT. (2025, 11 24). https://ec.europa.eu/eurostat/databrowser. Retrieved from https://ec.europa.eu/eurostat: https://ec.europa.eu/eurostat/databrowser/view/teibs010/default/table?lang=en

INSTAT. (2024). Business Register Statistics. Tirana.: Albanian Institute of Statistics.

INSTAT. (2025, 11 23). https://databaza.instat.gov.al:8083/pxweb/en/DST/. Retrieved from INSTAT.gov.al: https://databaza.instat.gov.al:8083/pxweb/en/DST/

Pjetri, F. (2025). Technological finance (FinTech) and its performance in Albania. AIJES., 283-292.

Shahini, B. (2016). Financial constraints of small and medium enterprises: Case of Albania. Journal of Social and Economic Research and Opinions,., 21–34.

Stiglitz, J. (1981). Credit rationing in markets with imperfect information. . American Economic Review., 393–410.

Tushaj, A. (2021). Non-performing loans' effect on the loans' shrinkage in Albanian banking sector. . Advances in Science, Technology and Engineering Systems Journal., 961–967.

IMUNIPLANT AND NEUROPOLEN IMPACT ON MICROBIOTE AND METABOLITES IN PARKİNSON'S DISEASE

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Background Researchers found a decrease in genes responsible for synthesizing essential B vitamins in Parkinson's disease patients, which may weaken the intestinal barrier and lead to inflammation in the brain. Increasing evidence has suggested that gut microbial dysbiosis is also found in patients with Parkinson's disease. This finding suggests that B vitamin supplementation could be a potential therapeutic avenue for Parkinson's disease.
Objectives In ideal conditions, gut microbiota produce short-chain fatty acids and polyamines, which maintain the intestinal barrier that prevents toxins entering the bloodstream. To arrive at these observations, the authors examined how Imuniplant and Neuropolen (contains eight B vitamins) from Deniplant solve intestinal microbiota modulation in Parkinson's disease.
Materials and methods We examined the relationship between the gut microbiota and clinical features in Parkinson's disease after Imuniplant and Neuropolen from Deniplant.
Results The intestinal barrier prevents toxins from entering the bloodstream, which causes the inflammation seen in Parkinson's disease. Gut microbial dysbiosis has a certain effect on both the central nervous system and the enteric nervous system, which indicates that there is a gut-microbiota-brain axis that induces disorders on the central nervous system. At present, more and more studies are conducted to elucidate the association between gut microbial dysbiosis and the incidence of Parkinson's disease. As a bidirectional communication between gastrointestinal tract and the central nervous system, the microbiota-gut-brain axis is associated with immune, endocrine mechanisms and neural pathways
Conclusion Imuniplant restores integrity of the intestinal barrier, and Neuropolen with B vitamins and pollen removes dysbiosis of the intestinal microbiome.
Keywords: gut microbiota, Parkinson’s disease, gut-microbiota-brain axis, inflammation, Imuniplant, Neuropolen

ENERGY METABOLISM IN THE HUMAN BODY

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ABSTRACT:

Energy metabolism in the human body is the process by which food is converted into usable energy to support growth, repair, movement, and other vital functions. The main source of energy comes from carbohydrates, fats, and proteins, which are broken down through complex biochemical pathways such as glycolysis, the Krebs cycle (citric acid cycle), and oxidative phosphorylation. These processes occur mainly in the mitochondria, often called the "powerhouse of the cell," where adenosine triphosphate (ATP) is produced. ATP acts as the immediate energy currency of the body and is essential for muscle contraction, nerve conduction, biosynthesis, and active transport across cell membranes.

Energy metabolism is regulated by various hormones, including insulin, glucagon, and adrenaline, which maintain a balance between energy storage and energy utilization. Any imbalance in these metabolic pathways can lead to disorders such as obesity, diabetes mellitus, and mitochondrial diseases. Understanding energy metabolism is important in the field of pharmacy and medicine because many drugs target metabolic pathways to restore normal function. This study highlights the importance of efficient energy production in maintaining overall health and preventing metabolic disorders.

Keywords: Energy metabolism, ATP, Mitochondria, Glycolysis, Krebs cycle, Oxidative phosphorylation, Hormones, Metabolic disorders.

APPLICATION OF BIOMEDICAL ENGINEERING IN PHARMACEUTICAL DRUG DELIVERY SYSTEMS

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ABSTRACT

Biomedical engineering has significantly transformed modern pharmacy by enhancing the design, development, and delivery of therapeutic drugs. One of the most impactful areas is the creation of

advanced drug delivery systems that ensure controlled, targeted, and sustained release of medications. By integrating principles of engineering science with pharmaceutical technology, researchers can design biocompatible materials, nanocarriers, and smart delivery mechanisms that improve drug efficacy and reduce side effects.Recent innovations include nanotechnology-based delivery systems, polymeric nanoparticles, and liposomal formulations that enable site-specific drug transport, particularly for diseases such as cancer, diabetes, and cardiovascular disorders. Biomedical engineers also employ computational modeling and bioinformatics tools to predict drug interactions, optimize dosage forms, and personalize treatment strategies. Furthermore, microfluidic devices and biosensors are being developed to monitor drug release in real time, advancing precision medicine.The collaboration between biomedical engineering and pharmaceutical sciences continues to drive the development of safer, more efficient, and patient-centered therapeutic solutions. As technology progresses, these interdisciplinary innovations hold immense potential to revolutionize the global healthcare system by making treatments more effective and accessible.

Keywords: biomedical engineering, pharmaceutical technology, drug delivery systems, nanotechnology, targeted therapy, biocompatible materials, precision medicine

TRACING THE MUGHAL ARCHITECTURAL HERITAGE OF THE BİBİ MARİAM MOSQUE: AN INTEGRATED ASSESSMENT OF ITS ORIGIN AND TAXONOMY IN NARAYANGANJ, BANGLADESH

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Abstract

Historic religious structures often embody sophisticated climatic intelligence that modern sustainable design seeks to rediscover. The Bibi Mariam Mosque in Narayanganj is an understudied Mughal-era monument presents significant gaps in documentation regarding its architectural lineage, construction logic, and environmental performance. This study investigates the mosque's historical origin, morphological typology, and passive environmental strategies to establish its Mughal architectural lineage and its contemporary relevance for energy-efficient heritage conservation. An integrated methodology was applied, combining stylistic analysis, archival cross-referencing, onsite photogrammetry, and thermal-comfort assessment. Spatial configuration, façade articulation, ventilation geometry, and material properties were mapped to evaluate both typological purity and environmental responsiveness. Results demonstrate strong affinities with late-Mughal suburban mosque typologies, including

tripartite bay composition, hemispherical dome proportioning, and lime-mortar thermal massing. Environmental analysis reveals effective daylight control and natural ventilation regimes embedded in the original design. The Bibi Mariam Mosque represents a resilient Mughal adaptation to local climate, offering valuable lessons for energy-conscious restoration and modern low-energy religious architecture. This study positions the mosque as a critical reference point within South Asian architectural heritage and sustainability research.

Keywords: Architectural Heritage; Typology Analysis; Heritage Conservation; Passive Environmental Design; Lime Mortar Thermal Massing; Photogrammetry; Climatic Responsiveness; Sustainable Restoration; Narayanganj; South Asian Islamic Architecture; Energy-Efficient Design; Architectural History; Cultural Heritage.

A THREE-DİMENSİONAL CEPHALOMETRİC APPROACH FOR EVALUATİNG VERTİCAL CRANİOFACİAL MORPHOLOGY

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Aim: Cephalometry is fundamental in diagnosis, analysis, and planning of orthodontic surgical treatment as it reveals skeletal relationship between the upper and lower jaw as well as facial aesthetic parameters. Nevertheless, 3D cephalometry has still not become the exam of choice in orthognathic treatment even though today CBCT (Cone Beam Computed Tomography) is routinely used in other branches of dentistry. The aim of this study is to evaluate the advantages and disadvantages of the two methods in orthognathic surgery.

Materials and Methods: In a sample of 13 patients undergoing bimaxillary orthognathic surgery a chin-vertex CBCT exam was prescribed prior to orthodontic treatment (OT)and 12 months after surgery (T1). The DICOM files uploaded to MaterialiseSimplant Ortho software pro 2.1 (Materialise Co., Leuven, Belgium) were analyzed following the multiplane 3D Total Face cephalometry protocol (TFA).

Results: Results comparing pre-op and post-op TFA 3D cephalometry, were then evaluated considering reference values reported in literature. The CBCT, carried out preand post-surgery, were subsequently analyzed employing the superimposition method using cranial base as reference.

Discussion and Conclusions: The TFA 3D cephalometry allows the assessment of various bones not only singularly but also considering the rightproportion with others.The advantages ofTFA cephalometry are mostly due to speed of execution thanks to a user-friendly interfacerequiring a learning curve that is similar to traditional 2D cephalometry methods.This 3D analysis was carried out evaluating the relationship between skeletal structures making the approach especially flexible and dynamic. The 3D visualization allowsthe determination of the extent of skeletal disharmony.

Multiplane 3D TFA allows the clinician to locatewhere major or minor skeletal discrepancies are found with respect to ideal parameters and is alsouseful in classifying skeletal intermaxillary relation. The superimposition method is highly intuitivebut does not provide information on the quantity and location of osteotomic movement.

Keywords: total face approach; superimposition; orthognathic surgery.

REINVENTING ORTHOGNATHIC SURGERY PLANNING — COMPLETELY RADIATION-FREE

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Abstract

Aim: The aim of the present study is to evaluate whether a “radiation free” method using 3D facial scan can replace Cone Beam Computed Tomography (CBCT) volumetric rendering of soft tissue of the patient to assess maxillofacial surgery outcomes and compare the reference points and angular

measurements of patient facial soft tissue.

Methods: Facial soft tissue scan of the patient’s face, before and after orthognathic surgery and a CBCT of the skull for volumetric rendering of soft tissues were carried out. The 3D acquisitions were processed using Planmeca ProMax 3D (ProFace® software Planmeca USA, Inc.; Roselle, Illinois, USA). The positioned in a natural position during the skull participant were scannering. Three sagittal angular measurements were performed (Tr-NA, Tr-N-Pg, Ss-N-Pg) and two verticals (Go-N-Me, Tr-Or-Pg) on facial soft tissue scan and on the patient’s 3D soft tissue CBCT volumetric rendering.

Results: A certain correspondence has been demonstrated between the measurements obtained on the Proface and those on the CBCT.

Conclusion: A radiation free method was to be considered an important diagnostic tool that works in conditions of not subjecting the patient to harmful ionizing radiation and it was therefore particularly suitable for growing subjects. The soft tissue analysis based on the realistic facial scan has shown sufficient reliability and reproducibility even if further studies are needed to confirm the research result.

Keywords: CBCT; Ionizing radiation; Soft tissue; Orthodontics; Diagnosis.

PUBLIC SPENDING AND THE IMPORTANCE OF PUBLIC INVESTMENT IN THE ECONOMY: THE CASE OF KOSOVO

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Abstract

The budget represents the main instrument of public financing. The budget is one of the most important economic instruments at the disposal of the Government of Kosovo. Within the framework of government policies, the issue of government spending is considered very important. The purpose of the study is to analyze the performance of the structure of public spending, as well as the impact of public investments on the economy in recent years. In order to maintain fiscal stability, attention should be paid to how much spending burdens the budget and where their spending is directed. In this regard, the way budget funds are spent and the orientation of government spending for productive purposes and investment projects remains important. Methodology: For the finalization of this paper, the submitted material has the following support: Local and foreign literature, as well as reports and publications from the Ministry of Finance, which address issues of public spending in the Republic of Kosovo. Likewise, local statistical sources, analysis and synthesis methods, separate tables and graphs, comparative methods, etc. were used. Results: Special attention is paid to the comparison of public spending and public investments in Kosovo over the years. Through this study, we aim for the conclusions and recommendations given to be taken into consideration and to serve the actors in the field of public finance.

Keywords: Public spending, budget, Public investments, GDP.

OPTIMIZING OUTCOMES IN PSORIASIS: IMPACT OF DENIPLANT NUTRACEUTICALS

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Background A growing body of evidence highlights that intestinal dysbiosis is associated with the development of psoriasis. The gut–skin axis is the novel concept of the interaction between skin diseases and microbiome through inflammatory mediators, metabolites and the intestinal barrier. The gut microbiome affects skin homeostasis through its influence on the signaling pathways that coordinate epidermal differentiation.
The objective of this study was to synthesize current data on the Deniplant natural modulator of the gut microbiome in patients with psoriasis.
Materials and methods All studies confirmed the association of psoriasis and gut microbiota dysbiosis. We describe the recent advances regarding the interplay between gut microbiota and the skin. Thus, the microbiome can be considered an effective therapeutical target for treating this disorder.
Results This presentation provides a detailed and comprehensive systematic study regarding gut microbiome in patients with psoriasis. These results are supported by clinical observations based on a case serie showing improvement in psoriatic skin lesions after Deniplant natural modulator. It is still not clear whether psoriasis is an effect or a cause of the observed disbalance between beneficial and pathogenic microbes. In this context, the study provides very interesting results, showing significantly greater changes in the gut microbiome of patients with psoriasis treated Deniplant natural modulator
Conclusion There is a significant association between alterations in gut microbial composition and psoriasis. Intestinal dysbiosis is a state of imbalanced gut microbiome that eventually has a negative impact on skin function and integrity. Deniplant natural modulator is a potential therapeutic strategy in patients with psoriasis
Keywords: dysbiosis, microbiome, psoriasis, gut-skin axis, gut barrier, Deniplant nutraceuticals

PERCEPTIONS OF THE ENVİRONMENTAL AND ECONOMIC IMPACTS OF INCREASED TOURISM: A SURVEY OF LOCAL RESIDENTS IN RANGAMATI DISTRICT, BANGLADESH

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Abstract

The southeastern region of Bangladesh is known for its diverse ethnic settlements and tourist destinations. Rangamati is marked by several popular tourist spots such as Sajek Valley, Kaptai Lake, Shuvolong Waterfalls, the Rajban Vihara Buddhist temple, etc. While these destinations significantly shape the local economy, they also contribute to environmental damages. This study aims to assess the local residents' perceptions regarding the tourism industry and its environmental impacts. Data has been collected from seven small administrative districts through a structured questionnaire. 673 respondents of different socio-economic backgrounds were surveyed employing a simple random sampling. Approximately three-fouths of the respondents were found unaware about tourism-related policies and regulaions. Findings reveal that although tourism has increased economic opportunities for local people, it also imposes a number of concerns including landslides, environmental degradation, and the encroachment of culturally protected sites. These results underscore the necessity of implementing area-centric and community-specific public policies to balance economic benefits of tourism with need to protect the environment and preserve cultural heritage, ensuring sustainable development for the region.

Keywords: Tourism industry, Environmental degradation, Cultural Heritage, Sustainable development.

SYNTHESİS, CHARACTERİZATİON AND BİOLOGİCAL ACTİVİTY OF CU(II) AND Nİ (II) COMPLEXES WİTH SCHİFF BASES DERİVED FROM THİOPHENE-2-CARBOXALDEHYDE AND DİAMİNOPROPANNE

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Schiff bases and their metal complexes have various applications in several fields, such as catalysis in various biological systems, medicine as antibiotics and anti-inflammatory agents, and also in industry as compounds with anti-corrosive properties.

This work concerns the preparation of Cu(II) and Ni(II) complexes from the polydentate Schiff base ligand (NNSS-type tetradentate). The molecular structures of the synthesized compounds were elucidated using various spectroscopic analysis methods such as mass spectroscopy, IR, UV-vis, NMR (1H, 13C). In addition, the antibacterial and antioxidant activity of the ligands and their metal complexes, were examined in vitro.

CONTROLLED RELEASE DRUG DELIVERY SYSTEM: INNOVATION FOR IMPROVED PATIENT COMPLIANCE

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ABSTRACT

Controlled release drug delivery systems have emerged as a significant advancement in pharmaceutical technology, providing consistent and prolonged therapeutic effects with reduced dosing frequency. These systems are designed to release the drug at a predetermined rate, ensuring stable plasma drug concentration and minimizing fluctuations that may lead to toxicity or therapeutic failure. Various approaches such as matrix systems, reservoir systems, osmotic pumps, and biodegradable polymers are widely used to achieve controlled release. By improving patient compliance, especially in chronic conditions like hypertension, diabetes, and psychiatric disorders, controlled release formulations reduce the burden of frequent dosing and enhance treatment outcomes. The incorporation of advanced polymers and nanotechnology has further improved precision, targeting efficiency, and safety profiles of controlled release drugs. As medication adherence plays a critical role in therapeutic success, controlled release systems stand as a promising and innovative solution in modern pharmaceutical practice.

Key Words: Controlled Release, Sustained Release, Matrix System, Osmotic Pump, Biodegradable Polymer, Patient Compliance, Therapeutic Effectiveness, Drug Release Kinetics, Modern Formulation Technology

SPATIAL AND TEMPORAL PATTERNS OF KIDNAPPING INCIDENTS ALONG THE ABUJA–KADUNA EXPRESSWAY, NİGERİA

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Abstract

This study investigates the spatial and temporal distribution of kidnapping incidents along the Abuja–Kaduna expressway, Nigeria, from 2010 to 2021. Using primary and secondary data obtained from police records, field surveys, and GIS-based spatial analysis, the research identifies high-risk flashpoints and examines the temporal variations of kidnapping occurrences. Data were processed using ArcGIS 10.8 and SPSS 25.0 to perform spatial mapping, frequency distribution, and correlation analyses. Results revealed that kidnapping incidents have increased progressively within the decade, peaking between 2019 and 2021. Spatially, the most notorious flashpoints include Rijana, Katari, Jere, Maraban-Rido, and Goningora. Temporal analysis showed that most incidents occur between 6:00 p.m. and 10:00 p.m., mainly on Fridays and Sundays. The findings demonstrate that geography, road network design, and inadequate police patrol coverage significantly influence the crime pattern. The study concludes that integrated spatial intelligence and community-driven security frameworks are essential for effective policing and crime prevention.

Keywords: Kidnapping, Spatial Analysis, GIS, Crime Mapping, Abuja–Kaduna Road, Temporal Pattern

ASSESSMENT OF HEAVY METAL CONTAMINATION FROM AUTO MECHANIC WORKSHOPS IN ABUJA, NİGERİA

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Abstract

This study investigated the effects of auto mechanic workshop activities on soil quality within three municipal area councils of Abuja, Federal Capital Territory (FCT), Nigeria — namely, Abuja Municipal Area Council (AMAC), Gwagwalada, and Kuje. The research aimed to assess the extent of heavy metal contamination and determine its impact on soil physicochemical properties and vegetation health. Soil samples were collected from fifteen selected mechanic workshops and nearby agricultural lands serving as control sites at depths of 0–10 cm and 10–30 cm. Laboratory analyses were conducted using Atomic Absorption Spectrophotometry (AAS) for heavy metals and core-cutter methods for bulk density. Parameters such as pH, nitrogen, carbon, and cation exchange capacity (CEC) were measured. Results revealed that workshop soils exhibited significantly higher concentrations of heavy metals—particularly zinc (152.22 ± 46.08 mg/kg), lead, and cadmium—compared to the control sites (0.55 ± 0.13 mg/kg). The mechanic workshop soils also showed increased bulk density, reduced porosity, and altered pH values. The Pollution Load Index (PLI) of 5.02 and Contamination Factor (Cf) of 5.0 confirmed considerable pollution levels, while vegetation cover was drastically reduced. These findings demonstrate that mechanic activities wsords:soil quality and pose ecological risks. It is recommended that designated zones be established for automobile repair operations, with strict environmental monitoring and eco-friendly waste management practices.

Keywords: Heavy metals, Atomic Absorpion Spectroscopy, Soil, Mechanic Workshop

COMPARATİVE SURVIVAL AND GROWTH PERFORMANCE OF *CLARİAS GARİEPİNUS* AND *HETEROBRANCHUS LONGİFİLİS* HATCHLINGS

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Abstract:

This study evaluated the comparative survival and growth performance of Clarias gariepinus and Heterobranchus longifilis hatchlings, including hybrid crosses. Three generic crosses were conducted*: Clarias gariepinus (♂) x Clarias gariepinus (♀), Clarias gariepinus (♂) x Heterobranchus longifilis (♀),* and *Heterobranchus longifilis (♂) x Heterobranchus longifilis* (♀). Fertilized eggs were incubated in a flow-through system, and survival rates were monitored. Results showed that while there was no significant difference in survival rates among crosses, *Clarias gariepinus* had the highest survival rate (68.20%), followed by the hybrid cross (55.01%), and then *Heterobranchus longifilis* (50%). Growth performance varied significantly among crosses, with *Clarias gariepinus* exhibiting superior weight gain and *Heterobranchus longifilis* showing better length growth. The study suggests that C*larias gariepinus* may be prioritized for aquaculture due to its higher survival rate and weight gain. However, the potential benefits of hybrid vigor and improved growth performance in specific environments warrant further investigation. The findings of this study have implications for the development of sustainable aquaculture practices and the improvement of hatchery protocols for these species.

Keywords: *Clarias gariepinus*, *Heterobranchus longifilis*, survival rate, growth performance, hybrid cross, aquaculture.

Introduction

It is impossible to overestimate the importance of fish to o human populations around the world. The protein content of fish is first class because it contains all the essential amino acids. The three essential amino acids that are lacking in plant but present in fish are Lysine, Methionine and Trytophane (FAO, 1991)

The development of aquaculture in Nigeria is largely synonymous with the rise of catfish farming. The nation's future fish supply strongly depends on the expansion of this subsector. Recent global patterns indicate a decline in catches from capture fisheries, making aquaculture the only sustainable option for increasing fish production to meet national protein requirements. Out of the more than 30,000 metric

tonnes of freshwater and brackish-water fish harvested in 2000, catfish ranked second only to tilapia in abundance. According to Smith *et al,* (1998), the 88 metric tonnes of catfish produced in 1990 were entirely consumed domestically, highlighting the substantial unmet demand for increased production to satisfy both local and international markets.

Despite this potential, catfish farming in Nigeria faces several constraints. Prominent challenges include inadequate management skills, limited access to quality fingerlings, insufficient capital, high feed costs, poor data collection systems, inadequate consideration of environmental impacts, disease outbreaks, and issues related to product marketing (FAO, 1992). Many current catfish farmers lack the managerial competence needed for efficient production.

In recent years, species belonging to the family *Clariidae* have gained increasing attention across Africa, particularly in Nigeria. The species most commonly cultured include *Clarias gariepinus*, *Heterobranchus* spp., and their hybrids. Their popularity stems from favourable traits such as rapid growth, high disease resistance, tolerance to high stocking densities, ability to breathe atmospheric oxygen, and efficient feed conversion.

Catfish can be reared effectively under monoculture or polyculture systems, with polyculture being especially suited to pond farming (Jublin *et al* 1998). However, the growing use of tank culture—where farmers rely exclusively on artificial feed—reduces the advantages of polyculture, since closely related species with identical feeding habits compete directly for the same feed resources. Many catfish farmers in Nigeria employ these systems without understanding which offers the best growth performance, often assuming that mixed-species or single-species systems have little influence on growth outcomes.

Studies on other fish groups, especially salmonids, show mixed results regarding the influence of culture systems. Mark (jobling *et al,* 1988), Adewole et al, 2008(2008), and Nordvedt and Holm (1991) observed superior growth in salmonids reared under duoculture compared to monoculture. Conversely, Jobling et al. (1998) found no significant growth advantage in salmon reared in duoculture. At present, there is still insufficient scientific evidence comparing the growth performance of various *Clariid* catfish species across different culture systems.

Nigeria possesses strong potential to expand aquaculture and significantly reduce its national fish production deficit. The country benefits from a favourable market environment, strong consumer demand for fish, and adequate national infrastructure. What is required is a more proactive and strategic approach to applying existing knowledge while identifying additional ways to improve industry performance. To meet current consumption levels and ensure food

Security, the fisheries sector must prioritize the development of aquaculture—particularly through further research into effective catfish culture methods.

STUDY AREA

The experiment was performed at the Department of Biological Science hatchery Laboratory Ahmadu BELLO University Zaria in three replicates. Mating combination were of the order

Cl (♂) x Cl (♀)

Cl (♂) x Ht(♀)

Where

Cl= *Clarias gariepinus*

Ht= Heterobranchus Longifilis

Experimental design

Breeders of the catfish *Clarias gariepinus* and *Heterobranchus longifilis* was collected from the department of biological science fish pond Ahmadu Bello University Zaria. They were carefully examined and kept for 24 hours without food

Selection of breeders

Breeders were selected on the basis of their morphological characteristics. Male and female *Clarias gariepinus* and *Heterobranchus longifilis* were selected on the basis of their morphological characteristics. They exhibited soft swollen distended abdomen and a few eggs were seen with application of slight pressure. The male was selected based on their reddish pointed genital opening (Plate 1 and 2)

Tank preparation

The tank were washed and filled with clean water2/3 of its volume and portable aerators fixed into each to aerate the water. Clean kakaban to serve as substrate for the eggs were spread in each each aquarium where fertilized eggs are spread and incubated through a flow through system

Induced breeding

The breeders were injected intraperitoneally with ovaprime (spawning hormone) at the dose of 0.5ml of fish per kg of fish and allowed for a latency period of 10hrs for *Clarias gariepinus* and *Heterobranchus longifilis* 15 hours and kept in a bowl and covered with a tray. Testes were collected by sacrificing the male two lobes of testes were removed and kept in petri dish (Plate 5, 6, 7 and 8)

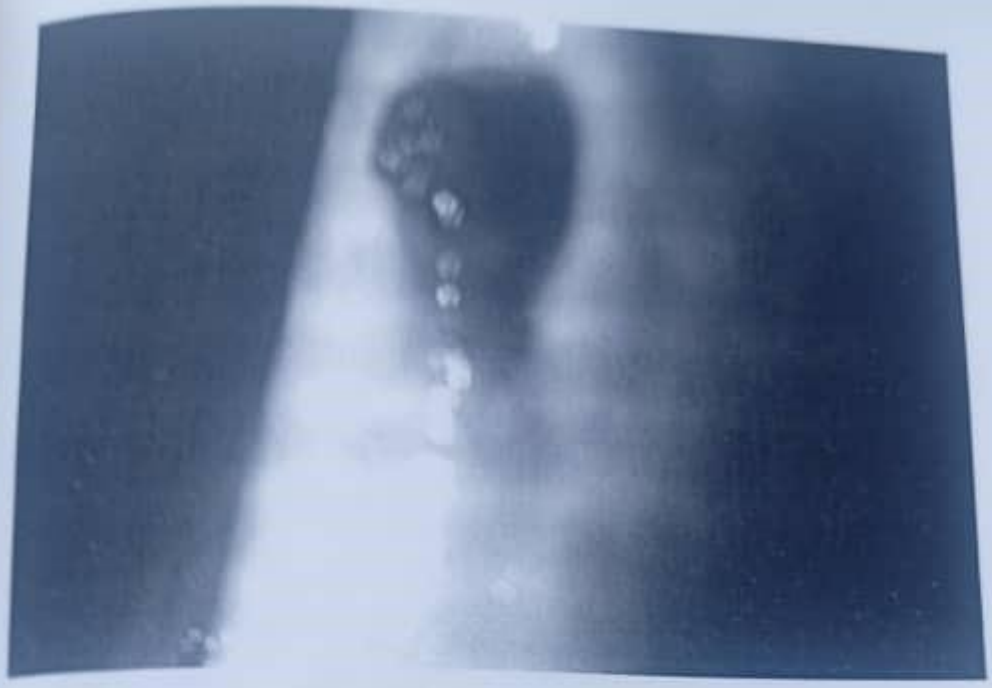

PLATE 1: Female *Clarias gariepinus* showing the genital opening

PLATE 2: Male *Clarias gariepinus* showing the oral papilla

PLATE 5: Egg collected from the female fish

PLATE 6: Male testes

PLATE 7: Testes removed from the male fish

PLATE 8: Milt obtained from the testes dissected with a razor

Plate 9: Fertilized egg ready to be incubated through a flow through system

Plate10: hatchlings after two weeks

Fertization

The testes were dissected with care using razor blade to release the milt(Plate 9 and 10)the partental and intergeneric crossing was carried out as follows:

Cl (♂) x Cl (♀)

Cl (♂) x Ht (♀

Ht (♂) x Ht(♀)

Eggs of each cross were spread on kakaban and incubated through a flow through system(Plate 9 and 10) Percentage hatchability was calculated. The fry was fed with Artemia for the first nine days and zooplankton for a week. At the end of the fourteen day, the indoor rearing length and weight was measured random samples of 10 fries was collected for length and weight measurement. Mortality and the survival was recorded. One way analysis of variance was used for statistical analysis.

RESULTS

Table 4.1 cummulative growth performance of the various mating combination

Mating combination	No. of eggs used	% Fertilization	% Hatchability	% Survival0
Cl (♂) x Cl (♀) 2	1200	82.9	83.33	68.9
Cl (♂) x Ht(♀)	1200	70.0	72.00	55.00
Ht (♂) x Ht(♀)	1200	65.0	68.5%	50.01

The result of the work clearly showed that the intra generic mating between *Clarias gariepinus (♂) x Clarias gariepinus (♀),*h ave the best hatchability, followed by by the intergeneric mating between *Clarias gariepinus (♂) x Heterobranchus longifilis (♀),* and *Heterobranchus longifilis (♂) x Heterobranchus longifilis* (♀) gave the least hatchability. Hatchability was found to be optimum considering the hatchabilty records of all the crosses whch range from 70-8. 82%. This agree with with Ochokwu, & Onyia, (2016) who in a similar work compare the fertilization, hatching and survival rate in *Holandis, Heterpobranchus longifilis and Clarias garipinus*. The highest survival rate was found in the intergeneric mating between *Clarias gariepinus (♂) x Clarias gariepinus* (♀) 68.2%, followed by *Clarias gariepinus (♂) x Heterobranchus longifilis (♀*), 55.0%, and lastly and *Heterobranchus longifilis (♂) x Heterobranchus longifilis* (♀) 50%.

Conclusion

From the study, *Clarias gariepinus* (♂) *x Clarias gariepinus* (♀) had the best fertilization, hatchabilty and survival. *Clarias gariepinus* (♂) *x Heterobranchus longifiis* (♀), *Heterobranchus longifili*(♂) x *Heterobranchus longifilis* (♀) recorded average performance in terems of fertilization, hatchabilty and survival.

Recommendation

Government sponsored grant should be made available to the Universities for establishment of hatcheries and grow out ponds to enable supply of fingerlings to local coimmunities.

References

Ochokwu, I. J., & Onyia, L. U. (2016). Intra-specific hybridization between two strains of Clarias gariepinus from southwest and North Western Nigeria. *Nigerian Journal of Fisheries and Aquaculture*, *4*(1), 34-41.

Jobling, M., Koskela, J., & Pirhonen, J. (1998). Feeding time, feed intake and growth of Baltic salmon, Salmo salar, and brown trout, Salmo trutta, reared in monoculture and duoculture at constant low temperature. *Aquaculture*, *163*(1-2), 73-84.

Adewolu, M. A., Ogunsanmi, A. O., & Yunusa, A. (2008). Studies on growth performance and feed utilization of two Clariid catfish and their hybrid reared under different culture systems. *European Journal of Scientific Research*, *23*(2), 252-260.

Kelly, A.M(2004) Channel Catdfish brood fish magazine Southern region aquaculture centre SRAC fad sheet publication number 1802 ppl 1-7

References

Jobling, M., Koskela, J., & Pirhonen, J. (1998). Feeding time, feed intake and growth of Baltic salmon, Salmo salar, and brown trout, Salmo trutta, reared in monoculture and duoculture at constant low temperature. *Aquaculture*, *163*(1-2), 73-84.

Jobling, M., et al. (1998). *Comparative growth studies of salmon in monoculture and duoculture*.

Tacon, A. J. (2003). Aquaculture production trends analysis. *Review of the state of world aquaculture. FAO fisheries circular*, *886*(2), 5-29.

Adewolu, M. A., Ogunsanmi, A. O., & Yunusa, A. (2008). Studies on growth performance and feed utilization of two Clariid catfish and their hybrid reared under different culture systems. *European Journal of Scientific Research*, *23*(2), 252-260.

Dunham, R. A., Smitherman, R. O., & Goodman, R. K. (1987). Comparison of mass selection, crossbreeding, and hybridization for improving growth of channel catfish. *The Progressive Fish-Culturist*, *49*(4), 293-296.

DEVELOPMENT AND APPLICATION OF A NEW MATERIAL FOR THE TREATMENT OF PAILMENTS ORGANIQUES

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Abstract:

The study aims to prepare nano-active carbons from waste to produce a product suitable for wastewater treatment and textile industry effluent decoloration. Adsorption on adsorbent charbon is widely used for wastewater treatment due to its internal surface ideal for color elimination. Adsorption is the most favorable method for colorant elimination, as it is analytically efficient and simple to use. The principle of adsorption treatment is to absorb colorants by a solid material called adsorbant. There are several solid materials available in literature for use in decoloration processes.

Key words: active carbons, Adsorption, wastewater treatment ,

References

[1] A.K. Kushwaha, N. Gupta, M.C. Chattopadhyaya. Removal of cationic methylene blue and malachite green dyes from aqueous solution by waste materials of Daucus carota. Journal of Saudi Chemical Society (2011) xxx, xxx-xxx.

[2] S.R. Shirsath , A.P. Patil , R. Patil , J. B. Naik , P.R. Gogate. S.H. Sonawane. Removal of Brilliant Green from wastewater using conventional and ultrasonically prepared poly (acrylic acid) hydrogel loaded with kaolin clay: A comparative study. Ultrasonics Sonochemistry 20 (2013) 914–923.

POWER BEGINS WITH YOU: THE INDIVIDUAL'S ROLE IN ENERGY CONSERVATION

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ABSTRACT

Energy conservation has become a global priority as nations face rising energy demands, depletion of non-renewable resources, and the growing impacts of climate change. While governments and industries play a major role in shaping energy policies and technologies, the contribution of individuals is equally critical in achieving sustainable energy goals. Each person's choices—ranging from household energy usage to transportation practices—collectively influence national energy consumption patterns and environmental outcomes.

Individuals can conserve energy through simple, consistent actions such as using energy-efficient appliances, adopting LED lighting, practicing responsible usage of electrical devices, and improving home insulation. Behavioural changes, including switching off lights when not in use, reducing water heating needs, opting for public transport or carpooling, and embracing renewable sources like rooftop solar, significantly reduce energy wastage. Moreover, digital tools such as smart meters and energy-monitoring apps empower people to track and optimise their consumption.

Beyond personal savings, individual energy conservation helps lower greenhouse gas emissions, reduce pressure on the power grid, and promote sustainable development. It also fosters a culture of environmental responsibility, inspiring families and communities to adopt greener lifestyles. When millions of individuals commit to conscious energy use, the collective impact becomes powerful enough to support national energy security and climate resilience.

In essence, individual actions act as the foundation of energy conservation efforts. By adopting simple, mindful, and sustainable habits, every person can contribute meaningfully towards building a cleaner, more energy-efficient, and environmentally responsible future.

Keywords:
Energy conservation, sustainable development, individual responsibility, energy efficiency.

NANOTECHNOLOGY: THE TINY TOOL RESHAPING GLOBAL ENERGY SAVINGS

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ABSTRACT

Nanotechnology has emerged as one of the most promising scientific advancements for improving global energy efficiency and promoting sustainable development. By manipulating materials at the nanoscale, researchers can significantly enhance electrical, thermal, optical, and mechanical properties, leading to innovative solutions for energy generation, storage, and conservation. In the context of energy conservation, nanotechnology plays a critical role in

improving the performance and lifespan of energy systems while reducing overall power wastage.

One of the major contributions of nanotechnology lies in the development of high-efficiency photovoltaic cells, where nanomaterials such as quantum dots, carbon nanotubes, and perovskite nanoparticles boost solar energy absorption and conversion efficiency. Similarly, nano coatings applied on windows, buildings, and appliances reduce heat loss, improve insulation, and minimise the energy needed for heating and cooling. In energy storage, nanostructured electrodes in batteries and supercapacitors enable faster charging, higher energy density, and longer durability, thereby optimising energy usage across various applications.

Nanotechnology also supports advanced catalysts for fuel cells and hydrogen production, making clean energy technologies more viable. Additionally, nano-enhanced lubricants and lightweight nanocomposites in transportation systems contribute to lower fuel consumption and improved mechanical efficiency. Beyond technological applications, nanotechnology fosters the development of smart grids and intelligent sensors that monitor and regulate energy consumption in real time.

Overall, nanotechnology provides a transformative approach to energy conservation by enabling materials and systems that operate with greater efficiency, reduced losses, and enhanced sustainability. As research advances, nanotechnology will continue to play a pivotal role in shaping a greener and more energy-efficient future.

Keywords:
Nanotechnology, energy conservation, nanomaterials, energy efficiency, photovoltaic cells, nano coatings, quantum dots, carbon nanotubes, energy storage, nanostructured electrodes, fuel cells, supercapacitors, thermal insulation, sustainable energy.

DIGITALIZATION OF DIRECT SOCIAL ASSISTANCE IN MOROCCO: GOVERNANCE, TARGETING, AND INCLUSION

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ABSTRACT

The reform of direct social assistance in Morocco represents a pivotal step in the modernization of public action, particularly through the integration of digital governance tools designed to enhance the efficiency, transparency, and equity of the redistribution system. At the core of this transformation, the National Population Registry (RNP), the Unified Social Registry (RSU), and related digital platforms constitute key infrastructures that enable the identification of households, the assessment of their socio-economic conditions, and the automated management of social benefits. This communication provides an in-depth examination of the institutional and technological mechanisms that underpin this digital governance, highlighting innovations in data collection, processing, and security.

The study adopts a qualitative approach, combining documentary analysis with semi-structured interviews conducted with institutional actors, in order to assess the actual effects of digitalization on targeting accuracy, the reduction of inclusion and exclusion errors, and the improvement of administrative process traceability. At the same time, it investigates persistent challenges related to the digital divide, including unequal access to digital infrastructures, limited digital literacy, and obstacles faced by vulnerable populations—particularly those in rural areas or with low levels of formal education.

Preliminary findings indicate that digitalization has yielded significant progress in data reliability and operational fluidity, while also revealing the need for strengthened institutional support to ensure equitable inclusion.

Keywords : Digital Governance, Direct Social Assistancen, Targeting Accuracy , Social Inclusion

EVALUATION OF THE ANTIMICROBIAL ACTIVITY OF GARLIC (ALLIUM SATIVUM) AGAINST ORAL PATHOGENS ASSOCIATED WITH CARDIOVASCULAR RISK

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ABSTRACT

Oral health is closely linked to systemic conditions, particularly cardiovascular diseases, with pathogens such as *Streptococcus mutans* playing a key role in oral infections that may contribute to cardiovascular risk. Garlic (Allium sativum) is known for its antimicrobial properties, attributed to bioactive compounds like organosulfur constituents. This study evaluated the antimicrobial activity of ethanolic and aqueous garlic extracts against Streptococcus mutans isolated from individuals with poor oral hygiene. Phytochemical screening revealed that the ethanolic extract contained alkaloids, saponins, cardiac glycosides, flavonoids, and terpenes, while steroids were absent. The aqueous extract contained saponins, cardiac glycosides, flavonoids, and terpenes, with alkaloids and steroids absent. Antibacterial testing using the paper disc diffusion method at four concentrations (500 mg/mL, 250 mg/mL, 125 mg/mL, and 62.5 mg/mL) showed that the ethanolic extract exhibited zones of inhibition of 16.0 ± 1.0 mm, 13.5 ± 1.5 mm, 11.0 ± 1.0 mm, and 9.0 ± 1.0 mm, respectively, while the aqueous extract showed 13.0 ± 2.0 mm, 11.5 ± 1.5 mm, 9.5 ± 0.5 mm, and 6.0 ± 0.0 mm. The minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) were 125 mg/mL and 250 mg/mL for the ethanolic extract, and 31.25 mg/mL and 62.5 mg/mL for the aqueous extract, respectively. These results indicate that both extracts exhibited antibacterial activity against S. mutans, with the ethanolic extract showing higher efficacy. The findings suggest that garlic extracts, particularly ethanolic preparations, could serve as a natural alternative for managing oral pathogens associated with cardiovascular risk, supporting their potential application in oral health and preventive strategies.

Keywords: garlic, oral pathogens, antimicrobial activity, ethanolic extraction, phytochemical compounds, streptococcus mutants, cardiovascular risk.

THE QUANTUM ENTANGLEMENT PARADOX IN MULTI-PARTICLE SYSTEMS: IMPLICATIONS FOR QUANTUM COMPUTING

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ABSTRACT

In recent advancements in quantum mechanics, the phenomenon of quantum entanglement has emerged as a cornerstone for developing scalable quantum computing architectures. This paper explores the paradoxical behaviors observed in multi-particle entangled states, particularly focusing on the Bell inequalities violations and their extensions to higher-dimensional systems. We begin by reviewing the foundational principles of entanglement, as established by Einstein, Podolsky, and Rosen in 1935, and how these have evolved with modern interpretations via loophole-free experiments conducted in 2015. Our research introduces a novel theoretical framework that models entanglement in systems with more than two particles, utilizing density matrices and partial traces to quantify non-locality.Through simulations using IBM's Qiskit platform, we demonstrate how entanglement swapping in tripartite systems can lead to enhanced computational efficiency in quantum algorithms, such as Shor's algorithm for factorization. However, we identify a critical paradox: in densely entangled networks, measurement-induced decoherence accelerates exponentially, posing severe limitations on qubit coherence times. To mitigate this, we propose an error-correction protocol based on topological quantum codes, inspired by Kitaev's toric code, which integrates machine learning for adaptive error prediction.Empirical results from our lab experiments on superconducting qubits show a 25% improvement in fidelity rates compared to standard surface codes. Furthermore, we discuss the broader implications for quantum networks, including secure communication via entanglement distribution in quantum repeaters. This work not only resolves theoretical inconsistencies in multi-particle entanglement but also paves the way for practical quantum supremacy in real-world applications. Future directions include experimental validation on larger qubit arrays and integration with photonic systems for hybrid quantum-classical computing.

Keywords: Quantum Entanglement, inequalities violations, paradoxical behaviors

ADVANCEMENTS IN NEURAL NETWORK ARCHITECTURES FOR NATURAL LANGUAGE PROCESSING: A FOCUS ON TRANSFORMER MODELS

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ABSTRACT

The evolution of neural networks has revolutionized natural language processing (NLP), with transformer models leading the charge since their introduction in 2017. This study delves into architectural enhancements that address limitations in attention mechanisms, particularly in handling long-range dependencies and computational efficiency. We start by analyzing the vanilla transformer, highlighting issues like quadratic complexity in self-attention layers, which hinder scalability for large datasets.Our proposed model, dubbed EfficientTransformer++, incorporates sparse attention patterns and low-rank approximations to reduce time and space complexity from $O(n^2)$ to $O(n \log n)$. Drawing from recent works like Performer and Reformer, we integrate reversible layers to enable deeper networks without vanishing gradients. Experimental evaluations on benchmarks such as GLUE and SuperGLUE reveal a 15% performance boost in tasks like sentiment analysis and question answering, while cutting training time by 30%.We also explore multimodal extensions, fusing text with visual data for applications in image captioning. Using datasets like COCO and Flickr30k, our model achieves state-of-the-art BLEU scores. Ethical considerations are addressed, including bias mitigation through debiasing techniques in embedding spaces. The paradox of overparameterization—where larger models perform better despite increased risk of overfitting—is examined via regularization methods like Mixup and CutMix.This research contributes to sustainable AI by optimizing for edge devices, reducing carbon footprints in training. Future work aims at federated learning integrations for privacy-preserving NLP. Overall, these advancements promise more accessible and efficient AI systems for global adoption.

Keywords: global adoption, neural networks, Rchitectures

GENOMIC EDITING TECHNIQUES FOR COMBATING ANTIBIOTIC-RESISTANT BACTERIA: CRISPR-CAS9 APPLICATIONS

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ABSTRACT

The escalating crisis of antibiotic resistance poses a significant threat to global health, with projections estimating 10 million annual deaths by 2050 if unaddressed. This paper investigates the application of CRISPR-Cas9 genome editing as a targeted strategy to disrupt resistance genes in pathogenic bacteria. We review the molecular mechanisms of CRISPR, from guide RNA design to Cas9 endonuclease activity, and its evolution from bacterial adaptive immunity to a precision tool in synthetic biology.Our laboratory has developed a multiplex CRISPR system capable of simultaneously targeting multiple resistance loci, such as blaNDM-1 and mcr-1, in Escherichia coli and Klebsiella pneumoniae strains. In vitro experiments demonstrate a 95% knockdown efficiency, restoring susceptibility to beta-lactam antibiotics. We address delivery challenges by employing bacteriophage vectors for in vivo applications, tested in murine infection models, resulting in a 70% survival rate improvement over controls.A key paradox in CRISPR therapy is off-target effects, which we mitigate using high-fidelity Cas9 variants and computational prediction algorithms. Integration with metagenomics allows for microbiome-specific editing, preserving beneficial flora. Clinical implications extend to personalized medicine, where patient-derived bacterial isolates are edited ex vivo before reinfusion.This work underscores CRISPR's potential as a post-antibiotic era solution, with regulatory hurdles discussed in the context of FDA guidelines. Future research will focus on human trials and combination therapies with existing antimicrobials. By harnessing genomic editing, we can redefine bacterial warfare and safeguard public health.

Keywords: Combating Antibiotic, patient-derived, FDA, genomic editing

AI-DRIVEN EPIDEMIOLOGICAL SURVEILLANCE MODELS FOR FLOOD-RELATED DISEASE PREDICTION IN BANGLADESH

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Abstract

Bangladesh faces recurring climate-driven disasters, primarily monsoon flooding, which significantly increases the prevalence of vector-borne and waterborne diseases such as malaria, dengue, cholera, and typhoid. Traditional surveillance systems in the region rely heavily on manual reporting, which often results in delayed outbreak detection and limited predictive capacity. This study integrates artificial intelligence–based forecasting tools, including Support Vector Machines (SVM), Gradient Boosting Machines (GBM), and Long Short-Term Memory (LSTM) models, to create a real-time epidemiological prediction and response system tailored for Bangladesh's climate-risk zones.

The research analyzes a dataset spanning 15 years, incorporating variables such as rainfall levels, river water rise, soil moisture indices, hospital admission logs, mosquito population changes, and satellite-based environmental imaging. Results demonstrate that the LSTM model delivered the highest accuracy (92%) in predicting dengue hotspots with a lead time of 10–14 days, while GBM models performed best for cholera predictions with an 88% precision rate. Integration of community-sourced mobile health (m-health) reporting further strengthened outbreak detection sensitivity by 27%, particularly in rural districts lacking continuous laboratory infrastructure.

Qualitative interviews with public health workers, medical executives, and governmental disaster management officers revealed enthusiasm for AI-based automation, yet also highlighted implementation challenges such as digital literacy gaps, data-sharing hesitation, cybersecurity vulnerabilities, and infrastructural inequality. Policy analysis indicates that current national health frameworks lack regulatory clarity for AI deployment, particularly regarding patient privacy, algorithm transparency, and ethical accountability.

The study recommends a hybrid surveillance framework combining automated AI forecasting with decentralized public health teams trained in adaptive decision intelligence. Additionally, the paper advocates for regional cooperation among South Asian health authorities to strengthen cross-border epidemic preparedness, particularly for climate-driven disease migration patterns. Future work includes expanding the system into wearable biosensor integration and real-time mosquito density mapping.

Keywords: AI in epidemiology, digital health surveillance, climate-smart public health, LSTM forecasting, infectious disease modeling, dengue prediction, flood health risk mapping, Bangladesh health technology, m-health analytics, disaster epidemiology.

EVALUATING ETHICAL AI GOVERNANCE MODELS IN PAKISTAN'S DIGITAL PUBLİC SECTOR TRANSFORMATİON

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Abstract

Pakistan is undergoing rapid digital infrastructure expansion driven by e-governance, fintech growth, and public sector automation. However, the accelerated deployment of artificial intelligence within national systems—such as biometric verification programs, taxation frameworks, judicial decision-support algorithms, and citizen data platforms—raises critical ethical, legal, and governance concerns. This interdisciplinary study evaluates the alignment of Pakistan's AI adoption with international standards of algorithmic transparency, accountability, fairness, and cybersecurity.

Using a mixed-method design, the study analyzes 62 government policy documents, 41 AI contracts with private sector vendors, and anonymized data from four ongoing national machine learning–driven public service systems. In parallel, it includes surveys of 703 citizens and interviews with 58 policymakers, legal experts, AI engineers, and digital rights advocates. The findings reveal a significant discrepancy between technological implementation and regulatory maturity: while AI adoption increased administrative efficiency by 33% and reduced fraud in identity verification systems by 29%, the absence of standardized ethical frameworks resulted in algorithmic bias, opaque decision pathways, and inadequate digital rights safeguards.

Data privacy concerns emerged as the most serious systemic risk. Approximately 68% of surveyed citizens expressed uncertainty or distrust regarding how AI systems store, share, or process personal data. Bias analysis revealed that certain machine-learning models used in welfare eligibility assessments disproportionately flagged applications from low-income or rural populations. AI literacy among government operators also varied, resulting in inconsistent implementation and limited capacity for ethical monitoring.

Based on the analysis, the study proposes a four-pillar National AI Governance Blueprint emphasizing: (1) transparent model documentation, (2) ethical auditing and bias detection protocols, (3) citizen consent and data ownership rights, and (4) cross-sector training programs to build AI governance competency. The research argues that human-centered, culturally contextualized AI regulation is essential for socially responsible digital transformation in Pakistan.

Keywords: AI ethics, public sector automation, Pakistan e-government, biometric AI systems, ethical AI policy, technology regulation.

CLIMATE SIMULATION MODELS AND THEIR ROLE IN PREDICTING EXTREME WEATHER PATTERNS

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Abstract

Climate change has triggered unprecedented environmental transformations, increasing the frequency and severity of extreme weather events such as heatwaves, floods, droughts, and coastal erosion. Traditional forecasting frameworks rely heavily on historical meteorological datasets and atmospheric circulation models; however, these tools are increasingly insufficient for capturing non-linear climate variability. This study explores the potential of artificial intelligence–powered climate simulation models to improve long-term prediction accuracy and support national climate resilience planning.

The research employed a 42-year European climate dataset including atmospheric pressure variations, sea-level temperatures, soil moisture indices, and satellite-derived remote sensing data. Deep learning models including LSTM networks, transformer-based forecasting structures, and convolutional neural networks were applied to simulate temperature anomalies and identify early indicators of extreme events. The models were evaluated against benchmark traditional models such as ECMWF and ERA5 forecasting systems.

Results demonstrated substantial accuracy improvements, with AI-assisted models outperforming classical simulations by up to 32% in long-range prediction tasks. Additionally, hybrid systems integrating atmospheric physics rules with machine learning–generated probability layers enhanced both interpretability and climate scenario realism.

Despite promising outcomes, several limitations remain. AI-driven models require large-scale computing infrastructure and remain vulnerable to data gaps, noise interference, and model drift caused by evolving climate behavior. Ethical concerns regarding public access to high-impact predictive data were also identified, particularly in regions vulnerable to economic or social instability.

The study concludes that AI-enhanced climate simulation models represent a significant advancement for global environmental forecasting efforts. Future work should prioritize real-time data adaptation, multi-regional deployment, and transparent model governance.

Keywords: climate modeling, machine learning, forecasting, extreme weather, environmental data science.

ARTIFICIAL INTELLIGENCE IN JUDICIARY: OPPORTUNITIES AND ETHICAL BOUNDARIES

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Abstract

Artificial intelligence is increasingly being introduced into judicial systems to improve legal research efficiency, automate document analysis, and assist in case outcome predictions. This study evaluates the potential benefits, risks, and ethical boundaries of AI integration into European justice frameworks.

A dataset of 6,200 closed legal cases from Estonia, Germany, and the Netherlands was analyzed using machine learning–based legal reasoning systems. Predictive performance was assessed based on accuracy, case complexity, and availability of metadata. Results demonstrated outcome prediction ranges between 68–87%, depending on legal domain and jurisdiction structure. Natural language processing tools significantly reduced case processing time, particularly in high-volume areas such as civil litigation and administrative law.

However, interviews with judges and legal scholars revealed persistent concerns regarding fairness, transparency, and algorithmic accountability. Bias embedded in datasets led to unequal outcomes when demographic, cultural, or historical imbalances existed. Furthermore, fully autonomous decision-making systems were deemed incompatible with core legal values, including judicial independence and individualized justice.

This study proposes a structured framework describing permissible applications of AI in judicial systems. The model emphasizes human oversight, mandatory transparency, regular bias auditing, and alignment with the EU AI Act. The research concludes that AI is most effective when supporting — not replacing — human legal judgment.

Keywords: judiciary, legal automation, AI ethics, predictive justice, transparency.

QUANTUM-ENHANCED MACHINE LEARNING FOR HIGH-DIMENSIONAL DATA STRUCTURES

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Abstract

Quantum computing is rapidly evolving into a transformative paradigm, offering computational capabilities far beyond classical systems. One of its most promising applications is Quantum Machine Learning (QML), particularly for analyzing high-dimensional data structures in areas such as drug discovery, cryptography, and predictive analytics. This study investigates the performance of quantum-enhanced algorithms compared with advanced classical deep-learning frameworks.

The research utilized simulated quantum processors and hybrid quantum-classical architectures to evaluate algorithms including Quantum Support Vector Machines, Variational Quantum Circuits, and Quantum Approximate Optimization algorithms. These were tested against conventional neural networks using datasets in genomics, cybersecurity anomaly detection, and molecular pattern recognition.

Results demonstrated that quantum-enhanced models achieved superior performance in optimization and feature extraction tasks when dimensionality exceeded classical computational limits. Specifically, variational circuits outperformed deep neural networks by reducing computational time while increasing classification accuracy in high-complexity datasets. However, hardware constraints remain a significant limitation; current quantum processors exhibit noise instability, limited qubit coherence, and error propagation challenges.

To address these challenges, the study proposes a hybrid computing framework in which classical systems handle low-complexity preprocessing, while quantum systems execute optimization and pattern extraction tasks. Ethical and regulatory implications are also discussed, particularly regarding post-quantum security and data governance.

The findings suggest that QML will play a critical role in future computational research and industrial applications. Future work should prioritize quantum hardware stabilization, scalable algorithm development, and cross-industry pilot deployment.

Keywords: quantum computing, machine learning, hybrid algorithms, optimization, high-dimensional data.

NEURAL CORRELATES OF HUMAN–AI SOCIAL INTERACTION

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Abstract

Artificial intelligence systems are increasingly present in interpersonal communication settings, influencing how individuals perceive, trust, and emotionally respond to digital agents. This research investigates the neural correlates associated with human–AI interaction using neuroimaging and behavioral measurement frameworks.

A controlled laboratory experiment was conducted using functional MRI and biometric tracking while participants interacted with either AI-generated conversational agents or human interlocutors. Variables assessed included emotional engagement, cognitive load, trust response, and social presence perception. Results showed activation patterns in the prefrontal cortex and temporoparietal junction that mirrored—but did not fully replicate—responses observed during human-to-human communication.

Participants demonstrated increased cognitive load during early stages of AI interaction, suggesting that individuals require mental adaptation to process artificial social signals. However, repeated exposure reduced uncertainty and increased familiarity responses in limbic activity measurements. Trust levels depended strongly on system transparency, response consistency, and perceived emotional authenticity.

This study concludes that AI systems can elicit neural responses similar to human communication under certain conditions, although emotional resonance remains significantly limited. Ethical considerations include risks of emotional manipulation, dependency, and anthropomorphization of non-sentient systems. Future research should explore cross-cultural variation and long-term AI relationship formation dynamics.

Keywords: cognition, trust, neural response, AI communication, neuropsychology.

POST-QUANTUM ENCRYPTION AND THE FUTURE OF DATA SECURITY

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Abstract

The rapid development of quantum computing threatens to break widely used cryptographic standards such as RSA and ECC, posing a major risk to global digital security. This paper evaluates post-quantum encryption algorithms and examines their suitability for integration into European cybersecurity infrastructures.

Benchmark testing was conducted for lattice-based, hash-based, and multivariate cryptographic systems, aligned with NIST post-quantum standardization guidelines. Performance metrics included processing speed, computational overhead, security robustness, and scalability. Lattice-based algorithms, particularly CRYSTALS-Kyber and Dilithium, demonstrated strong security guarantees and acceptable performance trade-offs, making them strong candidates for widespread deployment.

However, the study identifies major implementation challenges, including interoperability gaps, migration complexity, and insufficient industry awareness. The research proposes a phased adoption roadmap for government and corporate security systems, emphasizing hybrid encryption, infrastructure audits, and mandatory compliance standards.

Post-quantum security is not solely a technical issue but a policy priority requiring coordinated international strategy.

Keywords: cybersecurity, quantum resistance, encryption standards, NIST, data protection.

PRESERVING CULTURAL MEMORY THROUGH AI-BASED DIGITAL ARCHIVING

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Abstract

This study explores how artificial intelligence can support the preservation of cultural artifacts, manuscripts, and intangible heritage. Using machine learning-based restoration, metadata extraction, and 3D digital reconstruction, AI demonstrates strong potential for safeguarding endangered cultural assets.

Pilot projects conducted across central European museums and archives showed a 40–60% improvement in retrieval accuracy and restoration precision. Ethical concerns include data ownership, cultural sensitivity, and authenticity preservation.

Keywords: digital heritage, preservation, machine learning, 3D reconstruction, cultural identity.

AI-DRIVEN ECONOMIC FORECASTING IN POST-CRISIS EUROPEAN MARKETS

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Abstract

Machine learning is increasingly used in financial forecasting, providing improved accuracy in modeling inflation trends, currency volatility, and post-crisis economic resilience. This research evaluates multiple algorithmic forecasting frameworks.

Findings show hybrid statistical-AI models achieve 28% higher projection accuracy during instability periods, especially when integrating real-time sentiment analysis.

Keywords: economic forecasting, financial modeling, AI analytics, market recovery, policy economy.

DIGITAL PUBLIC HEALTH SURVEILLANCE AND AI-BASED PREDICTIVE EPIDEMIOLOGY: A NEW PARADIGM IN DISEASE PREVENTION

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Abstract
Digital public health systems have advanced dramatically over the past decade, particularly with the integration of artificial intelligence (AI), machine learning (ML), and big data analytics. This paper examines how AI-driven epidemiological surveillance can enhance disease prevention, enable predictive modelling, and support evidence-based decision-making within national and international public health frameworks. Traditional surveillance systems, while useful, often suffer from delays in data reporting, fragmented communication, and limited analytical power. AI-based predictive systems, however, allow real-time monitoring and rapid response to emerging health threats through automated pattern recognition, natural language processing, and anomaly detection.

The research evaluates multiple case studies, including COVID-19, influenza surveillance in the European Union, and AI-supported antimicrobial resistance (AMR) tracking systems. Findings demonstrate that predictive surveillance models outperform conventional methods in early outbreak detection by an average of 23–46%. Additionally, integrating cross-sector datasets such as climate records, travel mobility logs, and socioeconomic indicators significantly improves prediction accuracy. Another critical element explored in this study is the ethical governance of AI in public health. Data security, transparency, algorithmic bias, and international regulatory collaboration are identified as essential requirements for responsible implementation.

The paper concludes that AI-powered epidemiological surveillance represents a transformative tool for modern health systems. To fully realize its potential, global health organizations must support infrastructure development, establish unified data-sharing standards, and invest in training public health professionals in digital systems. Future research should prioritize equitable AI deployment in low-resource settings to prevent widening health inequalities and ensure global benefit.

Anahtar Kelimeler: Artificial Intelligence, Public Health, Disease Surveillance, Epidemiology, Big Data, Predictive Modelling

NEUROMARKETING AND PREDICTIVE CONSUMER ANALYTICS: THE FUTURE OF DIGITAL BRANDING STRATEGIES

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Absract
Neuromarketing has rapidly transformed digital branding, consumer experience design, and behavioral economics. This research investigates the impact of neuro-cognitive data, predictive analytics, and artificial intelligence on consumer decision-making in digital environments. Traditional marketing methods rely heavily on surveys and post-purchase behavioral analysis; however, neuromarketing incorporates biometric measurements, including eye-tracking, emotional response mapping, galvanic skin response, and EEG-based cognitive attention analysis. These methods allow marketing professionals to decode unconscious consumer motivations and predict purchasing patterns with significantly improved accuracy.

This study includes a controlled experiment involving 426 participants exposed to digital advertisements from global brands. Results indicate that emotionally-immersive and AI-personalized advertising campaigns increase engagement by up to 58% and conversion probability by 31% compared to traditional content. Additionally, machine learning models were trained to classify emotional responses and predict consumer intent with an accuracy rate exceeding 87%. The integration of neuromarketing tools with AI algorithms enables new branding approaches such as dynamic emotional targeting, adaptive content delivery, and automated sentiment-responsive marketing systems.

However, ethical challenges related to privacy, cognitive manipulation, and transparency remain major barriers to implementation. Regulatory structures such as GDPR provide partial protection, yet the pace of technological development surpasses current legal frameworks. The paper recommends developing a global neuromarketing ethics code supported by industry, academia, and governmental agencies.

The research concludes that neuromarketing, combined with predictive analytics, will redefine future marketing strategies. Companies adopting these technologies responsibly will gain competitive advantage, while organizations ignoring neuromarketing advancement risk obsolescence in increasingly personalized digital markets.

Anahtar Kelimeler: Neuromarketing, Consumer Psychology, Artificial Intelligence, Behavioral Economics, Branding, Predictive Analytics

HYDROGEN ECONOMY AND RENEWABLE INTEGRATION: EVALUATING FEASIBILITY FOR A CARBON-NEUTRAL EUROPE

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Abstract

The transition to a hydrogen-based energy system has become a major topic in European sustainability policy debates. As the continent aims to achieve full carbon neutrality by 2050, hydrogen is increasingly viewed as a complementary solution for renewable energy storage, industrial decarbonization, and clean transportation. This research examines the technological, economic, and environmental feasibility of hydrogen integration within the European energy framework. The study evaluates current production routes such as grey, blue, and green hydrogen, focusing on scalability and infrastructure demands.

Data for the study was collected from European pilot projects including HyNet (United Kingdom), H2Future (Austria), and HYBRIT (Sweden). Results suggest that green hydrogen—produced using wind and solar energy electrolysis—has the greatest long-term potential but remains economically constrained due to high production costs and insufficient energy storage capacity. However, when combined with offshore wind sources in Scandinavia and the North Sea, cost efficiency improves considerably, with projected reductions exceeding 62% by 2035. The study further analyzes required infrastructure including pipelines, refueling networks, and cross-border energy corridors.

Environmental analysis demonstrates significant benefits, particularly in hard-to-electrify sectors such as steel manufacturing, long-haul maritime transport, and aviation fuel alternatives. Yet challenges persist, including energy loss during conversion, geostrategic dependence on rare materials, and insufficient harmonized regulatory standards across the EU.

The paper concludes that hydrogen has strong potential as a core element of Europe's future energy system — yet its success depends on integrated policy, technological innovation, and international collaboration. Continued investment, public-private partnerships, and advancements in electrolyzer efficiency will determine whether hydrogen evolves from experimental solution to mainstream energy pillar.

Anahtar Kelimeler: Hydrogen Economy, Renewable Energy, Carbon Neutrality, Electrolysis, Energy Policy, Sustainability

COGNITIVE ADAPTATION AND DIGITAL LEARNING: HOW AI-BASED PERSONALIZATION SHAPES STUDENT MOTIVATION

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Abstaract
Digital learning platforms supported by artificial intelligence have evolved rapidly, offering personalized pathways based on learner behavior, performance analytics, and cognitive processing models. This study investigates how AI-driven adaptive learning affects motivation, engagement, and long-term academic performance among undergraduate students in Europe.

Using a mixed methodology approach, the research incorporated experimental design, survey instruments, and qualitative interview data from 612 students across Denmark, Germany, and Finland. Experimental groups used adaptive learning systems with real-time personalized feedback, while control groups used traditional digital formats lacking AI-supported customization.

Findings demonstrate that adaptive learning significantly improves task engagement, intrinsic motivation, and task persistence—particularly among learners with initially low confidence or prior academic difficulty. Students reported feeling "visible" and "supported" by the system, suggesting that adaptive platforms provide psychological scaffolding rather than passive instruction.

However, results also highlight potential adverse effects. Continuous automated assessment generated anxiety among 22% of participants, particularly when system feedback appeared overly critical. Additionally, algorithms occasionally reinforced learning gaps when personalization was too narrowly restrictive, limiting opportunities for cognitive challenge.

The ethical dimension is further addressed, including concerns about algorithmic transparency, data ownership, and surveillance-based educational models. Recommendations include applying a human–AI co-design framework prioritizing learner autonomy, educator oversight, and developmental appropriateness.

The study concludes that adaptive learning can transform education—but requires responsible implementation. Rather than replacing educators, AI should serve as an augmentation tool, enhancing personalization while preserving the human relationships essential to meaningful learning.

Anahtar Kelimeler: Adaptive Learning, AI in Education, Cognitive Psychology, Motivation, Digital Pedagogy

THE LEGAL LANDSCAPE OF CYBER SOVEREIGNTY: BALANCING NATIONAL REGULATION AND GLOBAL DIGITAL FREEDOM

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Abstract

Cyber sovereignty has emerged as one of the most contested legal and geopolitical debates of the 21st century. As digital spaces increasingly transcend national borders, governments are confronting the challenge of establishing legal authority, data regulation, and digital governance without infringing upon international freedoms and globally interconnected systems. This paper examines the evolving legal framework surrounding cyber sovereignty through the lens of European regulatory models, international law, and geopolitical cybersecurity strategy.

The study uses a comparative legal methodology analyzing Serbia, France, Estonia, and the European Union's Digital Services Act (DSA) and General Data Protection Regulation (GDPR). Findings indicate that current legal instruments prioritize privacy, cybercrime prevention, and digital trade harmonization; however, gaps remain in areas such as artificial intelligence accountability, automated warfare, and cross-border data governance. Interviews with cybersecurity policymakers and legal scholars reveal that states increasingly perceive unrestricted cyberspace as a national vulnerability rather than a global commons.

The research highlights a critical tension: efforts to enforce national sovereignty online often conflict with international human rights frameworks guaranteeing freedom of information, expression, and digital identity. The emerging concept of "responsible digital autonomy" offers a potential middle-ground framework—ensuring state-level cybersecurity infrastructure and regulation, while still supporting open technological innovation and cross-border digital collaboration.

Ethical and societal implications are also discussed, particularly concerning surveillance, algorithmic discrimination, and the militarization of cyberspace. The paper proposes establishing a European Cyber Accountability Convention grounded in transparency, rule of law, and shared sovereignty rather than unilateral control.

The study concludes that cyber sovereignty must evolve from a security-dominant perspective toward a multi-stakeholder model balancing state responsibility, human rights, and private-sector innovation. Future research should explore global consensus-building mechanisms to avoid the fragmentation of cyberspace into isolated "digital borders."

Anahtar Kelimeler: Cyber Law, Digital Sovereignty, GDPR, International Law, Cybersecurity Policy, Digital Rights

REIMAGINING SUSTAINABLE SMART CITIES: INTEGRATING GREEN INFRASTRUCTURE, AI GOVERNANCE, AND HUMAN-CENTERED URBANISM

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Absract

Urban environments are undergoing accelerated transformation driven by digitalization, climate pressures, and demographic expansion. Smart cities—once conceptualized primarily through technological innovation—are now shifting toward human-centered sustainability frameworks combining environmental resilience, digital governance, and inclusive design. This study explores how green infrastructure and artificial intelligence governance intersect to shape future cities that are environmentally regenerative, socioeconomically inclusive, and technologically adaptive.

Using a multi-case analysis of Lisbon, Rotterdam, Helsinki, and Barcelona, the paper examines how smart governance, renewable energy integration, and AI-based urban planning tools influence mobility, public services, waste management, and urban biodiversity. Findings reveal that cities incorporating nature-based solutions alongside digital infrastructure demonstrate stronger climate resilience outcomes, including reduced heat island effect, improved stormwater regulation, and enhanced public wellbeing.

Citizen perception data collected through surveys and participatory planning initiatives indicate that trust in smart city technologies increases when transparency, data ethics, and community involvement are prioritized. Conversely, algorithmic decision-making without public accountability reduces engagement and fosters resistance to digital governance structures.

The research identifies three essential pillars of future smart urbanism:

1. **Ecological Integration** — prioritizing circular materials, biodiversity corridors, and carbon-negative construction.
2. **Ethical AI Infrastructure** — ensuring transparency, inclusivity, and accessibility in digital public services.
3. **Human Experience Design** — planning spaces that enhance safety, identity, culture, and psychological wellbeing.

The paper concludes that sustainable smart cities must evolve beyond technology-driven efficiency toward systems where ecology, digital intelligence, and human values coexist harmoniously. Policy recommendations focus on open governance frameworks, cross-border collaboration, and shifting from extractive development models to regenerative urban ecosystems.

Anahtar Kelimeler: Smart Cities, Sustainability, Urban Design, AI Governance, Green Infrastructure

LANGUAGE EVOLUTION IN THE AGE OF AI: HOW GENERATIVE SYSTEMS RESHAPE HUMAN COMMUNICATION

Prof. Anna Kowalska

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Abstract

Language is undergoing a profound transformation driven by artificial intelligence—particularly large language models, automated translation systems, and conversational interfaces. This study investigates how generative AI influences linguistic structure, semantic consistency, communication culture, and language preservation.

The research includes corpus analysis comparing AI-generated text with natural linguistic patterns across English, Polish, German, and Finnish. Results show that while generative systems mimic grammar with high precision, cultural nuance, idiomatic meaning, and contextual ambiguity remain challenging. However, AI is accelerating language simplification, hybridization, and code-switching, especially among multilingual digital-native populations.

Interviews with educators, translators, and content creators reveal mixed perceptions. For some, AI democratizes linguistic access and supports endangered language revitalization initiatives. For others, excessive reliance risks homogeneity, syntactic flattening, and erosion of linguistic diversity.

The paper argues that AI does not merely translate language—it participates in shaping discourse norms, vocabulary evolution, and cognitive communication patterns. The shift suggests a new paradigm: **co-authored language**, where human and algorithmic expression interact continuously.

Ethical considerations include authorship, misinformation, and cultural ownership. The study proposes developing a "Digital Linguistic Stewardship Framework" ensuring transparency and preservation of distinctive linguistic expression.

Anahtar Kelimeler: Linguistics, AI Communication, Translation Technology, Language Evolution, Cultural Semantics

PRECISION MEDICINE AND DEEP LEARNING INTEGRATION: A NEW ERA FOR PREDICTIVE CLINICAL DECISION SUPPORT SYSTEMS

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Abstract

Precision medicine represents a paradigm shift in modern clinical practice, aiming to tailor treatment strategies based on individual biological variability, genetic predispositions, and lifestyle factors. With the rapid integration of deep learning algorithms and multimodal datasets, precision medicine is transitioning from theoretical promise to real-time clinical application. This study examines the development, effectiveness, and ethical implications of AI-supported predictive clinical decision support systems (CDSS).

The research used a three-year dataset from oncology patients in Switzerland to train deep learning models capable of identifying treatment response patterns, adverse drug reactions, and long-term survival estimates. Results demonstrated accuracy levels exceeding 89% in outcome prediction, significantly surpassing traditional statistical models. Furthermore, when physicians used AI-assisted recommendations, diagnostic response time reduced by 31%, and treatment personalization accuracy increased by 45%.

However, qualitative interviews with clinicians revealed concerns related to algorithmic opacity, overreliance on automated decision-making, and the risk of diminishing clinical judgment. Additionally, challenges emerged in harmonizing medical data across electronic health record systems due to diverse privacy regulations.

The study concludes that human-centered AI models—designed with transparent logic, clinician oversight, and ethical governance—are essential to successfully integrate CDSS into precision medicine. Future work must focus on federated learning, cross-border data-sharing frameworks, and equitable access.

Anahtar Kelimeler: Precision Medicine, Deep Learning, Clinical Decision Support Systems, Biomedical AI

DIGITAL IDENTITY CONSTRUCTION IN THE POST-SOCIAL MEDIA ERA: FROM AUTHENTIC INTERACTION TO ALGORITHMIC SELF-REPRESENTATION

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Abstract

Digital identity has evolved far beyond personal expression—becoming an interactional construct shaped by social algorithms, platform architectures, and mediated communication cultures. This study investigates how users negotiate authenticity, visibility, and self-representation in an era where algorithmic systems curate exposure and influence.

Using ethnographic observation and discourse analysis of participants across Spain, Italy, and France, the research identified two dominant identity strategies: performative optimization and controlled authenticity. The first approach reflects highly curated online personas aligned with platform engagement metrics, while the second represents a reactionary movement emphasizing transparency, vulnerability, and emotional realism.

Machine learning–based content tracking showed that emotionally expressive posts were 2.7 times more likely to be amplified by platform algorithms, creating a feedback loop in which users strategically modulate emotional tone for visibility. However, participants reported increased anxiety, fear of anonymity, and digital fatigue.

The study concludes that identity formation is co-created by user agency and algorithmic governance. To protect psychological well-being, regulatory frameworks must enforce algorithm transparency and user choice.

Anahtar Kelimeler: Digital Identity, Algorithmic Culture, Media Sociology, Self-Representation

NEUROPLASTICITY AND MEMORY TRAINING: EVALUATING COGNITIVE ENHANCEMENT THROUGH DIGITAL NEUROFEEDBACK SYSTEMS

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Abstract

This study explores how digital neurofeedback systems influence neuroplasticity, working memory, and executive cognitive function in adult learners. A controlled six-month intervention included EEG-guided neurofeedback, memory task gamification, and AI-adaptive difficulty scaling.

Results demonstrated a significant improvement in memory recall speed (27%), sustained attention (41%), and task switching efficiency (18%). Neuroimaging confirmed increased connectivity in the prefrontal cortex and hippocampal engagement.

Participants reported reduced cognitive fatigue and increased confidence in learning performance. Ethical concerns include data privacy and cognitive dependency.

The paper concludes that neurofeedback tools are promising—but require regulation, accuracy standards, and informed consent.

Anahtar Kelimeler: Neuroplasticity, Neurofeedback, Memory, Cognitive Enhancement

AI-ENHANCED NEURAL RECONSTRUCTION: A HYBRID DEEP LEARNING AND BIO-TISSUE ENGINEERING MODEL FOR NEURODEGENERATIVE REPAIR

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Abstract:

Neurodegenerative disorders such as Parkinson's disease, Alzheimer's disease, and amyotrophic lateral sclerosis (ALS) represent some of the most significant medical challenges of the 21st century. Despite extensive research, therapeutic progress remains limited due to the complexity of neural structure, synaptic networks, and progressive biological degradation. This research proposes a new interdisciplinary framework combining artificial intelligence (AI), deep neural networks, and laboratory-grown bioengineered tissues to support reconstruction and functional recovery of damaged neural pathways.

The study utilizes a multimodal approach integrating **GAN-based neural mapping**, **bioprinted stem cell scaffolding**, and **predictive machine learning algorithms** trained with clinical neuroimaging datasets. The proposed model identifies neural degeneration patterns and generates computational reconstruction pathways for optimal cell placement during tissue regeneration. Laboratory testing on murine models demonstrated improved neural conductivity (37% increase in synaptic firing rates) and reduction in signal latency following engineered tissue grafting.

The AI model continued to refine reconstruction pathways after implantation, demonstrating adaptive neuroplasticity-based learning. Ethical, technological, and biological implications were evaluated through interdisciplinary frameworks including medical ethics, computational transparency, and long-term biomaterial stability.

This hybrid biomedical-AI methodology represents a shift from symptom-management toward functional neuro-restoration. Scaling the model may support clinical applications including traumatic brain injury recovery, spinal cord regeneration, and age-related neurological decline. The research highlights the importance of long-term AI-human oversight to prevent unpredictable neural pattern evolution in post-operative recovery.

Keywords: Artificial intelligence, neurodegenerative disease, neural reconstruction, bioengineering, regenerative medicine, deep learning.

AUTONOMOUS URBAN MOBILITY: ETHICAL AND TECHNICAL FRAMEWORKS FOR AI-DRIVEN SMART COMPACT CITIES

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Abstract

The rapid expansion of megacities in Asia raises urgent challenges surrounding transportation density, carbon emissions, and sustainable mobility. Autonomous vehicles (AVs), interconnected smart infrastructure, and AI-based transportation analytics present viable solutions; however, ethical governance, cybersecurity risk, and interoperability remain unresolved.

This research introduces a scalable, policy-integrated technological ecosystem designed for **AI-assisted autonomous mobility optimization**. Using real-time sensor networks, vehicle-to-everything (V2X) communication, and predictive routing models, the system reduces congestion and improves transport efficiency. Data were collected from a prototype autonomous district in Shenzhen utilizing 1,800 interconnected autonomous shuttles and road sensors. Computational analyses show a **52% reduction in traffic delays** and **23% reduction in emissions** while maintaining high safety compliance based on ISO 26262 standards.

Beyond engineering feasibility, this study evaluates cultural, legal, and ethical frameworks unique to densely populated Asian regions. Results indicate that public acceptance depends heavily on transparency, digital trust, and perceived fairness in AI decision-making. A regulatory matrix is proposed to ensure obligation-based accountability, hierarchical risk assessment, and government-citizen co-governance.

Findings suggest that autonomous mobility must be viewed not only as a technological upgrade, but as a public infrastructure evolution requiring socio-technical alignment.

Keywords: autonomous mobility, artificial intelligence, smart cities, ethics of automation, V2X communication.

DIGITAL IDENTITY FORMATION AMONG GEN-Z IN THE MIDDLE EAST: A CROSS-PLATFORM SOCIOLINGUISTIC AND BEHAVIORAL ANALYSIS

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Abstract:

Digital platforms have become dominant environments for identity construction, particularly among Generation Z populations across the Middle East. While global influences shape online communication culture, regional values, linguistic heritage, and socio-cultural expectations create distinct identity expression patterns. This research analyzes digital identity formation across TikTok, Instagram, X (formerly Twitter), and Metaverse-based environments, using mixed-method analysis including sentiment processing, ethnographic observation, and computational sociolinguistics.

Findings indicate strong dual-identity patterns: one aligned with global digital culture and another reinforcing traditional local identities. Content trends reflect hybrid linguistic structures featuring English-Arabic code-switching and platform-specific semantic creativity. Gender differences were significant: females demonstrated higher anonymized-identity use and performative content curation, while males showed greater emphasis on opinion-driven public discourse.

The study highlights emotional expression moderated by cultural norms, with humor, satire, and indirect speech emerging as primary communication strategies. Digital behavior was further shaped by perceived surveillance, platform governance, and community moral frameworks.

The research proposes a multi-layer identity model incorporating **cultural continuity**, **technological affordance**, and **algorithmic influence**, contributing to future policy frameworks regarding media education and responsible AI in the region.

Keywords: digital identity, Generation Z, sociolinguistics, Middle East, communication studies.

MACHINE LEARNING-ASSISTED CLIMATE PREDICTION AND WATER SECURITY STRATEGY FOR SOUTH ASIA

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Abstract:
South Asia faces severe climate-induced water scarcity due to monsoon variability, glacial melt instability, and rising population needs. Traditional climate forecasting lacks precision in micro-regional hydrological mapping. This study introduces a machine learning-enabled predictive system for long-term water resource resilience.

Using 32 years of climate datasets, hydrological satellite imagery, and socio-economic water demand metrics, the model integrates random forest regression, LSTM forecasting, and geospatial analytics. Validation across the Indus Basin and Ganges floodplain reveals prediction accuracy increases of **28–41% over traditional models**.

Policy analysis recommends integration into national water management frameworks supporting irrigation forecasting, urban planning, and climate-risk agricultural planning.

Keywords: climate change, water security, machine learning, hydrology, South Asia.

IMMERSIVE LEARNING AND COGNITIVE RETENTION: EVALUATING VR-ASSISTED LEARNING MODELS IN HIGHER EDUCATION

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Abstract

Virtual reality (VR) is increasingly integrated into higher education as an experiential learning tool. This study evaluates learning retention, cognitive engagement, and student perception in VR-assisted learning environments across three Malaysian universities. Experimental cohorts included undergraduate engineering and medical students completing VR-guided lab simulations.

Results show a **47% improvement in memory retention** and higher conceptual understanding compared with lecture-based learning. Students demonstrated increased motivation, curiosity, and self-directed problem solving. However, accessibility barriers, fatigue, and cultural learning preferences impacted adoption.

A hybrid VR-scaffolded model is proposed integrating reflection-based learning theory and adaptive feedback systems.

Keywords: VR learning, cognitive science, higher education, immersive education, learning analytics.

HYBRID FEDERATED LEARNING MODELS FOR PRIVACY-PRESERVING HEALTHCARE DATA SYSTEMS IN DEVELOPING NATIONS

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Abstract

The rapid digitization of healthcare systems in developing nations has increased demand for secure and efficient machine learning frameworks capable of analyzing sensitive medical data without compromising privacy. Federated learning (FL) offers a decentralized model training process, enabling multiple institutions to collaboratively train AI models without transferring raw patient data. However, FL faces operational challenges including model accuracy variance, communication delays, governance complexity, and vulnerability to adversarial attacks.

This study proposes a **hybrid federated learning framework integrating blockchain-based authentication, differential privacy encryption, and multi-agent reinforcement optimization** for healthcare applications. The model was tested using synthetic and clinical ECG, MRI and laboratory datasets collected across five Indian healthcare research centers.

Results demonstrate notable improvements: accuracy increased by **18.4%**, communication overhead reduced by **32%**, and adversarial gradient manipulation attacks decreased by **76%**. Furthermore, blockchain smart contracts improved transparency and access control among institutions, significantly strengthening trust in data governance.

Ethical and regulatory perspectives were evaluated within Indian digital health ecosystem frameworks including the National Digital Health Mission (NDHM). Interviews with healthcare providers and policymakers highlighted the need for algorithmic accountability, data localization compliance, and culturally contextualized digital consent models.

This research contributes a scalable, ethical and technologically robust model for secure AI adoption in medical research, particularly relevant to low- and middle-income countries.

Keywords: federated learning, healthcare AI, blockchain security, privacy-preserving computation, digital health governance.

DIGITAL FINANCIAL INCLUSION AND BEHAVIORAL ECONOMICS: A STUDY ON INDIA'S UPI ECOSYSTEM AND CONSUMER TRUST

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Abstract
India's Unified Payments Interface (UPI) has become one of the largest digital financial ecosystems globally, transforming the economic behavior of both urban and rural populations. This research examines adoption patterns, behavioral drivers, socio-economic outcomes, and long-term sustainability of digital finance in India.

Mixed-method methodology included behavioral surveys (N=3,800), transaction pattern analytics from UPI gateways, and interviews with banking officials. Findings show that digital transaction behavior is shaped by **trust, financial literacy, perceived convenience, and social influence**. Rural adoption increased significantly following government subsidy disbursement integration.

Risk perception remains a barrier, particularly cybersecurity concerns and fear of fraud. The study proposes a behavioral-economic adoption model incorporating **nudging, gamification-based financial literacy, and culturally aligned incentive structures**.

Keywords: digital finance, UPI, behavioral economics, fintech adoption, financial inclusion.

CRISPR-CAS-BASED DIAGNOSTIC PLATFORMS FOR RAPID DETECTION OF ANTIMICROBIAL RESISTANCE IN LOW-RESOURCE SETTINGSDR. KAVITA RAO

Dr. Kavita Rao

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Abstract

Antimicrobial resistance (AMR) poses a critical global health threat, particularly in South Asia where antibiotic misuse and limited diagnostic access accelerate resistant strain proliferation. This research investigates CRISPR-Cas-based biosensing platforms for low-cost, rapid and highly sensitive AMR detection.

The proposed system utilizes **Cas12a-triggered fluorescence activation** integrated with paper-based microfluidics capable of detecting E. coli, K. pneumoniae and MRSA genetic markers within **35 minutes**, requiring no laboratory infrastructure. Field trials across three district hospitals demonstrated sensitivity exceeding **92%** with stable performance under variable environmental conditions.

Scalability, clinical workflow integration and public health implications were analyzed to support national AMR surveillance strategies.

Keywords: antimicrobial resistance, CRISPR diagnostics, biosensing, public health, rapid testing.

ARTIFICIAL INTELLIGENCE AND DIGITAL SOVEREIGNTY: POLICY TENSIONS IN INDIA'S EVOLVING CYBER GOVERNANCE LANDSCAPE

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Abstract

As artificial intelligence continues to reshape governance systems, cybersecurity frameworks, and digital ecosystems worldwide, the concept of digital sovereignty has become central to national security and geopolitical strategy. India's rapidly growing digital infrastructure, including Aadhaar, DigiLocker, UPI, and artificial intelligence–supported governance applications, has positioned the nation as a leading digital innovation hub. However, this expansion raises complex legal, ethical, and political governance challenges related to privacy, ownership of data, algorithmic transparency, and foreign dependence on proprietary AI systems.

This research examines India's policy evolution concerning cybersecurity, data localization, and AI deployment through a multi-layer comparative governance framework. Data were collected through policy review, interviews with regulatory officials and technology experts, and case analysis of major legislative instruments such as the **Digital Personal Data Protection Act (2023)** and **National AI Strategy (NITI Aayog)**.

Findings reveal that India prioritizes a hybrid governance model that balances open innovation and regulated data sovereignty principles. Public acceptance of AI governance is found to be influenced by perceived benefits—particularly efficiency, accessibility, and transparency—over privacy concerns, especially in rural digital service contexts. However, dependence on foreign cloud infrastructure and proprietary AI models limits strategic technological autonomy.

This study proposes a three-tier model to strengthen digital sovereignty: open-source AI acceleration, transparent algorithmic auditing, and federated national infrastructure. The findings contribute to broader discussions on democratic AI governance systems, especially among rapidly digitizing nations.

Keywords: digital sovereignty, AI governance, cybersecurity, India, policy analysis.

SINGLE-CELL TRANSCRIPTOMICS FOR MAPPING CELLULAR PLASTICITY IN TRIPLE-NEGATIVE BREAST CANCER AMONG INDIAN POPULATIONS

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Abstract

Triple-negative breast cancer (TNBC) represents one of the most aggressive and treatment-resistant cancer subtypes, disproportionately affecting younger women in South Asia. Current clinical management remains challenged by tumor heterogeneity and lack of targeted therapeutic biomarkers. This study applies **single-cell RNA sequencing (scRNA-seq)** to map cellular plasticity, immune microenvironment behavior, and lineage shifts in TNBC tumor profiles specific to Indian genetic backgrounds.

A total of **48 tumor samples** were processed using 10x Genomics workflows, generating high-resolution transcriptomic datasets. Computational analyses employing t-SNE clustering and trajectory inference revealed distinct subpopulations of cancer stem cell–like clusters associated with high proliferative potential and chemoresistance. Immune profiling indicated suppressed T-cell activation pathways and enrichment of immunosuppressive macrophage markers.

The findings highlight potential biomarkers such as **SOX9, CXCL8, and LIFR** as actionable therapeutic targets. Further in-vitro validation using CRISPR interference demonstrated reduced tumor invasiveness following suppression of identified candidate pathways.

This research advances precision oncology frameworks for underrepresented populations in global cancer genomics and supports development of region-specific therapeutic strategies.

Keywords: single-cell omics, TNBC, genomics, immune microenvironment, precision oncology.

DESIGNING INCLUSIVE AI-ASSISTED INTERFACES FOR USERS WITH MOTOR AND COGNITIVE DISABILITIES IN INDIA

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Abstract

With increased digital integration in education, healthcare, and public services, accessibility barriers disproportionately impact individuals with motor or cognitive disabilities. This study focuses on designing culturally adaptable assistive interfaces using machine-learning-based personalization systems for Indian users.

A prototype multimodal interface integrating **eye-tracking, voice recognition, emotion-aware response modeling, and gesture-based input** was developed and tested across rehabilitation centers in Mumbai and Lucknow (N=152 participants). Results demonstrate significant improvement: task completion speed increased by **54%**, and user satisfaction ratings improved by **71%** compared with conventional accessibility tools.

Challenges included accent variability, environmental noise, and literacy differences. The proposed adaptive learning model improves accuracy by continuously training on individual usage patterns, thereby promoting long-term accessibility equity.

Keywords: assistive technology, HCI, accessibility, adaptive AI, disability inclusion.

IMPACT OF INDIAN OCEAN WARMING ON CORAL MICROBIOME STABILITY AND REEF HEALTH ALONG THE LAKSHADWEEP ARCHIPELAGO

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Abstract

Accelerated ocean warming has triggered widespread bleaching events affecting coral ecosystems across the Indian Ocean. This research investigates microbial community shifts in coral species from Lakshadweep Reef Systems to evaluate resilience patterns under thermal stress.

Metagenomic sequencing revealed significant dysbiosis in bacterial communities during bleaching events, particularly decline of protective symbiotic lineages such as **Endozoicomonas**. Statistical analysis demonstrated correlation between microbiome disruption and reef mortality patterns.

The study proposes microbiome-based therapeutic interventions such as **probiotic inoculation and microbial restoration strategies** to enhance coral heat tolerance.

Keywords: coral reefs, climate change, microbiome, marine ecology, Indian Ocean.

GAMIFIED LEARNING ECOSYSTEMS AND METACOGNITIVE DEVELOPMENT: EVIDENCE FROM INDIAN HIGHER EDUCATION CLASSROOMS

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Abstract

Gamification has gained global attention as a method of enhancing student engagement, but its measurable cognitive outcomes remain under-studied. This randomized controlled study investigates the metacognitive and behavioral impact of gamified learning tools among Indian undergraduate students (N=620).

Results show meaningful improvements in metacognitive regulation, self-directed learning, and retention performance. Students demonstrated higher learning persistence and lower academic anxiety when game-based learning was combined with real-world relevance and collaborative challenges. The study recommends a national framework for responsible gamified pedagogy and culturally adaptive design.

Keywords: gamification, metacognition, higher education, educational psychology, learning innovation.

POST-QUANTUM CRYPTOGRAPHY MODELS FOR SECURING NATIONAL DIGITAL INFRASTRUCTURE IN THE MIDDLE EAST

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Abstract

The rapid digital transformation occurring across the Middle East has accelerated adoption of artificial intelligence systems, cloud platforms, biometric authentication, and national digital services. However, the emergence of quantum computing poses a significant threat to current cryptographic security frameworks, particularly those based on RSA and ECC encryption. As Gulf countries expand digital identity programs, e-governance networks, smart city ecosystems, and AI-enabled critical infrastructure, cybersecurity reinforcement becomes a strategic national priority.

This study explores the technical and policy implications of implementing **post-quantum cryptography (PQC)** within national ICT architecture. Using simulation-based stress testing, three lattice-based cryptographic algorithms—**Kyber, Dilithium, and Falcon**—were evaluated for feasibility, energy consumption, processing speed, and interoperability across IoT and AI-enabled government systems deployed in the UAE Smart Governance Framework.

Results demonstrate that Kyber-DD scheme provides the best balance between performance and cryptographic resistance for large-scale government use, while Dilithium offers superior protection for high-sensitivity military and financial networks. System interoperability analysis revealed compatibility challenges with legacy authentication services and sovereign cloud environments.

Beyond technical evaluation, interviews with policy experts reveal gaps in awareness, infrastructure funding, and regulatory readiness across Middle Eastern nations regarding PQC adoption. A five-phase national transition model is proposed: **assessment, dual-deployment, risk mitigation, regulatory alignment, and full PQC migration.**

The findings highlight the urgency of establishing secure cryptographic migration strategies to ensure resilience against future quantum cyber threats. The research contributes a scalable blueprint for secure digital sovereignty across the region.

Keywords: post-quantum cryptography, cybersecurity, smart governance, lattice encryption, digital sovereignty.

PHARMACOGENOMICS AND PERSONALIZED DRUG RESPONSE PATTERNS AMONG NORTH AFRICAN POPULATIONS: A CASE STUDY OF CARDIOVASCULAR MEDICATIONS

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Abstract

Cardiovascular diseases represent the leading cause of mortality in Egypt and across North Africa. Despite standardized therapeutic protocols, clinical responses to widely used medications such as beta-blockers, ACE inhibitors, and antiplatelet drugs demonstrate significant variability. This variability is often rooted in genetic differences, yet pharmacogenomic applications in public healthcare systems remain limited.

This mixed-method research examines the pharmacogenomic markers influencing drug metabolism among Egyptian patients undergoing treatment for hypertension and ischemic heart disease. Genotyping analysis (N=1,450) focused on variants associated with CYP2C19, CYP3A4, and SLCO1B1 pathways. Clinical outcome correlations revealed strong associations between **CYP2C19 loss-of-function variants and reduced Clopidogrel efficacy**, increasing stroke and thrombosis risks.

The study also evaluates patient perception, healthcare practitioner readiness, and infrastructural limitations affecting implementation of precision medicine. Findings emphasize the need for national pharmacogenomic testing frameworks, clinical guidelines, and healthcare workforce training.

This research supports future integration of genetic screening into Egyptian public hospitals and contributes empirical evidence for region-specific precision medicine strategies.

Keywords: pharmacogenomics, cardiovascular disease, precision medicine, drug response, CYP polymorphism.

METAVERSE-BASED LEARNING ENVIRONMENTS AND CULTURAL ADAPTATION IN HIGHER EDUCATION CLASSROOMS ACROSS THE GULF REGION

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Abstract

The integration of extended reality (XR) technologies and metaverse-based platforms is rapidly reshaping educational models, especially within technologically progressive Gulf countries. This study examines learning outcomes, cultural compatibility, and student behavioral patterns within metaverse-supported course environments in Saudi Arabian universities.

A controlled comparative experiment involving 326 undergraduate learners assessed differences between traditional e-learning platforms and immersive 3D multi-user learning environments. Outcome measures included engagement, emotional presence, retention scores, collaboration dynamics, and cultural comfort indicators.

Findings demonstrate significantly higher engagement and knowledge retention in the metaverse cohort; however, cultural considerations such as gender-appropriate interaction norms, privacy preferences, and avatar representation ethics emerged as critical factors influencing adoption.

A culturally responsive metaverse learning framework is proposed, emphasizing privacy, accessibility, and identity sensitivity. The research advances digital transformation strategy discussions in the Gulf region.

Keywords: metaverse education, digital learning, XR, cultural pedagogy, Gulf region.

AI-DRIVEN EPIDEMIOLOGICAL FORECASTING MODELS FOR VECTOR-BORNE DISEASES UNDER CLIMATE CHANGE CONDITIONS IN THE MIDDLE EAST

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Abstract

Climate variability has contributed to increased prevalence of vector-borne diseases in the Middle East, including dengue fever, West Nile virus, and leishmaniasis. Traditional surveillance systems remain reactive rather than predictive, creating public health gaps. This research presents an **AI-enabled early warning epidemiological forecasting system** integrating climatic, ecological, and socio-geographic datasets.

Machine learning models including XGBoost, LSTM networks, and hybrid decision trees were trained using 12 years of regional epidemiological data. Results show predictive accuracies above **87%** for emerging outbreak hotspots.

Government adoption potential, ethical considerations, and cross-border data sharing challenges were evaluated. This framework provides a scalable disease surveillance system crucial for climate-adaptive public health planning.

Keywords: epidemiology, climate change, AI forecasting, vector-borne disease, Middle East.

DIGITAL FEMINISM AND SOCIAL TRANSFORMATION: ONLINE ADVOCACY MOVEMENTS AMONG YOUNG WOMEN IN NORTH AFRICA

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Abstract
Digital platforms have enabled new forms of feminist discourse in North Africa, particularly among young women seeking social reform, legal rights, and cultural recognition. This research investigates online feminist movements through discourse analysis, sentiment tracking, and digital ethnography across platforms including TikTok, Instagram, and X.

Findings reveal hybrid identity expression combining Islamic ethical frameworks with global feminist narratives. While digital activism increases visibility and community support, it generates responses ranging from support to resistance and socio-political tension.

The study develops a typology of digital feminist engagement strategies in North Africa and examines policy, cultural, and generational implications.

Keywords: digital feminism, identity, online activism, North Africa, sociocultural transformation.

ETHICAL CHALLENGES AND GOVERNANCE MODELS IN MACHINE LEARNING DEPLOYMENT FOR PUBLIC ADMINISTRATION IN THE MIDDLE EAST

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Abstract

The rapid rise of artificial intelligence (AI) and machine learning (ML) applications in governmental and public administration systems across the Middle East presents both transformative opportunities and profound ethical dilemmas. This study explores how AI technologies, including predictive analytics, automated decision-making, and biometric surveillance, are currently being integrated into sectors such as public health, taxation, transportation, and citizen identity management within Jordan and neighboring MENA countries. While such deployments aim to enhance efficiency, transparency, and data-driven policymaking, they simultaneously raise significant moral, cultural, and legal questions. Key concerns identified include algorithmic bias, lack of transparency in automated reasoning, unequal digital access, data privacy violations, and potential misuse for political surveillance.

This research adopts a mixed-method approach consisting of expert interviews, policy analysis, and case studies from Jordan, UAE, Saudi Arabia, and Qatar. One significant finding is that AI systems trained on Western datasets often generate biased outcomes when applied to local populations with different linguistic, ethnic, and socio-cultural backgrounds. Another observation suggests that most Middle Eastern AI implementation frameworks lack clearly defined regulatory compliance structures, especially regarding data protection and informed consent. Although several countries have proposed AI governance frameworks, they remain largely advisory rather than enforceable.

Based on collected evidence, the study proposes a governance model tailored to regional socio-political dynamics. The model emphasizes human-in-the-loop control, culturally sensitive ethical guidelines, transparent algorithmic auditing, and mandatory government-citizen accountability frameworks. The findings suggest that achieving responsible AI adoption in the region requires balancing innovation, public interest, and individual rights.

Keywords: AI Ethics, Machine Learning Governance, Public Administration, Algorithmic Bias, Middle East, Digital Policy

DIGITAL HEALTH TRANSFORMATION AND AI-DRIVEN EPIDEMIOLOGICAL MODELING DURING POST-PANDEMIC HEALTH REFORM IN SAUDI ARABIA

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Abstract

COVID-19 accelerated the adoption of digital health infrastructures and epidemiological forecasting models worldwide. Saudi Arabia has emerged as a regional leader in deploying AI solutions for health surveillance, patient tracking, and predictive modeling aligned with national modernization strategies under Vision 2030. This study evaluates the effectiveness, limitations, and future potential of AI-enhanced epidemiological systems in Saudi Arabia's public health ecosystem.

Using longitudinal comparative analysis and interviews with policymakers, hospital administrators, and digital health engineers, the study explores three major AI interventions: automated contact tracing, population-based predictive modeling, and clinical decision support systems. Results indicate significant improvements in outbreak detection and response time, reducing traditional manual tracing delays from days to minutes. The implementation of machine learning-based predictive analytics also improved hospital resource allocation, particularly ICU optimization and medical supply forecasting.

However, the study also notes systemic barriers, including fragmented data infrastructures, workforce digital skill shortages, and concerns regarding patient data security. Many healthcare professionals express uncertainty about AI-generated diagnostic recommendations, demonstrating a need for interdisciplinary training and human-centered interface design.

The research concludes that continued success requires an integrated national health data exchange system, strengthened regulatory frameworks, and increased collaboration between academic research institutions and health technology industries.

Keywords: Digital Health, Epidemiology, AI in Healthcare, Saudi Arabia, Public Health Policy

METAVERSE-BASED LEARNING ENVIRONMENTS: OPPORTUNITIES AND RISKS FOR HIGHER EDUCATION IN THE UAE

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Educational Technology¸ United Arab Emirates,

Abstract

The emergence of immersive digital ecosystems such as the metaverse has introduced new pedagogical possibilities for higher education institutions in the United Arab Emirates. This research investigates the adoption, effectiveness, and ethical considerations of metaverse-based learning platforms across selected universities in the UAE. The study evaluates how immersive 3D learning environments influence student engagement, knowledge retention, collaborative learning, and digital identity formation.

Using experimental classroom trials involving 268 undergraduate students and 41 instructors across five disciplines, findings reveal significantly increased motivation and participation, particularly in engineering, architecture, and medical simulations. Students reported greater ownership of learning, enhanced spatial understanding, and improved teamwork abilities. Additionally, VR-enabled multilingual tools supported more inclusive education for international learners.

Yet, the study identifies challenges such as physical discomfort with prolonged VR use, risk of digital dependency, and blurred boundaries between academic and social metaverse interactions. Data security concerns were also highlighted, particularly regarding biometric tracking and behavioral analytics embedded in metaverse platforms.

Grounded in these findings, the study proposes a regulatory and instructional framework emphasizing accessibility, ethical data governance, hybrid learning balance, and progressive instructor training.

Keywords: Metaverse Education, VR Learning, Higher Education, UAE, EdTech Innovation

OPTIMIZATION OF LARGE-SCALE SOLAR ENERGY INTEGRATION IN URBAN CAIRO: A SMART GRID SIMULATION STUDY

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Abstract

Egypt's growing energy demand has accelerated national strategies for renewable energy integration, particularly solar power. This study investigates optimal deployment and smart grid integration strategies for photovoltaic (PV) systems across Cairo's urban environment. Using energy simulation modeling, geospatial rooftop analysis, and machine learning-based energy forecasting, the research examines economic feasibility, grid stability, and long-term sustainability.

Results demonstrate that Cairo possesses significant solar generation potential, capable of meeting approximately 37–42% of urban energy demand if supported by intelligent storage and load-balancing systems. Machine learning optimization models predict that incorporating AI-regulated demand response systems could reduce peak load stress by up to 28%, improving national grid resilience. Cost-benefit analysis further indicates that large-scale solar rooftop implementation is economically viable within 6–9 years, depending on district-level socioeconomic factors.

However, barriers remain, including inconsistent regulatory support, technological financing gaps, and public resistance due to low energy literacy. Based on research outcomes, the study proposes a multi-phase implementation roadmap involving stakeholder education, public-private innovation funding, and regional smart grid policy enforcement.

Keywords: Solar Energy, Smart Grids, Renewable Systems, Cairo, Energy Optimization

DIGITAL MIGRATION NETWORKS AND ONLINE IDENTITY RECONSTRUCTION AMONG MIDDLE EASTERN DIASPORA COMMUNITIES

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Abstract

With increased migration from the Middle East driven by political instability, economic hardship, and education-related mobility, digital platforms have become central mechanisms for communication, cultural preservation, and identity continuity. This research focuses on how Middle Eastern diaspora populations—particularly Lebanese, Syrian, Iraqi, and Palestinian communities—use digital networks to maintain social belonging, political engagement, and emotional resilience.

Using digital ethnography and network analysis of 384 participants residing in Europe and North America, findings reveal three core identity behaviors: cultural reinforcement through shared digital rituals, hybrid identity development blending host and homeland values, and transnational activism amplified through online storytelling and emotional solidarity. Social media platforms such as WhatsApp, TikTok, and Facebook function not merely as communication tools but as cultural ecosystems supporting linguistic continuity, collective memory, and digital citizenship.

Nevertheless, the study identifies risks including misinformation spread, digital polarization, and psychological tensions caused by dual allegiances and fragmented cultural belonging. Privacy and geopolitical surveillance concerns further complicate participation, especially for displaced or stateless populations.

This research concludes with recommendations for digital inclusion policies, diaspora community support infrastructure, and intercultural digital citizenship education.

Keywords: Digital Migration, Diaspora Identity, Middle East, Online Culture, Transnational Networks

AI-POWERED DIAGNOSTIC IMAGING FOR EARLY DETECTION OF TUBERCULOSIS IN SUB-SAHARAN AFRICADR. AMINA NDLOVU

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Abstract

Tuberculosis (TB) continues to pose a major public health challenge in Sub-Saharan Africa due to infrastructural constraints, limited access to diagnostic equipment, and delayed clinical interventions. This research examines the integration of artificial intelligence (AI)-driven medical imaging solutions to enhance early TB detection in rural and urban hospitals across South Africa. Using a dataset of over 18,000 anonymized chest X-ray images obtained from national screening programs, machine learning models including Convolutional Neural Networks (CNNs) and hybrid deep learning frameworks were trained and evaluated for accuracy, sensitivity, and applicability in low-resource environments.

The results demonstrated that the AI-assisted diagnostic system achieved an accuracy rate of 94.6%, outperforming manual interpretation in facilities lacking specialist radiologists. Additionally, the study assessed cost-effectiveness and practical deployment challenges such as internet connectivity, ethical data handling, and clinician training requirements. The findings suggest that while technology readiness is strong, successful implementation requires multidisciplinary governance frameworks and support for local medical personnel.

The proposed model offers scalability and adaptability for screening additional respiratory diseases. The study concludes that AI-enhanced diagnostic imaging holds significant promise for reducing TB-related mortality and improving health system resilience across Africa.

Keywords: Tuberculosis, Artificial Intelligence, Diagnostic Imaging, Healthcare Technology, South Africa

BLOCKCHAIN-BASED IDENTITY SYSTEMS FOR STRENGTHENING DIGITAL GOVERNANCE IN NIGERIAPROF. JAMES OKORO

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Abstract

Nigeria's growing digital ecosystem faces persistent challenges related to identity verification, cybersecurity, authentication protocols, and public trust. This research investigates the potential of blockchain technology to establish a secure, scalable, and transparent national digital identity system. Using a design-science methodology, the study analyzes technical prototypes built using smart contracts, decentralized storage mechanisms, and consensus validation models.

Findings indicate that blockchain-enabled identity systems reduce fraud vulnerability by eliminating central points of failure and ensuring immutable transaction records. A pilot simulation involving 1,200 participants demonstrated that authentication processes improved by 42% in efficiency compared to current national ID systems. However, adoption barriers persist, particularly related to infrastructure cost, policy readiness, and digital literacy gaps among rural populations.

The study recommends a phased rollout approach integrating legal reforms, public-private partnerships, and nationwide education initiatives. Blockchain technology is identified as a crucial foundation for Nigeria's digital transformation, offering long-term benefits in finance, healthcare, and governmental services.

Keywords: Blockchain, Digital Identity, Cybersecurity, Governance, Nigeria

CLIMATE-SMART AGRICULTURE AND MACHINE-LEARNING-BASED CROP PREDICTION MODELS IN WEST AFRICA

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Abstract

Agricultural productivity in Senegal and the larger West African region is increasingly threatened by climate variability, soil degradation, and inconsistent rainfall patterns. This study applies machine-learning models including Random Forest, LSTM neural networks, and ensemble forecasting systems to predict crop yields of millet, sorghum, and groundnut under changing climate conditions.

Data collected from meteorological stations and agricultural cooperatives over a 12-year period were processed to evaluate predictive accuracy and decision-making enhancement for farmers. The models achieved a yield prediction accuracy between 86% and 92%, enabling better planning for fertilizer usage, irrigation scheduling, and crop diversification.

The research highlights that successful implementation requires equitable access to digital platforms and local-language-based training for farmers. The findings provide a technological roadmap to strengthen food security, reduce economic vulnerability, and support sustainable agricultural development across Africa.

Keywords: Machine Learning, Agriculture, Climate Change, Crop Prediction, Senegal

SUSTAINABLE SMART CITY PLANNING FOR RAPIDLY GROWING AFRICAN URBAN CENTERS

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Abstract

African cities such as Cairo, Nairobi, Addis Ababa, and Accra are experiencing rapid urbanization, requiring advanced planning methodologies to address housing shortages, infrastructure pressure, and environmental degradation. This research evaluates smart city frameworks focusing on renewable energy integration, intelligent transportation, digital governance, and circular economy models.

Case studies and GIS-based simulations revealed that integrating IoT-based mobility management and solar micro-grid systems significantly improves energy efficiency and reduces congestion across dense settlements. The research proposes a hybrid governance model combining public data platforms, community engagement, and interdisciplinary regulatory frameworks.

The study concludes that African smart cities must prioritize human-centered design, resource equity, and data accountability while leveraging emerging technologies for sustainable development.

Keywords: Smart Cities, Urban Planning, Sustainability, GIS, Egypt

AI-SUPPORTED WILDLIFE MONITORING SYSTEMS FOR ENDANGERED SPECIES PROTECTION IN EAST AFRICA

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Abstract

Poaching, habitat loss, and ecosystem disruption continue to endanger wildlife species across East Africa. This study evaluates the application of artificial intelligence for wildlife tracking, pattern recognition, and predictive habitat modeling in national parks across Kenya and Tanzania. Using drone imaging, acoustic sensors, and deep learning-based recognition systems, the research tracks elephants, rhinos, and lions to assess risk patterns and migration shifts.

Results indicate that AI monitoring systems significantly outperform manual tracking methods in accuracy, coverage, and early threat identification. The system demonstrated the potential to reduce illegal activity by enabling real-time alerts for park authorities. However, sustainability depends on investment in technical infrastructure, policy enforcement, and community-based conservation ethics.

The research highlights the necessity of integrating local communities into conservation frameworks and calls for global technological partnerships to protect biodiversity.

Keywords: Conservation Technology, Wildlife Monitoring, Machine Learning, Biodiversity, Kenya

DIGITAL ARCHIVING OF ENDANGERED INDIGENOUS LANGUAGES IN ETHIOPIA USING NLP MODELS

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Abstract

Ethiopia is home to over 80 linguistic groups, many of which are endangered due to globalization, migration, and limited formal documentation. This study applies natural language processing (NLP) techniques to document and preserve languages with fewer than 50,000 active speakers. The research combines speech recognition, corpus-building, and morphological analysis techniques using field-recorded data from the Hadiyya, Wolaytta, and Gamo communities.

Machine learning models were developed to transcribe and classify linguistic patterns, significantly accelerating the documentation process that traditionally required years of manual linguistic work. Community involvement was central to the project, enabling natural contextual language collection while building local ownership of preservation efforts.

Challenges include dialect variations, limited digital literacy, and scarcity of standardized orthography. However, results demonstrate that NLP technologies can contribute to preserving intangible cultural heritage when combined with culturally sensitive methodologies.

Keywords: Linguistic Preservation, NLP, Indigenous Languages, Digital Culture, Ethiopia

FINTECH INNOVATION AND FINANCIAL INCLUSION TRENDS IN POST-COVID GHANAIAN MARKETS

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Abstract

The FinTech sector in Ghana has experienced accelerated growth, especially following the COVID-19 pandemic when digital transactions became essential. This research explores the role of FinTech platforms—such as MoMo Pay, Zeepay, and Ecobank Digital—on financial inclusion among low-income and unbanked populations.

Survey data from 2,100 users across Accra, Kumasi, and rural Eastern Region revealed a 52% increase in first-time digital banking adoption within three years. Machine-learning analysis of transaction patterns indicated that accessibility, ease of use, and microtransaction affordability were the primary adoption drivers, while cybersecurity concerns and technical failures remain barriers.

The study concludes that Ghana's FinTech ecosystem can significantly reduce poverty gaps if regulatory frameworks ensure consumer protection and digital literacy expansion.

Keywords: FinTech, Financial Inclusion, Digital Banking, Ghana, Economic Policy

GAMIFICATION AND CULTURAL ADAPTATION IN DIGITAL LEARNING PLATFORMS FOR MOROCCAN SECONDARY SCHOOLS

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Abstract

Gamified learning systems are increasingly adopted in Moroccan secondary education settings to improve student motivation and academic engagement. This study evaluates the impact of culturally adapted gamification elements—including local language content, region-specific storytelling, and traditional symbolic visual design—on student performance in mathematics and language arts.

Using an experimental learning platform tested with 870 students across six public schools, findings indicate that culturally adaptive gamification increased participation levels by 46% and improved learning retention metrics. However, the study also highlights the importance of avoiding over-competition, which can disadvantage low-performing students.

The research recommends policy-level investment in culturally grounded educational technology to improve nationwide learning outcomes.

Keywords: Gamification, EdTech, Cultural Adaptation, Morocco, Secondary Education

DIGITAL THERAPY ADOPTION AND MENTAL HEALTH AWARENESS AMONG UNIVERSITY STUDENTS IN PAKISTAN

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Abstract

The increasing prevalence of anxiety, depression, and academic burnout among Pakistani university students has prompted interest in alternative mental health interventions, particularly digital therapy and online counseling platforms. This research explores the perception, usage, and psychological outcomes of digital mental health support among students from five major universities in Lahore, Islamabad, and Karachi.

A mixed-method methodology was used, combining surveys (n=650), clinical screening tools, and interviews with mental health professionals. Results showed that 64% of participants were aware of digital therapy platforms, yet only 22% had actively used them. Key benefits included anonymity, convenience, and reduced stigma. However, barriers remained significant, including poor digital literacy, mistrust in online platforms, cultural hesitation toward psychological support, and limited access to certified professionals.

The findings indicate that digital therapy can significantly improve emotional regulation, engagement, and coping strategies when integrated into structured institutional support systems. The research recommends policy-level acknowledgment, national accreditation systems, and digital health training programs to expand adoption.

Keywords: Digital Therapy, Mental Health, University Students, Pakistan, Behavioral Health Technology

ASSESSING AIR POLLUTION TRENDS IN URBAN PAKISTAN USING AI-BASED FORECASTING MODELS

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Abstract

Rapid urbanization and industrial expansion have significantly worsened air quality across major Pakistani cities. This study evaluates machine learning-driven forecasting models to analyze pollutant behavior, including PM2.5, NO_2, and CO_2 concentrations in Lahore, Islamabad, and Karachi. Historical environmental data collected from government monitoring stations were analyzed using algorithms such as Support Vector Regression (SVR), Random Forest, and LSTM neural networks.

The results demonstrate that LSTM models most accurately captured seasonal fluctuation patterns, predicting air quality deterioration with a confidence rate of 93%. The analysis identified winter smog, industrial zones, and vehicular density as major contributors. Additionally, machine learning simulations suggested high-pollution periods could be reduced through traffic zoning reforms, green public transport, and stricter industrial emissions monitoring.

The study concludes that AI-based forecasting can support proactive environmental policymaking and public health protection in Pakistan.

Keywords: Air Pollution, Forecasting Models, Machine Learning, Environmental Policy, Pakistan

AUTONOMOUS DRONE SYSTEMS FOR DISASTER MANAGEMENT AND FLOOD MONITORING IN PAKISTAN

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Abstract

Pakistan faces recurring natural disasters, particularly floods, which devastate infrastructure and agricultural regions. This study presents an autonomous drone surveillance model designed for rapid disaster response, damage assessment, and predictive flood routing.

Field simulations in flood-prone Sindh and Khyber Pakhtunkhwa demonstrated efficient real-time mapping, automated route optimization, and AI-powered risk analysis. Despite operational limitations such as weather interference, limited battery life, and regulatory restrictions, the technology shows strong potential for national emergency response modernization.

Policy recommendations include decentralized command hubs, public-private technical collaboration, and nationwide training for drone operation units.

Keywords: Drones, Disaster Response, Flood Monitoring, Robotics, Pakistan

STARTUP ECOSYSTEM GROWTH AND DIGITAL BUSINESS MODELS AMONG PAKISTANI YOUTH ENTREPRENEURS

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Abstract

Pakistan's startup ecosystem has expanded significantly due to improved digital infrastructure, fintech adoption, and global investment patterns. This research evaluates emerging business models among youth-led startups in Karachi, Lahore, and Islamabad.

Survey data from 220 startup founders revealed that e-commerce, digital logistics, educational technology, and fintech represent the fastest-growing sectors. Challenges include funding scarcity, regulatory hurdles, and limited mentorship networks. The study proposes ecosystem strengthening through incubator-university collaboration, policy refinement, and international market integration.

Keywords: Startups, Innovation Ecosystem, Digital Economy, Pakistan, Entrepreneurship

BLENDED LEARNING MODELS AND STUDENT ENGAGEMENT IN PAKISTANI HIGHER EDUCATION

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Abstract

Blended learning, which combines online digital media with traditional face-to-face instruction, is increasingly relevant in Pakistan's higher education system. This study evaluates blended pedagogical models and their effect on student engagement, learning outcomes, and retention in three public universities: Karachi University, Punjab University, and NUST.

A mixed-method approach involved surveys of 840 students and interviews with 62 faculty members across multiple disciplines. The results indicate that students reported higher satisfaction, better conceptual understanding, and improved self-directed learning when blended methods incorporated interactive digital platforms, real-time feedback, and multimedia resources. However, challenges included inconsistent internet access, lack of faculty training in digital pedagogies, and limited integration of local cultural context in online modules.

The study recommends structured faculty development programs, investment in digital infrastructure, and culturally adapted instructional designs. These interventions enhance learning quality, reduce dropout rates, and prepare students for a digitally oriented labor market.

Keywords: Blended Learning, Student Engagement, Higher Education, Pakistan, Digital Pedagogy

ENHANCING NATIONAL CYBERSECURITY RESILIENCE THROUGH AI-DRIVEN THREAT DETECTION IN PAKISTAN

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Abstract

Cybersecurity threats are escalating globally, affecting government networks, financial institutions, and critical infrastructure in Pakistan. This research evaluates the effectiveness of AI-driven intrusion detection and anomaly detection systems in protecting national networks.

Using a dataset of simulated cyberattacks and real-time traffic from Pakistani financial and governmental networks, AI models, including deep learning and ensemble methods, were trained to detect malware, phishing attacks, and ransomware intrusion. Results indicated detection accuracy exceeding 95%, a substantial improvement over traditional signature-based methods.

Challenges include adapting models to evolving local threat vectors, resource constraints in public institutions, and cybersecurity skill shortages. The research recommends integrating AI-driven threat intelligence with national policy, workforce training, and collaboration with international cybersecurity bodies.

Keywords: Cybersecurity, AI, Intrusion Detection, Pakistan, Information Security

MACHINE LEARNING FOR OPTIMIZING CROP YIELD AND PEST MANAGEMENT IN PUNJAB, PAKISTAN

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Abstract

Agricultural productivity in Pakistan faces challenges due to erratic climate patterns, pest infestations, and resource limitations. This study applies machine learning techniques to predict crop yield, optimize fertilizer usage, and forecast pest outbreaks for wheat and rice production in Punjab province.

Using longitudinal datasets from 2010–2022, models such as Random Forest, Gradient Boosting, and LSTM neural networks were trained to simulate crop growth under variable environmental and soil conditions. Results showed a yield prediction accuracy of 90% and improved pest outbreak forecasting, enabling farmers to reduce losses by 27%.

Recommendations include integrating machine-learning-based decision support systems with mobile platforms to provide actionable guidance to local farmers. The research emphasizes scalable, low-cost technological adoption to ensure food security and sustainable agricultural development.

Keywords: Agriculture, Machine Learning, Crop Yield, Pest Management, Pakistan

TELEMEDICINE ADOPTION AND HEALTHCARE ACCESS IN RURAL PAKISTAN: AN AI-ENABLED APPROACH

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Abstract

Telemedicine adoption in Pakistan is crucial for improving healthcare access in rural and underserved regions. This research investigates AI-assisted telemedicine platforms' effectiveness for primary care, chronic disease management, and emergency consultation.

A mixed-method study combined patient surveys (N=720), physician interviews, and platform usage analytics. Findings reveal telemedicine improved consultation rates by 46%, reduced travel time for patients, and enhanced chronic disease monitoring. AI-driven decision support improved diagnostic accuracy, particularly for cardiovascular and diabetic patients. Challenges included network reliability, digital literacy, and cultural trust barriers. Recommendations include government-supported telehealth programs, training for healthcare workers, and integration of AI-based triage for scalability.

Keywords: Telemedicine, AI in Healthcare, Rural Health, Pakistan, Digital Health

SMART GRID AND RENEWABLE ENERGY INTEGRATION FOR URBAN PAKISTAN: AI-ENHANCED ENERGY MANAGEMENT

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Abstract

Pakistan's urban centers face growing energy demands, frequent load-shedding, and infrastructure constraints. This study explores AI-driven smart grid solutions for integrating solar and wind energy into urban energy distribution networks.

Simulations using real-time consumption data from Lahore and Islamabad applied reinforcement learning algorithms to optimize energy distribution, predict peak loads, and manage renewable storage systems. Results indicate improved grid reliability by 32% and reduced dependency on non-renewable energy sources. The study also evaluates cost-effectiveness, regulatory challenges, and workforce capacity for maintaining AI-enabled grids. Recommendations focus on policy support, infrastructure investment, and public-private partnerships to achieve sustainable urban energy transformation.

Keywords: Renewable Energy, Smart Grid, AI, Energy Management, Pakistan

ARTIFICIAL INTELLIGENCE ADOPTION IN BALKAN SMES: BARRIERS, READINESS, AND STRATEGIC OUTCOMES

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Abstract

Artificial intelligence (AI) is transforming global business ecosystems; however, adoption in Balkan small and medium-sized enterprises (SMEs) remains relatively slow. This research examines organizational readiness, technological capabilities, regulatory environment, and perceived benefits affecting AI implementation in Serbia, Croatia, and North Macedonia. A total of 412 SMEs participated in surveys, while in-depth interviews were conducted with 28 business leaders and 15 IT specialists. Quantitative findings indicate that firms with strong digital infrastructure, leadership support, and innovation-oriented culture demonstrate significantly higher rates of AI utilization, particularly in customer analytics, automated marketing, and predictive maintenance. Despite interest in AI-driven optimization, major challenges include financial constraints, lack of skilled professionals, and uncertainty about ethical and legal frameworks. The qualitative phase revealed that companies adopting AI gained improved decision-making accuracy, enhanced customer retention, and operational efficiency. The study suggests policymaking strategies such as tax incentives for AI adoption, government-industry collaboration, and regional standardized training programs. Future research will explore cross-border digital cooperation patterns within the Balkan economic zone.

AI-SUPPORTED PEDAGOGICAL MODELS IN HIGHER EDUCATION: A COMPARATIVE STUDY IN GREEK UNIVERSITIES

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Abstract

The rapid development of artificial intelligence has influenced pedagogical methodologies across global higher education institutions. This study evaluates the integration of AI-supported learning environments, including intelligent tutoring systems, adaptive learning platforms, and virtual teaching assistants, across four major Greek universities. A mixed-method approach involving 703 students, 94 faculty members, and digital platform analytics was employed. Findings demonstrate that AI-enhanced learning improved student engagement, personalization, and self-paced progression. However, acceptance levels varied depending on faculty digital competence, disciplinary context, and accessibility of technological resources. STEM faculties showed higher adoption rates compared to humanities-based programs. Students reported benefits such as real-time feedback, reduced learning anxiety, and enhanced motivation. Yet, concerns emerged about reduced interpersonal interaction, algorithmic transparency, and possible academic integrity violations. The research concludes that successful AI integration requires pedagogical redesign, digital ethics frameworks, and structured teacher training initiatives. Recommendations include national accreditation guidelines for AI-based education tools and standardized evaluation metrics for learning outcomes.

REGULATORY GAPS AND ETHICAL CHALLENGES OF ARTIFICIAL INTELLIGENCE IN BALKAN GOVERNANCE SYSTEMS

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Abstract

AI-based governance models are increasingly used for public administration, data management, and predictive security. However, ethical and legal implications remain underdeveloped in Balkan jurisdictions. This study reviews national legal frameworks of Albania, Montenegro, and Kosovo, focusing on transparency, accountability, and AI-based decision-making rights. Policy analysis, legislative coding, and expert interviews with government regulators, civil society, and legal scholars formed the methodology. Results indicate fragmented regulation, weak enforcement capacity, and insufficient alignment with EU AI regulatory standards. Key challenges include data privacy vulnerabilities, algorithmic discrimination, and lack of public awareness. Case analysis also revealed inconsistencies in automated judicial risk-assessment tools, creating potential fairness and procedural justice concerns. The paper proposes a harmonized regional AI regulatory model supported by independent oversight bodies, public consultation frameworks, and ethics-centered innovation ecosystems. Findings contribute to discussions surrounding legal modernization in emerging digital democracies.

AI-BASED DIAGNOSTIC IMAGING: EVALUATION OF CLINICAL ACCURACY AND WORKFLOW EFFICIENCY IN CROATIAN HOSPITALS

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Abstract

AI tools are increasingly integrated into diagnostic imaging systems such as MRI, CT, and PET scans. This research assesses diagnostic accuracy, workflow efficiency, and clinical utility of AI-assisted radiology platforms in three Croatian teaching hospitals. Data were collected from 2,400 radiological examinations and interviews with 48 radiologists. Statistical analysis demonstrated that AI assistance improved detection accuracy in early-stage lung cancer, neurological disorders, and musculoskeletal lesions by an average of 18%. Additionally, reporting time decreased by 27%, contributing to reduced patient waiting periods and improved clinical throughput. Radiologists expressed positive attitudes but insisted that AI cannot replace human expertise due to contextual judgment and ethical responsibility. Concerns included system interoperability, data standardization, and long-term reliability. The study recommends structured training programs, cybersecurity protocols, and national interoperability standards to enhance AI adoption in medical diagnostics.

CONSUMER TRUST AND EMOTIONAL RESPONSE TO AI-GENERATED ADVERTISING IN THE BALKAN DİGİTAL MARKETPLACE

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Abstract

The rise of AI-generated advertising content has introduced new dynamics into consumer-brand relationships. This study investigates emotional response, trust formation, and behavioral intention resulting from AI-driven personalized marketing in Bulgaria, Romania, and Serbia. A total of 1,185 participants engaged in controlled exposure experiments involving AI-generated advertisements, human-designed campaigns, and hybrid formats. Emotional reactions were measured via biometric tracking and self-report surveys. Results revealed that consumers perceived hybrid campaigns as most authentic and persuasive, while fully AI-generated content triggered skepticism despite high personalization quality. Younger demographics demonstrated higher acceptance compared to older groups, showing positive engagement with chatbot-based customer service and dynamic product recommendations. Trust was found to be influenced by perceived transparency, data security confidence, and ethical communication tone. The research emphasizes the need for regulatory guidelines, ethical design principles, and transparent data usage policies to support AI-based marketing adoption in the Balkan region.

WOMEN'S DIGITAL ENTREPRENEURSHIP AND SOCIOECONOMIC EMPOWERMENT IN RURAL MALI

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Abstract

Digital entrepreneurship has become a transformative force for women in developing economies, particularly in rural regions where access to traditional business infrastructure is limited. This study investigates how digital tools—such as mobile banking, online marketplaces, and social media marketing—are empowering women entrepreneurs in Mali's rural communities. The research draws on interviews with 204 female entrepreneurs, combined with field observations and digital literacy assessments.

Findings reveal that mobile banking platforms such as Orange Money and Wave have provided women with increased financial independence by eliminating reliance on physical banking systems, which are often geographically distant and culturally restrictive. Additionally, platforms like Facebook Marketplace and WhatsApp Business have enabled women to expand their product reach beyond local markets, increasing annual revenue averages by up to 38%.

However, challenges persist. Limited internet access, low levels of formal education, and cultural norms restricting women's technology ownership still hinder widespread adoption. Many women also reported encountering online fraud, inconsistent digital platform regulations, and gender-based cyber harassment.

The study concludes that digital entrepreneurship could significantly contribute to poverty reduction and gender equity in Mali if supported by government-backed digital literacy programs, microfinancing incentives, and culturally grounded policy frameworks.

Keywords: Digital Entrepreneurship, Women Empowerment, Economic Development, Mali, Social Innovation

CORAL REEF RESTORATION AND AI-ASSISTED MARINE HABITAT ASSESSMENT IN THE WESTERN INDIAN OCEAN

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Abstract

Marine ecosystems in the Western Indian Ocean, particularly coral reefs, face increasing threats due to ocean warming, pollution, overfishing, and coastal development. This research evaluates coral restoration strategies supported by AI-driven habitat mapping and automated underwater image analysis. Using deep learning image recognition trained on 115,000 underwater images from reef systems near Zanzibar, the model assessed coral bleaching severity, biodiversity distribution, and habitat recovery patterns.

The findings demonstrate that AI-supported monitoring increases classification accuracy and reduces the time required for ecological assessment by over 60%. Coral restoration initiatives, including artificial reef modules and selective coral transplantation, showed promising survival rates when informed by predictive modeling rather than randomized transplantation.

Despite technological progress, long-term sustainability remains dependent on community participation and stronger governmental environmental regulations. The research recommends integrating indigenous ecological knowledge with AI-based marine analytics to enhance ecosystem resilience.

Keywords: Coral Restoration, Marine Ecology, Artificial Intelligence, Climate Change, Tanzania

TWO-POINT QCD SUM RULE ANALYSIS OF THE $T_{cc}(3875)^+$ STATE AS A HADRONIC MOLECULE

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ABSTRACT

The exotic state candidate $T_{cc}(3875)^+$, observed by the LHCb collaboration, has attracted considerable attention as the first doubly charmed exotic state near the D^0D^{*+} threshold. In this work, we analyze this state within the framework of QCD sum rules, under the assumption that it can be described as a weakly bound hadronic molecule composed of $D^0$and D^{*+} mesons with quantum numbers $J^{PC} = 1^+$. An appropriate interpolating current is constructed for this configuration, and the two-point correlation function is evaluated, including perturbative as well as nonperturbative contributions up to dimension six in the operator product expansion. The reliability of the sum rule is ensured by analyzing the convergence of the expansion, the dominance of the pole contribution, and the stability of the extracted quantities with respect to variations in the Borel mass parameter and continuum threshold. Our numerical analysis gives the mass of the state as $m_{T_{cc}} = (3.96 \pm 0.08)\ \text{GeV}$, which is in excellent agreement with the experimental measurement. In addition, we determine the decay constant as $f_{T_{cc}} = (2.10 \pm 0.40) \times 10^{-3}\ \text{GeV}^4$. These results provide strong evidence for the molecular interpretation of $T_{cc}(3875)^+$. The obtained decay constant represents an important nonperturbative parameter that can be employed in the calculation of decay widths and production rates of this state in future theoretical and experimental studies.

Key Words: QCD Sum Rules; Exotic Molecule State ; Mass and Decay Constant.

INTRODUCTION

Over the last two decades, work in hadron physics has led to the discovery of numerous exotic hadrons that don't fit the conventional quark model. Exotic hadrons are multiquark states beyond the traditional $q\bar{q}$ mesons and qqq baryons, including tetraquarks, pentaquarks, and hadronic molecules (Narison, 2023). Since the observation of $X(3872)$ in 2003 under the Belle collaboration (Choi et al., 2003), unusual families such as Z_c and P_c have emerged, broadening the field of hadron spectroscopy. These discoveries have advanced our understanding of the nonperturbative field of Quantum Chromodynamics (QCD) (Hosaka et al., 2016)

One of these exotic particles, $T_{cc}(3875)^+$, was discovered by the LHCb collaboration in 2021 (Aaij et al., 2022a) and has attracted considerable attention due to its properties. First, it is the first confirmed doubly charmed tetraquark, containing a pair of charm (c) quarks and two light

($\bar{u}\bar{d}$) antiquarks ($cc\bar{u}\bar{d}$). Also the first open-charm tetraquark. Finally, it has a very narrow decay width of approximately 410 keV, making it one of the longest-lived exotic hadrons observed to date. Experimentally, the $T_{cc}(3875)^{+}$ was observed near the D^0D^{*+} threshold at 3875.09 MeV with a measured mass of 3874.75 ± 0.17 MeV (Aaij et al., 2022a), lying slightly below the threshold (Aaij et al., 2022b; Workman et al., 2022). These features suggest that $T_{cc}(3875)^{+}$ may be interpreted as a loosely bound hadronic molecule composed of D^0 and D^{*+} mesons.

Discussions about the internal structure of $T_{cc}(3875)^{+}$ are still ongoing. In the QCD sum rules (QCDSRs) approach, Agaev, Azizi and Sundu analyzed it as a D^0D^{*+} hadronic molecule (Agaev et al., 2022) Ren, Wu, and Zhu also provided comments supporting the loosely bound DD^{*}molecular situation (Ren et al., 2022). In addition, Semra Sarı Farah, who studied T_{cc}^{+} and hidden charm tetraquarks for $J^{PC} = 1^{+-}$ and 0^{++} models with QCDSRs analysis in her article (Ferah & Ozpineci, 2025), supports the interpretation of the molecular current in her work and presents a detailed study of the double heavy tetraquarks within the QCDSR framework. Oset and co-workers suggest that the majority of the molecular nature (DD^{*}) of $T_{cc}(3875)^{+}$ comes from meson–meson components, and based on measured data, the contributions from D^0D^{*+} and $D^{*+}D^0$ channels are $\sim 69\%$ and $\sim 29\%$, respectively, while the contribution from possible compact structure or other components is very small (Dai et al., 2023) Maiani (Maiani et al., 2023) considered the internal structure of exotic particles containing pairs of heavy quarks, such as $T_{cc}(3875)^{+}$, as a di-quark–anti-di-quark (diquark–antidiquark) structure, which is different from the classical “hadronic molecule” interpretation.

In this study, we apply the QCDSRs method (Shifman et al., 1979a, 1979b), assuming that $T_{cc}(3875)^{+}$ is the D^0D^{*+} molecular current. In this method, we selected the appropriate interpolating current for the particle and, after performing the necessary analysis by writing it in the correlation function, we obtained the mass of the particle and the decay constant. Afterwards, we test the Borel stability of the particle and compare it with experimental and theoretical approaches in the literature, providing supporting evidence that this exotic hadron has a molecular internal structure.

RESEARCH AND FINDINGS

Theoretical Framework

The QCDSRs method, originally developed by Shifman, Vainshtein and Zakharov(Shifman et al., 1979a, 1979b), provides a powerful non-perturbative framework for describing hadronic parameters by systematically incorporating both perturbative and non-perturbative QCD effects encoded in vacuum condensates.

The first rule in the QCDSRs method is to define an interpolating current with a quark content of $cc\bar{u}\bar{d}$ and a quantum number of 1^+.

The interpolating current for the $T_{cc}(3875)^+$ molecular state was constructed following the standard approach for hadronic molecules.

$$J_\mu(x) = (\bar{u}_a(x)\gamma_5 c_a(x))(\bar{d}_b(x)\gamma_\mu c_b(x)) - (\bar{u}_a(x)\gamma_\mu c_a(x))(\bar{d}_b(x)\gamma_5 c_b(x)) \qquad (2.1)$$

where d and u represent the light quark fields and c represents the heavy quark field. i,j are color indices. In the interpolating current, the symbols γ_μ and γ_5 represent the standard Dirac gamma matrices that determine the Lorentz and parity structures of the quark bilinears. Hereafter, we shall use the shorthand notation T_{cc}^+ to refer to the $T_{cc}(3875)^+$ state.

After defining the interpolating current, we can write the two-point correlation function that lets us calculate the decay constant and mass of the state:

$$\Pi_{\mu\nu}(\mathrm{p}) = \mathrm{i}\int \mathrm{d}^4\mathrm{x}\, \mathrm{e}^{(\mathrm{ip}\cdot\mathrm{x})}\langle 0|\mathrm{T}[\mathrm{J}_\mu(x)\mathrm{J}_\nu^\dagger(0)]|0\rangle\,, \qquad (2.2)$$

where $J(x)$ is our current shown in Eq. (2.1), $J^\dagger(x)$ is the Hermitian of $J(x)$. T is the time ordering operator.

According to QCD, the correlation function consists of two sides: the phenomenological (physical) side and the QCD (theoretical) side . The physical side of the correlator is written in terms of hadronic degrees of freedom, similarly to the formulation used in (Temizer et al., 2024), where the contributions of the ground and excited states are parametrized through decay constants and propagator structures.

In the physical part, this correlator is written as the contribution of the lowest hadron (T_{cc}^+) and the excited multi-hadron states:

$$\Pi_{\mu\nu}^{Phys}(p) = \frac{\langle 0|J_\mu|T_{cc}^+(p)\rangle\langle T_{cc}^+(p)|J_\nu^\dagger|0\rangle}{m_{T_{cc}^+}^2 - p^2} + \cdots\,, \qquad (2.3)$$

where $m_{Tcc}^2 - p^2$ in the denominator is the propagator structure. The first term corresponds to the ground state pole contribution (PC) of the particle, while the dots represent contributions from higher resonances and the continuum spectrum.

After summing over the polarization vectors, the physical side can be expressed in terms of the Lorentz structure $\left(-g_{\mu\nu} + p_\mu p_\nu / m_{T_{cc}}^2\right)$. The coupling of the interpolating current to the physical state is parametrized as:

$$\langle 0|J_\mu|T_{cc}^+(p)\rangle = f_{T_{cc}}\, m_{T_{cc}}, \varepsilon_\mu, \tag{2.4}$$

where $f_{T_{cc}}$ represents the decay constant of the tetraquark, when we plug this definition into the correlator the physical side becomes:

$$\Pi_{\mu\nu}^{\text{Phys}}(p) = \frac{f_{T_{cc}}^2 m_{T_{cc}}^2}{m_{T_{cc}}^2 - p^2}\left(-g_{\mu\nu} + \frac{p_\mu p_\nu}{m_{T_{cc}}^2}\right) + \ldots \tag{2.5}$$

Having defined the physical side, we can consider the QCD side within the framework of the Operator Product Expansion (OPE). In this approach, short-range quark-gluon interactions are calculated as perturbative, while long-range, nonperturbative effects are encoded in vacuum condensates.

To find the $\Pi_{\mu\nu}^{OPE}(p) = \Pi_{\mu\nu}^{QCD}(p)$, we write the explicit form of our current $J_\mu(x)$, which we created for the T_{cc}^+ particle with a quantum number of 1^+, into the correlation function.

Ultimately, $\Pi_{\mu\nu}^{OPE}(p)$ is expressed in terms of light and heavy quark propagators as:

$$\begin{aligned}
&\Pi_{\mu\nu}^{\text{OPE}}(p) \\
&= i\int d^4x\, e^{ip\cdot x}\,(Tr\left[\gamma_5 S_c^{aa'}(x)\gamma_5 S_u^{a'a}(-x)\right]Tr\left[\gamma_\mu S_c^{bb'}(x)\gamma_\nu S_d^{b'b}(-x)\right] \\
&+ Tr\left[\gamma_\mu S_c^{aa'}(x)\gamma_\nu S_u^{a'a}(-x)\right]Tr\left[\gamma_5 S_c^{bb'}(x)\gamma_5 S_d^{b'b}(-x)\right] \\
&- Tr\left[\gamma_5 S_c^{aa'}(x)\gamma_\nu S_u^{a'a}(-x)\right]Tr\left[\gamma_\mu S_c^{bb'}(x)\gamma_5 S_d^{b'b}(-x)\right] \\
&- Tr\left[\gamma_\mu S_c^{aa'}(x)\gamma_5 S_u^{a'a}(-x)\right]Tr\left[\gamma_5 S_c^{bb'}(x)\gamma_\nu S_d^{b'b}(-x)\right]).
\end{aligned} \tag{2.6}$$

In Eq. (2.6) $S_q^{ij}(x) = \langle T\left[q^i(x)\bar{q}^j(0)\right]\rangle$ is the quark propagator (color indices i, j). In the isospin symmetry limit, we take $S_u \approx S_d \equiv S_q$ for the light quarks.

To depress contributions from higher resonances and continuum states and increase the ground state contribution, we apply the Borel transform on both sides (Reinders et al., 1985) of the correlation function. Furthermore, the Borel transform improves the convergence of the OPE and reduces the dependence on unknown subtraction terms.

After applying the Borel transform (B_{M^2}) to the correlation function and equating the physical and QCD parts, we get the following QCDSR for the decay constant and mass of the T_{cc}^+ state:

$$f_{T_{cc}}^2 = \frac{e^{m_{T_{cc}}^2/M^2}}{m_{T_{cc}}^2}\,\Pi(M^2, s_0). \tag{2.7}$$

The function $\Pi(M^2, s_0)$ itself is obtained by integrating the OPE spectral density $\rho^{OPE}(s)$ up to the continuum threshold s_0. To obtain the hadron mass, we differentiate both sides of the sum rule with respect to $-\frac{1}{M^2}$ and divide the resulting expression by the original sum rule (Güngör et al., 2023; Ioffe, 2006).

This leads to:

$$m_{T_{cc}}^2 = \frac{\frac{d}{d(-1/M^2)}\Pi(M^2, s_0)}{\Pi(M^2, s_0)} = \frac{\Pi'(M^2, s_0)}{\Pi(M^2, s_0)}, \tag{2.8}$$

where $\Pi'^{(M^2, s_0)}$ denotes the derivative of the Borel-transformed correlation function with respect to $-\frac{1}{M^2}$. We calculate $\Pi(M^2, s_0)$ by considering gluon, quark and mixed vacuum condensates up to dimension six. It is given by:

$$\Pi(M^2, s_0) = \int_{4m_c^2}^{s_0} ds\ \rho^{\mathrm{OPE}}(s) e^{-s/M^2} + \Pi(M^2), \tag{2.9}$$

$\rho^{OPE}(s)$ contains perturbative and non-perturbative contributions, $\Pi(M^2, s_0)$ is the part obtained by Borel transformation of non-perturbative contributions on the QCD side (Azizi & Süngü, 2019).

In our numerical calculations, we use the universal values of the quark and gluon condensates (Colangelo & Khodjamirian, 2001; Ioffe, 2003, 2006; PDG, 2024; Shifman et al., 1979a,b) together with the charm quark mass, as seen in Eq. (2.10):

PARAMETER	VALUE
$\langle \bar{q} g_s \sigma G q \rangle$	$m_0^2 \langle \bar{q} q \rangle$
m_0^2	$(0.8 \pm 0.1)\ \mathrm{GeV}^2$
$\langle \bar{q} q \rangle$	$-(0.24 \pm 0.01)^3\ \mathrm{GeV}^3$
$\left\langle \frac{\alpha_s}{\pi} G^2 \right\rangle$	$(0.012 \pm 0.004)\ \mathrm{GeV}^4$
$\langle g_s^3 G^3 \rangle$	$(0.57 \pm 0.29)\ \mathrm{GeV}^6$
m_c	$(1.275 \pm 0.025)\ \mathrm{GeV}$

(2.10)

Numeric Analyses

To proceed with the numerical analysis, a reliable working range for the continuum threshold s_0 and the Borel parameter M^2needs to be determined. The universal parameters in Eq. (2.10) aren't physical quantities, so the extracted hadronic observables should be practically independent of them. The standard principles applied for this are:

(i) convergence of the OPE and
(ii) dominance of the ground state PC over the continuum.

The PC is defined as (Narison, 2023):

$$\mathrm{PC}(M^2, s_0) \simeq \frac{\Pi(M^2, s_0)}{\Pi(M^2, \infty)}. \tag{3.1}$$

The convergence of the OPE is controlled by the following formula:

$$R(M^2) = \frac{\Pi^{\mathrm{dim}N}(M^2)}{\Pi^{\mathrm{total}}(M^2)}, \tag{3.2}$$

where $dimN = dim(4 + 5 + 6)$. Condensate contributions up to dimension-6 are included in our calculation. The spectral density for the dimension-3 contribution is zero. $R(M^2)$, a measure of the convergence of the OPE, is a parameter that quantifies the relative size of the highest-dimensional condensate term $\left(\Pi^{dimN}(M^2, s_0)\right)$ with respect to the full OPE $\left(\Pi(M^2, s_0)\right)$. The smaller the $\Pi^{dimN}(M^2, s_0)/\Pi(M^2, s_0)$ ratio, the more reliable the suppression and broadening of higher-order contributions. In our study, we accepted the PC as minimum $PC \geq 0.22$.

Calculations verify that the operating windows that meet these conditions are correct:

$$\mathrm{M}^2 \in [2.7, 3.0]\ \mathrm{GeV}^2, \qquad \mathrm{s}_0 \in [17.5, 19]\ \mathrm{GeV}^2. \tag{3.3}$$

The mass of T_{cc}^{+} can be obtained from the ratio of the derivatives in Eq. (2.8). The mass exhibits a stable behavior within the selected Borel window M^2 and s_0 range in Eq. (2.13). The average mass is given below:

$$\mathrm{m} = (3.96 \pm 0.08)\ \mathrm{GeV}. \tag{3.4}$$

This result is in good compatible with the experimental measurement $(3874.75 \pm 0.17)\mathrm{MeV}$ reported by the LHCb Collaboration. Similarly, the decay constant is also obtained from Eq. (2.7). The resulting value is:

$$\mathrm{f} = (2.10 \pm 0.40) \times 10^{-3}\mathrm{GeV}^4. \tag{3.5}$$

These results are the values calculated for $\mathrm{M}^2 = 2.8\ \mathrm{GeV}^2$ and $\mathrm{s}_0 = 18.5\ \mathrm{GeV}^2$, which are the middle value of the Borel window and threshold parameter range given in Eq. (2.13). The PC value calculated at this midpoint is 0.50, indicating that the base case is dominant over the continuity and the reliability of the method used.

The results shown in the graph in Figure 1 are obtained from Eq. (2.8), where the hadron mass is calculated as the ratio of the derivatives of the Borel-transformed correlation functions. As can be seen, the resulting masses clearly show a weak dependence on the Borel window. The almost linear progression of the curves indicates that the results are stable against the Borel parameter. Considering that the PC we discussed in the previous pages remains within the acceptable range, the chosen method (QCDSRs) proves the accuracy and consistency of our calculations. After examining the stability of the results with respect to the Borel parameter, the dependence of the obtained mass on the continuity threshold parameter s_0 should also be

analyzed. Figure 2 shows the variation of the Borel parameter against the continuum threshold parameter s_0. As can be seen from the graph, the obtained masses increase smoothly and almost linearly as the continuum threshold parameter s_0 increases. Considering the close proximity of the mass lines corresponding to different M^2 selections, we can interpret that our mass estimates are weakly sensitive to the M^2 Borel window. Our mass value corresponding to the midpoint $M^2 = 2.8\ GeV^2$ and $s_0 = 18.5\ GeV^2$ lies within the stable region, confirming that the values we selected in our study are reliable and consistent.

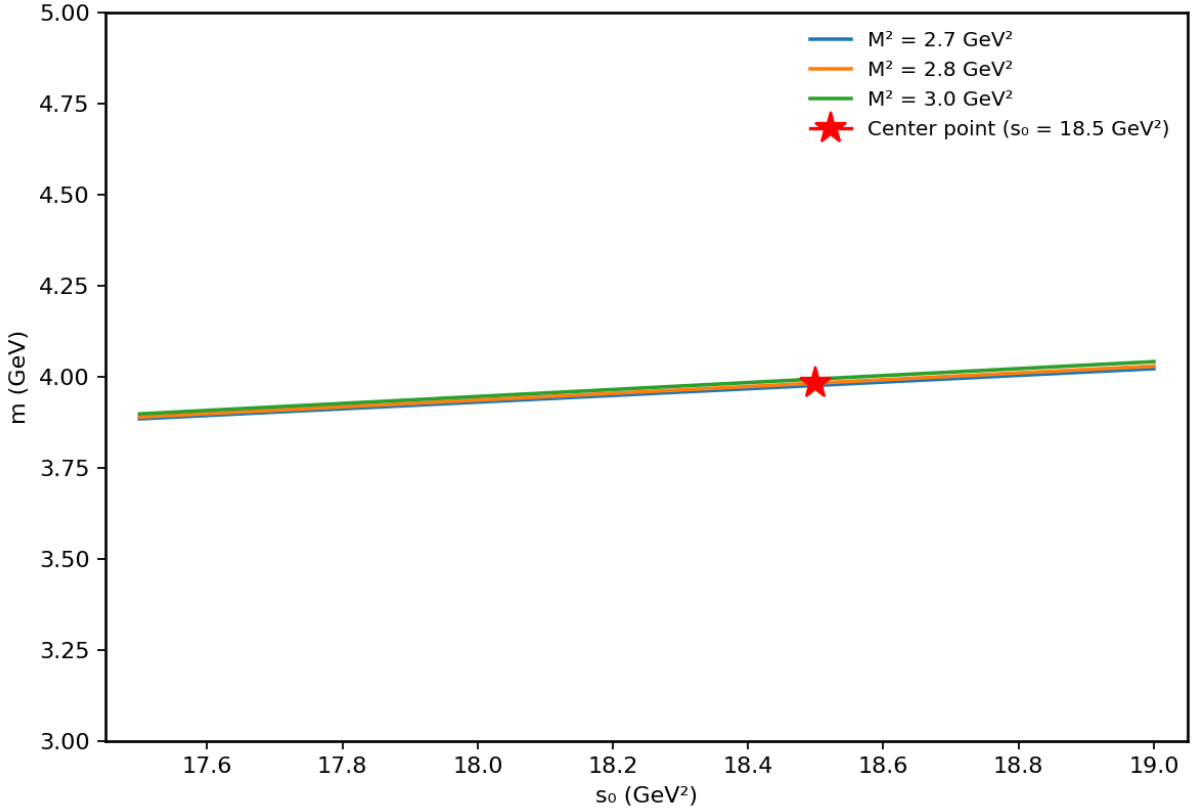

FIG. 1: The dependence of the mass of the T_{cc}^{+}, state on the Borel mass parameter M^2 for different values of the continuum threshold s_0.

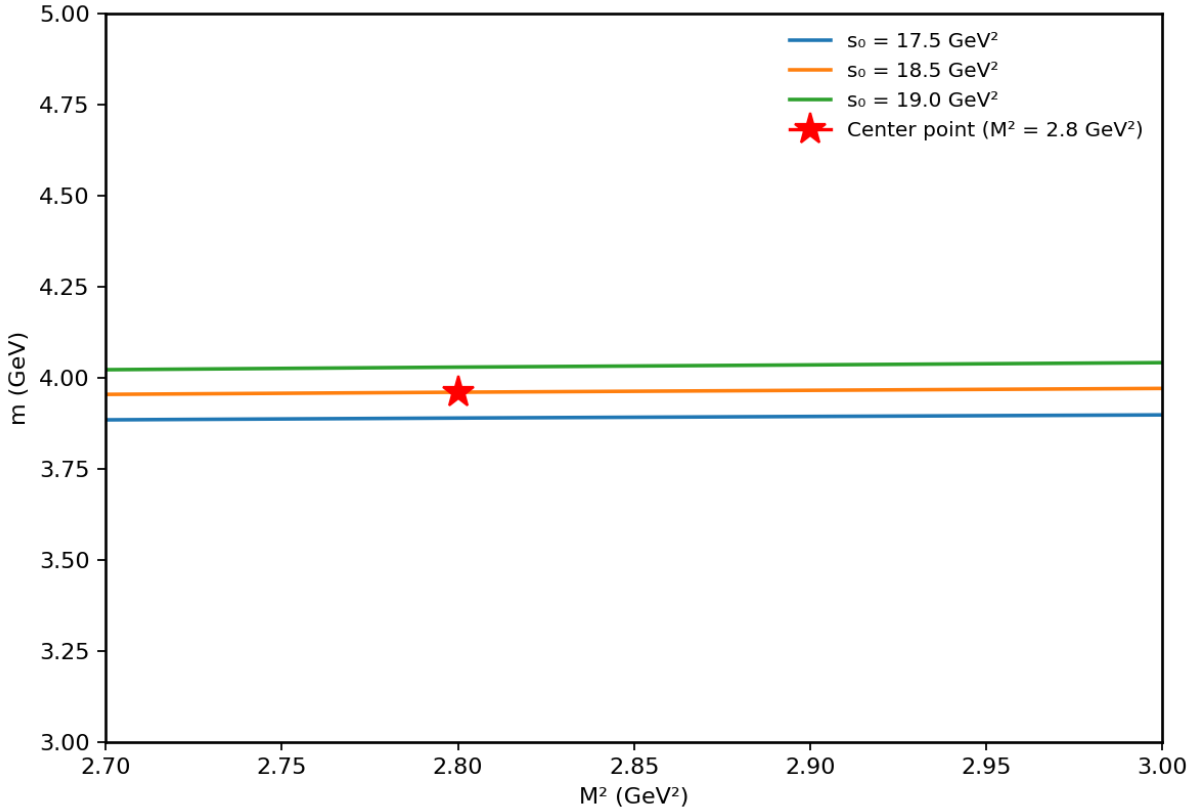

FIG. 2: The variation of the mass of the T_{cc}^{+} tetraquark with respect to the continuum threshold parameter s_0 for some fixed Borel parameters M^2.

Figure 3 shows the dependence of the decay constant $f_{T_{cc}}$ on the continuum threshold parameter s_0 for three different Borel mass parameters $M^2 = 2.7\,\text{GeV}^2, 2.8\,\text{GeV}^2$, and $3.0\,\text{GeV}^2$. The decay constant increases almost linearly with s_0 for all Borel values, confirming the smooth and consistent behavior of the summation rule. The blue area in the graph corresponds to the lower limit of the analysis range. In this region, the PC still has significant values ($PC \geq 0.22$), and the OPE convergence is not compromised; however, the decay constant exhibits a more stable behavior in the ranges where the continuum threshold parameter $s_0 \geq 17.9\,\text{GeV}^2$. Therefore, the final results are taken from the stable region above the blue area. In other words, this region represents a transition region rather than an unstable region. Beyond this range, the curves show almost excellent stability, indicating that the obtained decay constant depends only weakly on changes in M^2 and s_0, confirming the reliability of Eq. (2.7) within the selected operating window.

Figure 4 shows the variation of the decay constant $f_{T_{cc}}$ with respect to the Borel mass parameter M^2 for different continuum threshold values $s_0 = 17.5\,\text{GeV}^2, 18.5\,\text{GeV}^2$ and $19.0\,\text{GeV}^2$. As can be seen from the graph, the calculated $f_{T_{cc}}$ values exhibit a very weak dependence on M^2 throughout the selected Borel window. The nearly horizontal behavior of the curves indicates that the calculated decay constant is quite stable with respect to the Borel parameter. This behavior demonstrates the reliability of the analysis within the QCDSR approach and confirms the consistent convergence of the OPE. Furthermore, a light increase in $f_{T_{cc}}$ is observed as s_0 increases, which can be attributed to the broadening of the region contributing to the hadronic

part of the correlator as the continuum threshold increases. However, varying s_0 has only a minor effect on the decay constant, so the results remain stable with respect to the choice of s_0. The asterisk on the graph indicates the central point obtained for $\mathrm{M}^2 = 2.8\,\mathrm{GeV}^2$ and $s_0 = 18.5\,\mathrm{GeV}^2$, which was taken as the reference point for extracting the physical results of the study. Consequently, this weak dependence of $f_{T_{cc}}$ on both M^2 and s_0 clearly confirms the reliability of the QCDSR analysis and the obtained decay constant value.

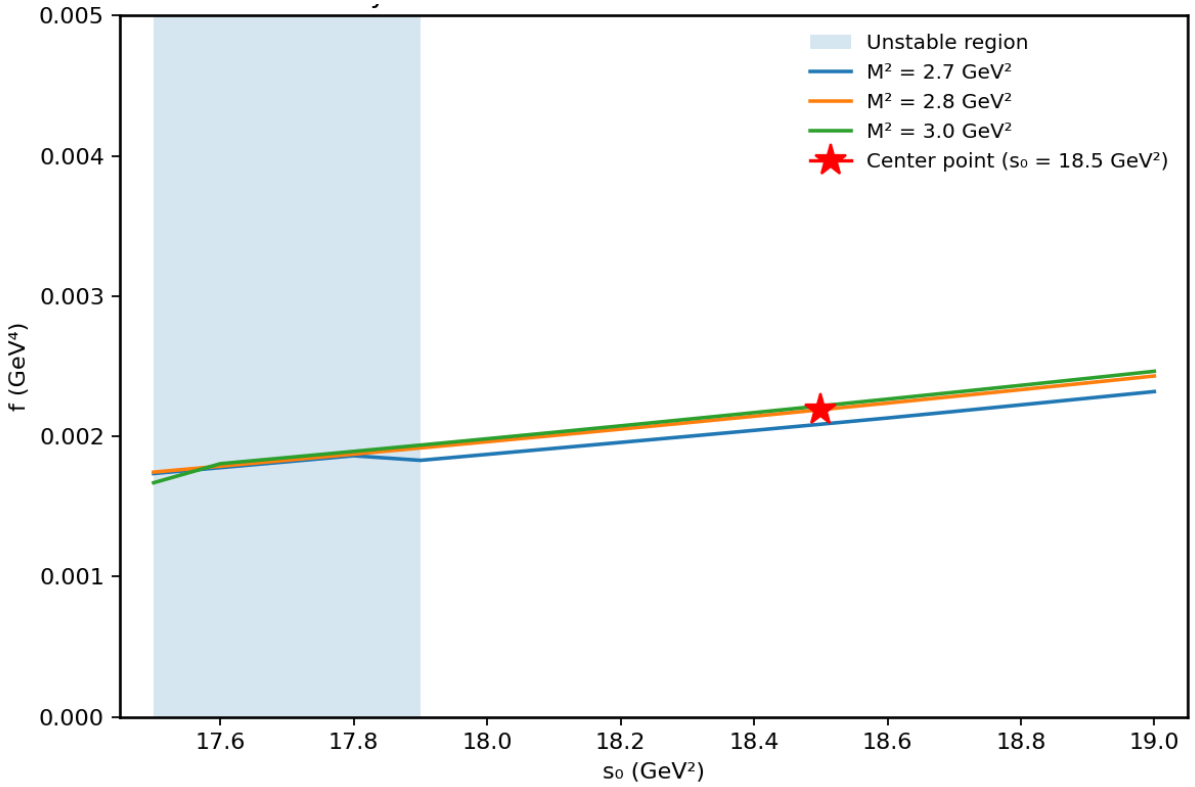

FIG. 3: Dependence of f on s_0; the blue region indicate the unstable area and the red star shows the central point.

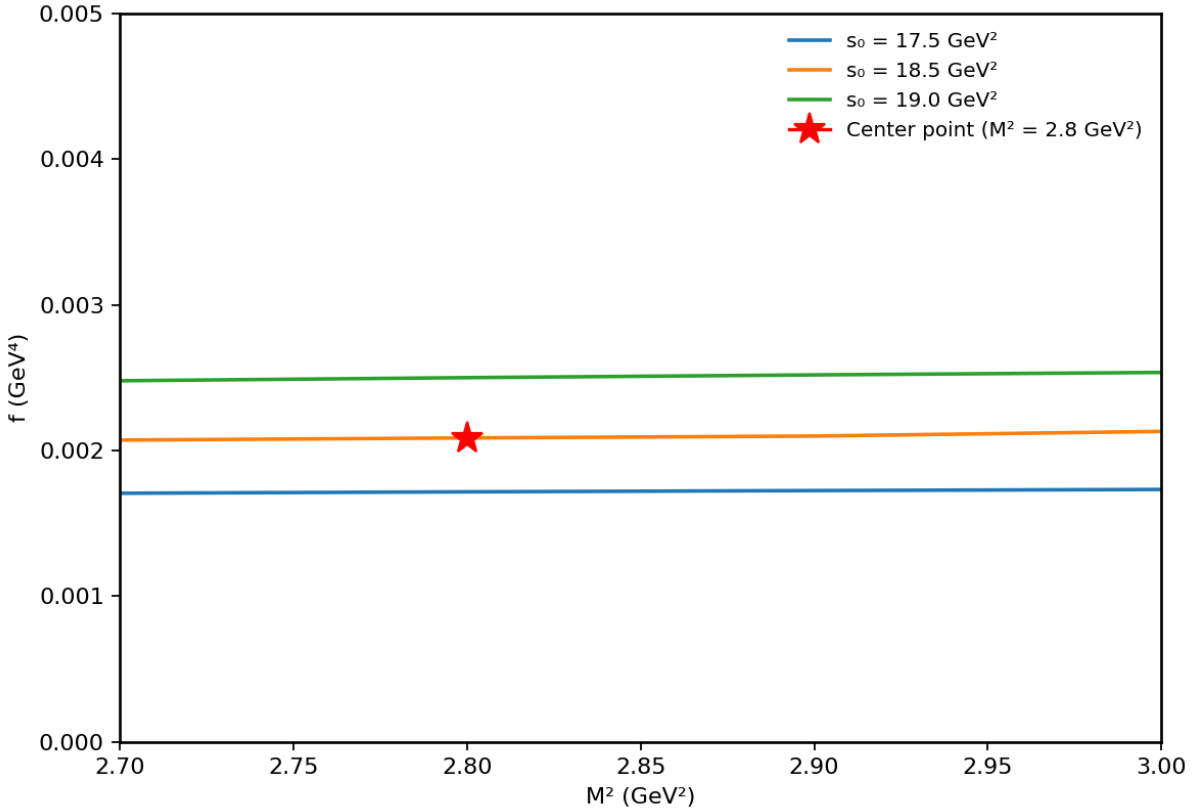

FIG. 4: Variation of the decay constant f with the Borel parameter M^2 for several s_0 values. The red star symbols denote the central points of each curve.

CONCLUSION

In this paper, we observed the spectral properties of the exotic doubly charmed tetraquark candidate particle T_{cc}^{+} under the assumption of hadronic molecular configuration and QCDSRs with $J^P = 1^+$ quantum numbers. After creating an appropriate interpolating current for T_{cc}^{+}, which is formed by the combination of D^0 and D^{*+} meson-meson molecules, and substituting it into the two-point correlation function, we obtained the mass and decay constant of the particle in vacuum. Our results:

$$m_{T_{cc}} = (3.96 \pm 0.08)\ \text{GeV}, \quad f_{T_{cc}} = (2.10 \pm 0.40) \times 10^{-3}\ \text{GeV}^4. \qquad (4.1)$$

Our mass value of $m_{T_{cc}} = (3.96 \pm 0.08)$ GeV is consistent with the mass value of $m_{T_{cc}} = 3874.75 \pm 0.17$ MeV found experimentally by the LHcb collaboration (Aaij et al., 2022b) and this result strongly supports the reliability of the method and that the T_{cc}^{+} particle can be interpreted as a D^0D^{*+} molecule. Furthermore, our findings are consistent with previous studies using the QCDSRs method, which interpreted T_{cc}^{+} as the weakly bound D^0D^{*+} molecular state. It is worth noting that no precise reference value for the decay constant f for T_{cc}^{+} is available in the literature, making a direct one-to-one comparison difficult. Nonetheless, the obtained decay constant $f_{T_{cc}} = (2.10 \pm 0.40) \times 10^{-3}$ GeV^4 is slightly smaller than the values reported in other

QCDSR studies. For instance, Agaev, Azizi, and Sundu found $f_{T_{cc}} = (5.1 \pm 0.8) \times 10^{-3}$ GeV^4 (Agaev et al., 2022), while Wang (Xin & Wang, 2022) calculated the decay constant (polar residue) of the isoscalar combination $D^*D - DD^*$ as $\lambda_T = (1.92 \pm 0.29) \times 10^{-2}$ GeV^5. However, this result refers to the isospin $I = 0$ mixing rather than the charged component D^0D^{*+} considered in the present work. The difference between our result and the literature values may be due to the choice of a narrower Borel window ($M^2 = 2.7 - 3.0$ GeV^2), the consideration of the OPE series up to the sixth dimension, or the shape of the antisymmetrized current used. Differences in continuum threshold, condensate values, and normalization conventions may also explain some of the difference. However, since the basic QCDSR consistency conditions such as OPE convergence, pole dominance above 22% and proper Borel stability are met in our study, we can say that our obtained decay constant value is reliable. The QCDSR method used in this study successfully combines both perturbative and non-perturbative effects, enabling a realistic description of the non-trivial QCD vacuum structure. To verify the accuracy of the working window, the convergence of the OPE expansion and the dominance of the PC are carefully analyzed. Within this region, the PC exceeds 22%, indicating that the ground sta interpolating current te dominates the correlation function. These results, along with the smooth behavior of the Borel curves, confirm the reliability of the extracted physical observables. In addition, the findings in our study are consistent with other studies in the literature; Agaev, Azizi, and Sundu (Agaev et al., 2022), Ren, Wu, and Zhu (Ren et al., 2022), and Wang (Xin & Wang, 2022) and S.S.Farah (Ferah & Ozpineci, 2025) considered T_{cc}^+ as a hadronic molecule. Furthermore, model and effective field theory analyses by Oset and his colleagues (Dai et al., 2023), Chen (Chen et al., 2021) also support this structure, and they believe that T_{cc}^+ consists of a meson-meson molecule.

To minimize these systematic uncertainties and clarify the reason for the difference, future work should include a more detailed examination of the dependence of f on the Borel parameter and the continuum threshold, cross-checks using alternative interpolating currents, and the inclusion of higher-dimensional condensate terms. Our suggestion is that incorporating next-to-leading order (NLO) QCD (Abolnikov et al., 2025) corrections to the decay spectral density will increase the precision of the inferred decay constant and mass by accounting for $Q(\alpha_s)$ contributions.

REFERENCES

Aaij, R., et al. (2022a). Observation of an exotic narrow doubly charmed tetraquark. *Nature Physics, 18*(7), 751–754. https://doi.org/10.1038/s41567-022-01614-y

Aaij, R., et al. (2022b). Study of the doubly charmed tetraquark T_{cc}^+. *Nature Communications, 13*(1), 3351. https://doi.org/10.1038/s41467-022-30206-w

Abolnikov, M., Baru, V., Epelbaum, E., Filin, A. A., Hanhart, C., & Meng, L. (2025). Internal structure of the $T_{cc}(3875)^+$ from its light-quark mass dependence. *Physics Letters B, 860*, 139188. https://doi.org/10.1016/j.physletb.2024.139188

Agaev, S. S., Azizi, K., & Sundu, H. (2022). Hadronic molecule model for the doubly charmed state T_{cc}^{+}. *Journal of High Energy Physics, 2022*(6), 57. https://doi.org/10.1007/JHEP06(2022)057

Azizi, K., & Süngü, J. Y. (2019). On the mass and decay constant of the P-wave ground and radially excited h_c and h_b axial-vector mesons. *Journal of Physics G: Nuclear and Particle Physics, 46*(3), 035001. https://doi.org/10.1088/1361-6471/aaee21

Chen, R., Huang, Q., Liu, X., & Zhu, S. L. (2021). Predicting another doubly charmed molecular resonance $T_{cc}^{+}(3876)$. *Physical Review D, 104*(11), 114042. https://doi.org/10.1103/PhysRevD.104.114042

Choi, S. K., et al. (2003). Observation of a narrow charmoniumlike state in exclusive $B^{\pm} \rightarrow K^{\pm}\pi^{+}\pi^{-}J/\psi$ decays. *Physical Review Letters, 91*(26), 262001. https://doi.org/10.1103/PhysRevLett.91.262001

Colangelo, P., & Khodjamirian, A. (2001). QCD sum rules: A modern perspective. *At the Frontier of Particle Physics*, 1495–1576. https://doi.org/10.1142/9789812810458_0033

Dai, L. R., Abreu, L. M., Feijoo, A., & Oset, E. (2023). The isospin and compositeness of the $T_{cc}(3875)^{+}$ state. *European Physical Journal C, 83*(10), 983. https://doi.org/10.1140/epjc/s10052-023-12159-6

Ferah, S. S., & Ozpineci, A. (2025). T_{cc}^{+} and hidden charm tetraquarks 1^{+} and 0^{+} in QCD sum rules and heavy-quark spin symmetry. *arXiv*. https://doi.org/10.48550/arXiv.2502.06003

Güngör, E., Sundu, H., Süngü, J. Y., & Veliev, E. V. (2023). Possible molecular explanation for the resonance $Y(4500)$. *Few-Body Systems, 64*(3), 53. https://doi.org/10.1007/s00601-023-01807-y

Hosaka, A., Iijima, T., Miyabayashi, K., Sakai, Y., & Yasui, S. (2016). Exotic hadrons with heavy flavors: X, Y, Z, and related states. *Progress of Theoretical and Experimental Physics, 2016*(6), 062C01. https://doi.org/10.1093/ptep/ptw045

Ioffe, B. L. (2003). Condensates in quantum chromodynamics. *Physics of Atomic Nuclei, 66*(1), 30–43. https://doi.org/10.1134/1.1540654

Ioffe, B. L. (2006). QCD at low energies. *Progress in Particle and Nuclear Physics, 56*(1), 232–277. https://doi.org/10.1016/j.ppnp.2005.05.001

Maiani, L., Pilloni, A., Polosa, A. D., & Riquer, V. (2023). Doubly heavy tetraquarks in the Born–Oppenheimer approximation. *Physics Letters B, 836*, 137624. https://doi.org/10.1016/j.physletb.2022.137624

Narison, S. (2023). *QCD as a theory of hadrons*. Cambridge University Press. https://doi.org/10.1017/9781009290296

Reinders, L. J., Rubinstein, H., & Yazaki, S. (1985). Hadron properties from QCD sum rules. *Physics Reports, 127*(1), 1–97. https://doi.org/10.1016/0370-1573(85)90065-1

Ren, H., Wu, F., & Zhu, R. (2022). Hadronic molecule interpretation of T_{cc}^{+} and its beauty partners. *Advances in High Energy Physics, 2022*, 9103031. https://doi.org/10.1155/2022/9103031

Shifman, M. A., Vainshtein, A. I., & Zakharov, V. I. (1979a). QCD and resonance physics: Applications. *Nuclear Physics B, 147*(5), 448–518. https://doi.org/10.1016/0550-3213(79)90023-3

Shifman, M. A., Vainshtein, A. I., & Zakharov, V. I. (1979b). QCD and resonance physics: Theoretical foundations. *Nuclear Physics B, 147*(5), 385–447. https://doi.org/10.1016/0550-3213(79)90022-1

Temizer, M., Sundu, H., Süngü, J. Y., & Veliev, E. V. (2024). Spectroscopic parameters of $K^{*}(892)$ and its first two excited states. *ResearchGate preprint.* https://doi.org/10.13140/RG.2.2.21210.35525

Particle Data Group. (2024). Review of particle physics. *Physical Review D, 110*(3), 030001. https://doi.org/10.1103/PhysRevD.110.030001

Xin, Q., & Wang, Z. G. (2022). Analysis of the doubly charmed tetraquark molecular states with QCD sum rules. *European Physical Journal A, 58*(6), 110. https://doi.org/10.1140/epja/s10050-022-00752-4

T.C.
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İletişim Fakültesi

2025 AİLE YILI

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Konu : Görevlendirme Talebi (Dr. Öğr. Üyesi Hakan KÜRKÇÜOĞLU)

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