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CONGRESS**

**December 20-21, 2024  
Istanbul**

**CONGRESS BOOK**

isrAcademy  
Publishing  
isbn: 978-625-95570-0-7



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December 2024



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Asst. Prof. Dr. Krzysztof DROZDZOL (Opole University of Technology, Poland)  
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Dr. Ernest Kováč (Comenius University, Slovakia)  
Dr. Wafa BOULAGOUAS (University of Batna, Algeria)

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Coordinator: Ummugulsum Kuzubas EYIGUN (Kocaeli University)

# International Scientific Research Congress

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# International Scientific Research Congress

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(Online)

## CONGRESS PROGRAM

## PARTICIPATING COUNTRIES

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Algeria  
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Hungary  
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KKTC  
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Oman  
Pakistan  
Poland  
Romania  
Russia  
South Africa  
Sri Lanka  
Sudan  
Turkiye  
United Kingdom  
United States  
Vietnam

December 20, (Friday)

10.00 - 12.00

SESSION - 1 HALL - 1

Moderator: Asst. Prof. Dr. Atina Shofawati

AUTHORS	AFFILIATION	TITLE
Mihai-Andrei Lazăr	Babeş-Bolyai Univeristy of Cluj- Napoca	The Noun Phrase in Dosoftei's Writings. The Quantifier
Ana Morari (Bayraktar), Dr. Andreea – Nicoleta Dragomir	University Lucian Blaga of Sibiu	Preserving Human Dignity: The Impact of European and International Public Law on Managing Mass Graves
Mihai Rotaru	Alexandru Ioan Cuza University of Iaşi	Verbal Errors of Romanian Learner English: Causes and Solutions
Asst. Prof. Dr. Atina Shofawati	Universitas Airlangga	Performance of Capital Market at the Covid 19 Pandemic Period in Indonesia: Bibliometrics Approach
Maisha Karim	UCSI University, Bangladesh Branch Campus	Women in Peace and Reconciliation: Lessons from Bosnia-Herzegovina and Northern Ireland

Science and Engineering

December 20, (Friday)  
10.00 - 12.00

SESSION - 1 HALL - 2  
Moderator: Prof. Dr. Yılmaz UYAROĞLU

AUTHORS	AFFILIATION	TITLE
Fatih SALİHOĞLU Prof. Dr. Yılmaz UYAROĞLU	Sakarya University	Ferroresonance Analysis and Artificial Intelligence Based Detection in Electrical Power Systems
Emre ÖZDEMİR Prof. Dr. Yılmaz UYAROĞLU	Sakarya University	Artificial Intelligence Based Busbar Differential Protection System
Zülfiye Melisa SAYGINER	Yıldız Technical University	Comparison of Techniques that Increase RSA Speed
Dr. Berrak ÇALIŞKAN Prof. Dr. Enes ŞAYAN	Atatürk University	Effect of Synthesized Nanocomposite Photo-Cathode Electrodes on the Performance of Dye Sensitized Solar Cells

December 20, (Friday)  
12.30-14.30

SESSION - 2 HALL - 1  
Moderator: Prof. Dr. Stefan Balint

AUTHORS	AFFILIATION	TITLE
Dr. Andreea V. Cojocaru Prof. Dr. Stefan Balint	West University of Timisoara	Neuro-psychological interpretations of mathematical results reported in case of continuous- time Hopfield Neural Networks. Part 1.
Dr. Andreea V. Cojocaru Prof. Dr. Stefan Balint	West University of Timisoara	Neuro-psychological interpretations of mathematical results reported in case of discrete- time Hopfield Neural Networks. Part 2.
Assoc. Prof. Dr. Monika Choudhary, Res. Asst. Saloni Singh Parihar	Sharda University Agra	Reducing carbon Footprint and Enhancing Sustainability in Natural Printing Practices via Imprint Technology using Pre-Mordant and Post-Mordant Techniques on Cotton Fabric Printing with Flower and Leaf
Saisandri Saini	MNIT, Jaipur	Exploring $\alpha$ -Starobinsky Inflation: Observational Constraints Starobinsky Inflation: Observational Constraints
Khalid A. Abouda Xu Degang Wail M. Idress Hager M. Elmaki Aala A. Ahmed Waleed M. Idress	Central South University Alzaiem Alazhari University Omdurman Islamic University	Multi-Modal Spatio-Temporal Fusion Classifier for Real-Time Flotation Process Monitoring and Optimization Using PCA and GRU
Prof. Dr. Mohamed MOUHINE Mina DERIFE Said ABOUMDIAN Taoufik TBATOU	Ibn Tofail University	Seismic Risk Improvement for Irregular Building Structures by Incorporating Shear Walls

December 20, (Friday)  
12.30-14.30

SESSION - 2 HALL - 2  
Moderator: Dr. Irina-Ana DROBOT

AUTHORS	AFFILIATION	TITLE
Assoc. Prof. Dr. Agnes KÖRNYEI	Pázmány Péter Catholic University	"Multilateral Cultural Diplomacy" has been accepted for presentation at the "International Scientific Research Congress
Dr. Irina-Ana DROBOT	Technical University of Civil Engineering Bucharest	The Novel <i>Tomorrow</i> by Graham Swift: Why Does It Have No Ending?"
Dr. Irina-Ana DROBOT	Technical University of Civil Engineering Bucharest	The Short Story <i>The Duchess and the Jeweller</i> by Virginia Woolf: an Analysis
Dr. Ghiță Iulia-Adelina Assoc. Prof. Dr. Eftimie Simona	Petroleum - Gas University of Ploiești	Academic Motivation and Self-Efficacy: An Integrative Analysis Using MSLQ and SELF to Predict Learning Outcomes
Dr. Ghiță Iulia-Adelina Assoc. Prof. Dr. Eftimie Simona Dr. Stan Angela	Petroleum - Gas University of Ploiești	Interventions for Enhancing Motivation and Self-Efficacy in Educational Settings
Theodora Melista	Hellenic Mediterranean University	The Integration of Gender Identity in Social Work Education: Ethical and Deontology

Health Sciences

December 20, (Friday)

15.00 - 17.00

SESSION - 3 HALL - 1

Moderator: Asst. Prof. Dr. Burcu SEZGİN

AUTHORS	AFFILIATION	TITLE
Asst. Prof. Dr. Burcu SEZGİN	Eskişehir Osmangazi University	Comparison of Greenness Profiles of Chromatographic Methods Used for the Determination of Macrolide Group Antibiotics in Environmental Waters
Yeşim ASLAN	İstanbul Aydın University	EMDR Terapisi ile Kaygının Ele Alınması: Bir Olgu Sunumu
Lect. Muhammed Pınar Assoc. Prof. Dr. Işıl Öz	KTO Karatay University, Başkent University	Use of Contralateral Suppression Test in Evaluation of Efferent Auditory System
Lect. Muhammed Pınar Dr. Özge Kale Nedim Turğut	KTO Karatay University, Başkent University	Use of Virtual Reality in Benign Paroxysmal Positional Vertigo
Asst. Prof. Dr. Hasan DAĞLI Dr. İbrahim Seyfettin ÇELİK	Kahramanmaraş Sütçü İmam University	Investigation of the Effects of Tribulus Terrestris (TT) and Its Compounds on Healthy Cells
Agata ALEKSA Prof. Dr. Magdalena ROST-ROSKOWSKA Dr. Łukasz CHAJEC	University of Silesia in Katowice	Effects of Nano Styrene on the Midgut of Soil Invertebrate <i>Lithobiusforficatus</i> - Preliminary Studies
Asst. Prof. Dr. Wissam Bouhidel Prof. Dr. Benhassine Wissal	University of Batna 2	The Joint Health and Safety Commission and the Challenges of Workplace Adjustments

December 20, (Friday)  
15.00 - 17.00

SESSION - 3 HALL - 2  
Moderator: Asst. Prof. Dr. Sibel ÇALIŞKAN ERCAN

AUTHORS	AFFILIATION	TITLE
Yeliz Arslan Turan Asst. Prof. Dr. Sevgi Şahin	Atılım University Başkent University	EFL Instructors' Perceptions of ICC (Intercultural Communicative Competence) in Türkiye Context
Aysu ŞAHİN	İstanbul Aydın University	The Use of EMDR (Eye Movement Desensitization and Reprocessing) in the Treatment of Specific Phobia
Dr. Hilal GÜRLER	Türkiye	Determination of Metaphorical Perceptions Of Students Learning Turkish As A Foreign Language towards Turkish
İlyas DAL Asst. Prof. Dr. Sibel Çalışkan Ercan	İstanbul Arel University	A Qualitative Evaluation on the Historical Development of Local Governments in Turkey
Dr. Güzde TOPRAKCI ALP	Akdeniz University	Participation of Women in the R&D Workforce



December 20, (Friday)

17.30 – 19.30

SESSION - 4 HALL - 1

Moderator: Assoc. Prof. Dr. Nikolaos Trihas

AUTHORS	AFFILIATION	TITLE
Dr. Charikleia Pitsou Sophia Kouzouli	University of Patras Directorate of Secondary Education of Eleia	Sustainable Development Goals as a Catalyst for Forming Global Citizens in Democratic Educational Contexts
Dr. Charikleia Pitsou Sophia Kouzouli	University of Patras Directorate of Secondary Education of Eleia	Cultural Heritage, Sustainable Development Goals, and Digital Citizenship through an Interdisciplinary Learning Scenario
Assoc. Prof. Dr. Nikolaos Trihas Lect. Ioannis Valachis Asst. Prof. Dr. Emmanouil Perakakis Asst. Prof. Dr. Konstantinos Tsilimpokos	Hellenic Mediterranean University Hellenic Open University University of the Aegean	Disintermediation in Travel Distribution Channels: The New Role of Travel Agencies in the Changing Tourism Industry
Lect. Ioannis Valachis Assoc. Prof. Dr. Nikolaos Trihas Asst. Prof. Dr. Emmanouil Perakakis	Hellenic Open University Hellenic Mediterranean University	Innovative Initiatives In Destination Management to Achieve Sustainable Tourism Development
Nikos Roumpis	Hellenic Open University	Diames: Educational Material for Teaching Greek as a Foreign Language to Refugees & Immigrants

December 20, (Friday)

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SESSION - 4 HALL - 2

Moderator: Asst. Prof. Dr. Sunder BUKYA

AUTHORS	AFFILIATION	TITLE
Dr. Aida Smajlagić Asst. Prof. Dr. Amra Džambić Asst. Prof. Dr. Merima Ibišević	University of Tuzla	Synthesis and characterization of ibuprofen complex with Cu(II)-ion
Asst. Prof. Dr. Jasmina Dedić Asst. Prof. Dr. Edina Huseinović Emina Mehmedović Emir Horozić	University of Tuzla	The Effect of Different Solvents and Their Aqueous Mixtures on the Polyphenol Content and Antioxidant Activity of <i>NIGELLA Sativa</i> Seed Extracts
Filip Petrovski	Ss. Cyril and Methodius University - Skopje	Application of Global Geopotential Models and Digital Terrain Models for Determination of Local Geoid Model
Amadi Ugwunna Dickson Godpower C. Enyi Nuhu Mohammed	University of Salford	Model for Predicting Density and Viscosity of CO <sub>2</sub> for Enhanced Gas Recovery and Carbon Sequestration in Depleted Gas Reservoir: A Case study of Niger-Delta Formation
Ms. Sharifa Bakhit Al-Awaid Dr. Sivamani Selvaraju	Univresity of Technology and Applied Sceinces, Salalah	Transformation From Traditional to Contemporary Techniques in Sand Filter Bed: A Review
Manogna CHALASANI Anushka MOHANTY Asst. Prof. Dr. Sunder BUKYA	Mahindra University, Hyderabad, India	Exploring Cognitive Load and Behavioral Intention in Online Food Delivery Services: Insights from the Indian Market

December 21, (Saturday)

10.00 – 12.00

SESSION - 1 HALL - 1

Moderator: Asst. Prof. Dr. Umut Şah

AUTHORS	AFFILIATION	TITLE
Eliška Nacházlová	Jan Evangelista Purkyně University	Regional Differences in Motivations regarding Labor Mobility: University Students' Perspective
Busenur Atila Asst. Prof. Dr. Umut Şah	European University of Lefke	The Mediating Role of Romantic Intimacy in the Relationship Between Emotional Attachment and the Perception of Shared Happiness in Adults
Tuğçe Sarı Asst. Prof. Dr. Umut Şah	European University of Lefke	Attachment Styles, Self-Construal, and Perceived Stress in University Students
Chadia Qotni	University Moulay Ismail, Meknès	The Intelligent Coherent States of a Spin System
Emmanuel Ofori Ntim Dr. Mawuko Dza	University of Ghana University of Education	Ghana's Debt Restructuring Debacle: Securing Debt Sustainability to Deepen Economic Woes

December 21, (Saturday)

10.00 – 12.00

SESSION - 1 HALL - 2

Moderator: Assoc. Prof. Dr. Jostina Dhimitri

AUTHORS	AFFILIATION	TITLE
Assoc. Prof. Dr. Muhamad Fazil Ahmad	Universiti Sultan Zainal Abidin	An AI Chatbot Communication for Micro-Learning in Higher Education
Assoc. Prof. Dr. Muhamad Fazil Ahmad	Universiti Sultan Zainal Abidin	Intertwining Threads of Sustainability: A Comparative Study of Ryukyu Bingata and Kasuri with Terengganu Batik and Songket
Assoc. Prof. Dr. Jostina Dhimitri Xhuliana Zdrava	University "Eqrem Çabej"	Degradation Risk Assessment for conservation priorities in Albania's geosites focus on Gradec and Osum canyons, and Pirrogashi Cave
Xhuliana Zdrava	University "Eqrem Çabej"	A comprehensive Evaluation Approach using Geosite Assessment Model, the case of Sotira and Bogova Waterfalls in Albania
Ayon Deb Omar Faruk	The University of Adelaide Aarhus University	The Jaganmohan Community and the Influence of Their Akhara Culture in Habiganj, Bangladesh
Yuri Iliev	Sofia University	The Holy Eucharist and the Eschaton
Dr. Bejan OCTAVIAN	Center for Criminological Prevention and Assistance	Towards a Deeper Understanding of Global Economic Processes

Science and Engineering

December 21, (Saturday)

12.30 – 14.30

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Moderator: Prof. Dr. Roslan Zainal Abidin

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Ngo Quang Duc Nguyen Quang Hoc Tran Anh Tuan Le Nguyen Dinh Khoi Pham Duy Hoang Nguyen Bich Lam	Hanoi National University of Education	Effects of Magnetic Field and Structural Parameters on Multi-photon Absorption Spectra in Morse Quantum Wells with Electron-phonon Interactions
Prof. Dr. Mohd Ramzi Mohd Hussain Dr. Ali Saifuddin Nor Azhar Assoc. Prof. Dr. Izawati Tukiman Amira Arisya Mohamad Nadzri	International Islamic University Malaysia	Urban Green Space as Sustainable Environmental Health: A Review
Prof. Dr. Roslan Zainal Abidin Dr. Mohd Amirul Mahamud Assoc. Prof. Dr. Mohd Remy Rozainy Mohd Arif Zainol	Universiti Sains Malaysia	Forecasting Landslides with Regards to Rainfall Erosivity and Soil Erodibility
Prof. Dr. Roslan Zainal Abidin Dr. Mohd Amirul Mahamud Assoc. Prof. Dr. Mohd Remy Rozainy Mohd Arif Zainol	Universiti Sains Malaysia	Evaluation and Validation of Soil Loss Risk Level at Cameron Highlands Resort in Malaysia
Wail M. Idress Yuqian Zhao Khalid A. Abouda Aala A Ahmed Wifag Hassan Ola Abdalla Tahani Elhindi	Central South University, Omdurman Islamic University, Alzaiem Alazhari University, Sudan University of Science and Technology, K. Teaching Hospital of Dermatology and Venereology	Vision Transformer for Automated Onychomycosis Detection: A Scalable Solution for Resource-Limited Settings
Dr. Amer Ajanovic	University of Sarajevo	Parametric Impedance Matching in Coplanar Wavelength Transmission Lines for Radiofrequency Sensors
Dr. Amer Ajanovic	University of Sarajevo	Trigger Sound Signal Processing for Activating Automated Engineering Systems

December 21, (Saturday)

12.30 - 14.30

SESSION - 2 HALL - 2

Moderator: Asst. Prof. Dr. Emine Sevinç POSTACI

AUTHORS	AFFILIATION	TITLE
Gülşah ADANIR Prof. Dr. Petek BALLAR KIRMIZIBAYRAK	Ege University	Investigation of the Effects of Some Endoplasmic Reticulum Stress-Related Molecules in Combination with Cisplatin on Cisplatin-Resistant Lung Cancer
Burcu ÖZÇELİK	İstanbul Aydın University	Working on Self-Worth with EMDR: A Case Report
Gabriela GUTOWSKA-KURANT Assoc. Prof. Dr. Małgorzata KOSTECKA	University of Life Sciences in Lublin	The Role of Mindfulness as a Therapeutic Technique in the Treatment of Eating Disorders
Hacer YILMAZ Asst. Prof. Dr. Emine Sevinç POSTACI	Canakkale Onsekiz Mart University	Pre-Hospital Emergency Health Service Workers' Perception of Disaster Preparedness
<i>Asst. Prof. Dr. Bensekhria Nardjesse</i> Prof. Dr. Benhassine Wissal	Mostefa Benboulaid University, Batna 2, Algeria	Evaluation of Physical Workload in an Algerian Maternity: Risk Identification and Ergonomic Prevention Strategies
Asst. Prof. Dr. Bensekhria Nardjesse Prof. Dr. Benhassine Wissal	Mostefa Benboulaid University, Batna 2, Algeria	Application of the WISN Method for Assessing Healthcare Staffing Needs in a Maternal and Child Health Facility in Algeria

December 21, (Saturday)

15.00 – 17.00

SESSION - 3 HALL - 1

Moderator: Prof. Dr. Nursel DİLSİZ

AUTHORS	AFFILIATION	TITLE
Asst. Prof. Dr. F. NOBAKHT-ERSI M. HOSEINPOUR	Urmia University	The Impact of Geomagnetic Storm Conditions on the Ground Positions
Jahanzeab HUSSAIN Runmin ZOU Samina AKHTAR	Central South University, Wuhan University	Robust Frequency Regulation in Renewable Energy-Based Power Systems Using a Cascade Control Approach
Neşe Ceyda TEKDOĞAN Prof. Dr. Nursel DİLSİZ	Gazi University	Development and Electrochemical Analysis of Boron-Doped Graphene/Iron (II, III) Oxide Based Nanocomposites for Supercapacitors
Asst. Prof. Dr. Merve KIZILIRMAK TATU	Gazi University	The Use of Artificial Intelligence in Mental Health Care: Opportunities and Challenges
Kenan Selçuk ÖZKAN Prof. Dr. Arif GÖK	Kütahya Dumlupınar University	Improvement of Material Transportation in Conveyor Systems Using the TRIZ Methodology
Assoc. Prof. Dr. Hülya KARACA ATSAROS	Anadolu University	Metabolic Engineering of <i>S. Cerevisiae</i> to Produce Taxadiene

December 21, (Saturday)

15.00 - 17.00

SESSION - 3 HALL - 2

Moderator: Asst. Prof. Dr. Hatice Dođan

AUTHORS	AFFILIATION	TITLE
Halime GÖZLÜKAYA	Süleyman Demirel University / İstanbul Technical University	Examining Cultural Values in Urban Conversation Areas: Burdur Urban Site as a Case Study
Hatice HAMATOĞLU	Istanbul Aydın University	Addressing Generalized Anxiety Disorder with the Schema Therapy Approach: A Case Study
Uğur DUMAN	Erciyes University	In the Context of Allegory and the "Other," Emir Alper's Cinema From Beyond the Hill to Burning Days
Fethi AYGÜN	Hasan Kalyoncu University	The Effect of Macro-Economic Factors on Foreign Trade: The Example of Türkiye
Asst. Prof. Dr. Hatice DOĐAN	Nevşehir Hacı Bektaş Veli University	Similar Approaches to Woman in Talmud and Hadith Narratives



December 21, (Saturday)

17.30 - 19.30

SESSION - 4 HALL - 1

Moderator: Prof. Dr. Cavanshir ZEYNALOV

AUTHORS	AFFILIATION	TITLE
Tome GEGOVSKI	Ss. Cyril and Methodius University - Skopje	Application of the PSInSAR Technique for Monitoring Deformations in the City of Skopje
Prof. Dr. Cavanshir ZEYNALOV Sariya GASIMOVA	Nakhchivan State University	The Role of Technoparks in Education
Mahammad BAYRAMOV	Nakhchivan State University	Typological Characteristics Of Nakhchivan Mosques in XI-XIX Centuries
Dr. Ouassila TOUAFEK Lect. Naima TOUAFEK Prof. Dr. Mohamed EL HATTAB	Blida 1, Algeria; ENSB-Constantine, Blida 1, Algeria	Biosynthesis of Copper Oxide Nanoparticles and Determination of Their Antioxydant and Photocatalytic Properties
Dr. Imane TREA Prof. Dr. Mouhamed MAHFOUD Asst. Prof. Dr. Fadila HADDAD	Technology Houari Boumedienne, USTHB, Algeria	Blood Flow in Stenotic Vessels
Samia DEKKICHE Kaouthar BOUDIAF	University Batna2, Algeria	Contribution to the Prospection of the Biodiversity of Microbial Symbiotic Bacteria of <i>Cicer arietinum</i> in some Areas of the Aurès Region, Algeria
Samia DEKKICHE Kaouthar BOUDIAF	University Batna2, Algeria	Evaluation of The Anti-Fungal Potential of <i>Centaurea Omphalotricha</i>

December 21, (Saturday)

17.30 - 19.30

SESSION - 4 HALL - 2

Moderator: Prof. Dr. Boudjemaa Soumaya

AUTHORS	AFFILIATION	TITLE
Sonia Bianca Blaj	University of Medicine, Pharmacy, Science and Technology (UMFST)	Considerations on Civil Liability in cases of Pharmaceutical Malpractice
Assoc. Prof. Dr. Elyebdri Nassima Assoc. Prof. Dr. Baba Ahmed Siham Assoc. Prof. Dr. Miloud Abid Dalila Dr. Zatla Selma Chaima Prof. Dr. Abourezal Nesrine Prof. Dr. Lounici Ali	Abou Bekr Belkaid University University Hospital Center Tlemcen	Skin Rash Related to the Use of Wood Ash in Wound Healing, about a Case
Assoc. Prof. Dr. Elyebdri Nassima Assoc. Prof. Dr. Saida Hanane Zitouni Nourine Chaima Benkhira Hafsa Zaoui	Abou Bekr Belkaid University Oran University	Aromatherapy and Periodontal Diseases, a Systematic Review of Literature
Assoc. Prof. Dr. Natalia Fedorova Assoc. Prof. Dr. Maria Grigoreva Lect. Dmitry Dyukov Elena Prozorova	Novgorod State University Yaroslav the Wise	Age-related Features of the Layered Structure and Microcirculation of the Skin in Women with Different Morphotypes of Aging
Prof. Dr. Boudjemaa Soumaya Nadji Said Asst. Prof. Dr. Radjai Chahrazed Prof. Dr. Benaldjia Hannen Prof. Dr. Grainat Nadia Prof. Dr. Alamir Barkahoum Boulekroune Ines	University of Batna  University of Algiers	The Importance of Therapeutic Monitoring of Tacrolimus in Kidney Transplant Recipients for the Prevention of Side Effects
Dr. Anna Ostróžka Prof. Dr. Magdalena Rost- Roszkowska Dr. Łukasz Chajec Prof. Dr. Grażyna Wilczek	University of Silesia in Katowice	Effect of Nickel on the Midgut of Freshwater Shrimp <i>Neocaridina Davidi</i>

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# Multilateral Cultural Diplomacy

## *Specific Features and Added Value of Regional Cooperation*

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**Assoc. Prof. Dr. Ágnes KÖRNYEI**

Pázmány Péter Catholic University, Hungary

### **ABSTRACT**

Nowadays the political agenda already includes culture, an important sector of the international relations. There are specificities of international cultural cooperation for example not based on reciprocity alone, not depending on the culture and cultural richness of the participating countries, special inclusion of NGOs, much more diverse and complex toolbox than the traditional diplomacy.

The analysis focuses on the evolution of the cultural cooperation in the frame of international organizations established by states (cultural issues intertwined by economic interests, the utopian approach of the "intellectual cooperation", the appearance of the national cultures in intergovernmental organizations, the universal institutionalization), on the instruments of cultural diplomacy varying greatly from region to region (instruments commonly used by nation states as well, specific regional instruments (e.g. presidency, thematic year, regional awards, special programmes like Capital of Culture)).

Cultural diplomacy has to operate effectively in an increasingly competitive and expanding cultural space, where the norm crusader Europe's influence is steadily diminishing, so this study aims to provide an overview of the non-European regional IGOs (e.g. ASEAN, AU, LAS, OAS, OIC) and institutionalized international cooperation created on a linguistic or cultural basis (e.g. OIF, Ibero-American Summits, CPLP, TÜRKSOY) to demonstrate the generally accepted multilateral cultural diplomacy.

**Keywords:** cultural diplomacy, evolution of international cultural cooperation, toolbox of multilateral cultural diplomacy, regional IGOs' activity in cultural issues

The increasing role of culture and civilization in international relations is a generally accepted phenomenon today. Cultural cooperation is now a fundamental part of international politics, and the "global cultural landscape has changed rapidly over the past decades"<sup>1</sup>. The strengthening of cultural relations between states has also been encouraged at regional level, as it supports integration, fosters a favourable climate for economic and

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<sup>1</sup> Joint Communication from the European Parliament and the Council: Towards an EU strategy for international cultural relations <http://eur-lex.europa.eu/legal-content/HU/TXT/PDF/?uri=CELEX:52016JC0029&from=EN>

political cooperation and elevates a region's profile in the world. Beyond intergovernmental organisations with a specific linguistic or cultural bases, regional organisations with general political purposes are also integrating the cultural dimension into their cooperation.

Intergovernmental organisations, like nation states, have recognised the key role of cultural relations in building identity and fostering common self-definition (for example, by preserving cultural heritage, promoting cultural diversity or encouraging intercultural dialogue). This is particularly evident in multilateral organisations based on cultural, religious or linguistic grounds, shared cultural traditions or historical links among member states facilitate and strengthen regional cooperation.

Behind the increase in "supply", there is also an increase in "demand". Today, participation in international cultural programmes and projects is of growing importance: most countries are involved in multilateral cultural cooperation, whether universal (e.g. UNESCO, WIPO, World Bank) or regional. Some countries are more active, and others are very active in certain cultural fields<sup>2</sup>. It is interesting to note that, in the context of the European Union, the cooperation between Member States in third countries is also remarkable (see EUNIC) as part of the effort to create a common European identity.

The increasing political dimension to cultural relations in international organisations can be experienced mostly by cooperation but even in conflicts. For instance, the relations between the United States and UNESCO or the use of the International Organisation of La Francophonie (OIF) in the Franco-American cultural "war" illustrate these dynamics. Cultural cooperation has now developed in nearly all international organisations, depending of course on their original purpose. The role of culture is expanding even in the context of economic organisations (e.g. through the integration of education, cultural heritage into international development policy), but also in security-focused IGOs (see the concept of human security, the ideological basis of NATO, its current science policy).

This analysis focuses on the distinct characteristics of international cultural relations, explores their emergence in the framework of intergovernmental organisations set up by states, and reviews the toolbox available to IGOs, drawing on examples from nine<sup>3</sup> international organisations active in cultural fields. Additionally, the analysis briefly contrasts bilateral and multilateral cultural diplomacy, the official policy of the governments and evaluates whether internationally institutionalised cultural relations provide added value.

## 1. The Specificities of International Cultural Cooperation

Unlike other areas of international interaction, international cultural relations follow changes in political relations with a certain lag. The institutionalised mechanisms of cultural contacts, which are more complex and take longer to build up than other forms of

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<sup>2</sup> For example, France and Italy are very active in international archaeological projects and research, and Japan has set up generous foundations in cooperation with UNESCO (the Japanese Funds-in-Trust (JFITs) established by the Japanese government in areas of UNESCO's competence, such as eradicating illiteracy, protecting cultural heritage (cultural projects) and maintaining the ecosystem (scientific and research projects)) with particular focus on developing countries in Asia.

<sup>3</sup> African Union (AU), Organisation of American States (OAS), League of Arab States (LAS), Association of Southeast Asian Nations (ASEAN), Organisation of Islamic Cooperation (OIC), Organisation internationale de la Francophonie (OIF), Community of Ibero-American Nations (Comunidad Iberoamericana de Naciones, CIN) (it is not a real IGO yet), Community of Portuguese Language Countries (Comunidade dos Países de Língua Portuguesa, CPLP), International Organisation of Turkish Culture (TÜRKSOY) (originally named (*Türk Kültür ve Sanatları Ortak Yönetimi*, TÜRKSOY) and was later renamed the International Organisation of Turkish Culture (*Uluslararası Türk Kültürü Teşkilatı*), but the acronym was retained)

international relations, continue to operate for some time despite the cooling climate. The institutional background of cultural cooperation helps the other forms and elements of international relations to catch up and acts as a stabilising force. In times of crisis, when almost all forms of contact are suspended, cultural relations are the only means of maintaining relations. In moments of tension and conflict, external cultural relations serve as the only viable means of communication.

Cultural cooperation between countries, differing from other dimensions, does not rely on strict reciprocity (e.g. differences in language prevalence, translation costs). They can be established even if the parties do not share exactly the same burden, but each member of the project can contribute technical, creative or organisational expertise to the joint success.

Moreover, the necessity for cooperation does not depend on the culture or on the cultural richness of the country. A country with a luxuriant culture can exist without a robust cultural diplomacy (e.g. Greece, Egypt).

Interestingly, there is little correlation between a country's economic development or political system and the model of cultural diplomacy it employs. For instance, while Great Britain was a global power, it lagged behind less developed Italy in establishing the instruments of cultural cooperation during the last century. Nor can the political system be determining, since the former socialist states aggressively promoted cultural links to showcase ideological superiority, not be mentioned fascist and Nazi propaganda or Cold War public diplomacy either. The countries transitioning from the dictatorships, such as Greece, Spain and Portugal placed less emphasis on cultural cooperation.

The contemporary expansion of cultural diplomacy also reflects the emergence of new actors. For example, nations like China, South Korea, and Turkey are rapidly increasing their investments in cultural institutions and programs. Historically, cultural relations were predominantly bilateral, but the rise of multilateral cooperation can be observed. Although multilateral cooperation requires much more time, patience and other resources to reconcile different objectives, expectations and interests. Cultural conventions had already been reached between the two world wars, but it was only in the second half of the last century that the process accelerated. Then the number of potential partners increased dramatically, first with the independence of the former colonies and then, more culturally relevant, with the dissolution of the federations in the east of Europe (Czechoslovakia, the Soviet Union, Yugoslavia).

A specific feature is that different areas of culture have different degrees of potential for cooperation. For example, there is no doubt that language is strongly linked to identity, so it is difficult to build cooperation in this area (but e.g. encouraging translations with public support). Even between countries speaking the same language<sup>4</sup>, there can be difficulties, as language also reflects a way of thinking. The use of lingua franca - Latin in the past, and later French in diplomacy or Portuguese in trade in certain regions, not to mention the role of English today - requires a specific approach and may pose the risk of "linguistic imperialism". Smaller countries with less widely spoken languages are therefore more likely to be able to assert themselves only in fields unrelated to language, such as music or the fine arts like Italy.

Further different national models<sup>5</sup> of international cultural cooperation have evolved according to the degree of political influence and historical traditions, which are much more

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<sup>4</sup> e.g. differences between Brazilian and European Portuguese (Portuguese Language Orthographic Agreement of 1990)

<sup>5</sup> Környei, Ágnes: Models of cultural diplomacy *Grotius- Studies* 2015 [Magyarország szomszédsági kapcsolatainak a jövője](#)

diverse and complex than the traditional institutional set-up of diplomacy. There are relatively autonomous models operating through 'arms' length' agencies (e.g. British Council, ICCR) and there are systems based on bodies operating under the direct influence of foreign policy (like France, Italy). Some countries have built up a complex institutional structure (e.g. Germany), others have created a network with a small number of agencies in a narrow field (e.g. Scandinavian countries, Central Europe). One approach relies heavily on NGOs playing an important role since the development of cultural external relations (see France), while others are top-down systems without NGOs (e.g. China) or through pseudo-foundations (e.g. the US during the Cold War).

## **2. The Formulation of Cultural Diplomacy**

Until the beginning of the 20<sup>th</sup> century, there was no institutionalised cultural cooperation, and the actors involved in cultural external relations were not guided by a single set of objectives.

In 1912, the cultural historian Karl Lamprecht from Leipzig gave a lecture on international understanding in Heidelberg, which has been quoted ever since, where he already formulated a few building blocks of a cultural foreign policy (schools abroad etc.). Although the First World War did not give way to this vision, in the following years a new form of diplomacy was born, cultural diplomacy, whose methods and instruments were different from those of other areas of diplomacy. The institutionalisation of cultural diplomacy, the emergence of multilateral governmental cooperation in the area of culture came into existence after the First World War.

In fact, it was the Cold War that exposed cultural diplomacy, as countries could use it specifically to promote their own political systems, to showcase and emphasise their good points. During the Cold War, there was a 'battle' in the field of science (e.g. space exploration) or art, which further increased the role of art in politics, with artists becoming known not only nationally but also internationally.

The area of cultural relations has been of particular importance since the 1960s, with a significant increase both in volume and in proportion of international relations. It increasingly took on a distinct identity and became separate from the other areas of international relations: political, economic and military relations. In 1966, the German Foreign Minister Willy Brandt described cultural foreign relations as the third pillar alongside politics and trade. In the US conception in this period, culture appeared as a 'fourth dimension'<sup>6</sup> alongside these three classical areas, namely political interests, commercial interests and the military and defence policy associated with the pursuit of these interests.

The importance of cultural diplomacy has increased moving from the bipolar world of the Cold War to the uncertainties of a multipolar world. This has profound implications for the ways in which nations construct and project their national identities. Cultural, religious and ethnic factors now play a more significant role than ever in collective and self-defining. Emerging Asian powers have understood the importance of culture and use it deliberately as a tool<sup>7</sup>, while also developing different economic and political models that compete with the West. Today, we are therefore talking about a new era of cultural diplomacy, about a competitive space.

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<sup>6</sup> Coombs, Philip H.: *The Fourth Dimension of Foreign Policy: Educational and Cultural Affairs*, Harper & Rows, New York 1964. pp.158.

<sup>7</sup> 2004 Confucius Institute, 2005 King Sejong Institute (Sejong Hakdang), 2009 Yunus Emre Institute

### 3. The Evolution of Multilateral Cultural Diplomacy

The national states that emerged in the 19th century had already created the first forms of cooperation in the cultural field by the end of the century. Initially, in the first phase up to the First World War, international cooperation was sporadic in certain areas. Most of the issues (world exhibitions<sup>8</sup>, intellectual property<sup>9</sup>, telecommunications<sup>10</sup>) were linked to interests, mainly economic interests. The civilians and the academic community had carried out extremely important preparatory work before international cooperation was established (see copyright, protection of cultural property in the event of military conflict<sup>11</sup>).

The second phase in the development of multilateral cultural cooperation lasted from the outbreak of the First World War until the end of the Second, when the issue of "intellectual cooperation" emerged in the frame of the first universalistic IGO<sup>12</sup>. The Committee for Intellectual Cooperation of the League of Nations<sup>13</sup>, set up to promote the international exchange of ideas and scholars, operated an executive secretariat, the International Institute of Intellectual Cooperation since 1926<sup>14</sup>, publishing a resolution in 1938 on the nature of "intellectual conventions", excluding political and economic subjects from their scope. However, this period can be divided further, following the political changes. The multilateral debates at the beginning of the interbellum took an idealistic<sup>15</sup> approach to the nature of intergovernmental cultural exchange, but from the 1930s onwards this post-WWI pacifist attitude facing the political reality shifted towards national interests and the representation of national culture<sup>16</sup> in the context of the League of Nations<sup>17</sup>. An

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<sup>8</sup> The Convention on International Exhibitions was signed in Paris on 22nd November 1921 and its governing and coordinating body, the Bureau International des Expositions (BIE), was established in 1931. The Paris-based organisation's General Assembly still regulates the organisation of different types of exhibitions, and fairs, selects the winning entries for the world exhibitions.

<sup>9</sup> The first conference on copyright was held in Paris in 1858; 20 years later, in 1878, the International Literary and Artistic Association was founded. Following the Berne Conference in 1885, the Convention for the Protection of Literary and Artistic Works was adopted on 9 September 1886. The treaty has been amended seven times since then, but it still sets the basic standards for international copyright protection. In 1883 the other basic treaty was established: the Paris Convention for the Protection of Industrial Property. Both conventions created an „international office“, which merged in 1893 under the name of the United International Bureau for the Protection of Intellectual Property. This was replaced in 1970 by the World Intellectual Property Organization, which still provides comprehensive regulation and standard setting at the universal level.

<sup>10</sup> The International Telecommunication Union (ITU) (originally International Telegraph Union, from 1934 Telecommunication), established by the international telegraph convention signed in 1865, defines the international telecommunication cooperation since the advent of radio and television to the digital world, has been setting international standards in an increasing number of areas of telecommunications playing an important role in the transmission of culture.

<sup>11</sup> It is interesting to note that the protection of civil cultural property first appeared in humanitarian law. The Hague Conventions of 1899 and 1907 brought only changes by declaring the earlier drafts prepared by eminent international scholars in binding instruments.

<sup>12</sup> On the proposal of the Council of the League of Nations (hereinafter "the Council"), the world organisation unanimously adopted, at its second General Assembly on 21 September 1921, a decision to set up an International Committee on Intellectual Cooperation (ICIC) (hereinafter "the Committee"). By a decision of 24 September 1931, the Council and the General Assembly of the League of Nations reorganised the institutions and created the Organisation of International Intellectual Cooperation (OIIC), which included all the organisations affiliated to the League of Nations and active in the field of intellectual cooperation.

<sup>13</sup> The so-called "Committee of Twelve" (later increased to 19 members), founded in 1919, included Henri Bergson (chairman), Marie Curie, Albert Einstein, Béla Bartók, Thomas Mann, Paul Valéry, among others representing the intellectual elite of the time, who were active in various subcommittees (e.g. bibliography, literature, art).

<sup>14</sup> Its tasks were taken over by UNESCO in 1946.

<sup>15</sup> the important aim was to preserve the *bona fide* nature of cultural relations and to keep them as far as possible from economic and political interests

<sup>16</sup> In the 1930s, countries representing civilisations beyond Europe have also become intensively involved in intellectual cooperation. Japan's main objective was to introduce its culture to the Western world, while China was looking forward to rebuilding their self-image (after the Japanese invasion). Geographical expansion made it

examination of the themes of cooperation suggests that utopian, universal demands (textbook revision<sup>18</sup>, „moral disarmament“<sup>19</sup>) have not received the necessary political support. However, the interbellum period witnessed not only the creation of institutions to manage culture interpreted broadly, but also the emergence of multilateral cooperation in certain cultural sectors<sup>20</sup> developed at different times at the universal level. The creation of conventions and institutions is obviously a sign of cooperation, but it can also be a way of representing conflicts. French-English<sup>21</sup>, but also French-German<sup>22</sup> rivalry was evident in the Commission's work, but the Institute in particular became a 'battleground', as it was seen as an instrument of French cultural hegemony<sup>23</sup>. At that time, not only was it possible to talk about the internationalisation of certain themes, but countries from regions outside Europe were also becoming active in the field of multilateral cultural cooperation. In the Americas, the institutional and conceptual framework for cooperation were already in place (the Inter-American congresses, the Pan American Union). For example, on 15 April 1935 a regional convention, the Pan-American Treaty on the Protection of Artistic and Scientific Institutions and Historic Monuments, the so-called Rerih/Roehrich Pact, was signed in Washington. The League of Nations represented a new international arena for Latin American republics, a possibility to escape from the excessive influence of the USA, and international intellectual cooperation was therefore promoted by them from its very beginning in 1922. Although the US was not a member of the League of Nations, it was involved in intellectual cooperation: the Rockefeller and the Carnegie Foundations contributed substantial sums to some of the

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even more striking that the general approach was shifting from universality based on Western civilisation to uniqueness based on national cultures, from intellectual cooperation to international cultural exchange.

<sup>17</sup> The International Convention on Intellectual Cooperation signed in Paris on 3 December 1938 became the first international cultural convention and the Commission's last result. Since international intellectual cooperation was to be based on national committees (Article 2.), which were obviously representative of their own national cultures, the Commission was no longer a universal intellectual community, as had been planned in the 1920s, but an organisation of national cultures, a 'federation of cultures'.

<sup>18</sup> In 1926, the Assembly of the League of Nations adopted a resolution based on a draft by Julio Casares: all countries should remove untrue remarks insulting other countries from their textbooks, because they hinder international understanding. The resolution placed the revision of textbooks under the responsibility of national intellectual cooperation committees. This was a voluntary mechanism, and its effectiveness is illustrated by the fact that it was used only three times complaining about incorrect data.

<sup>19</sup> the idea was put forward by Polish Foreign Minister August Zaleski in September 1931 and presented at the Geneva Disarmament Conference on 14 March 1932 calling for disarmament to be preceded by the easing of spiritual tensions between the countries

<sup>20</sup> the Rome-based International Educational Cinematographic Institute (IECI) (Istituto Internazionale del Cinema Educatore ) operating between 1928 and 1937, the Geneva-based institution for university education, the International University Office (OIRU) (1923-1946), International Museums Office (1926-1946) initiating and organising among others the Athens Conference on the Restoration of Historic Monuments in 1931 expressing for the first time the need for international cooperation in the field of monument conservation, International Bureau of Education (IBE) set up in Geneva in 1925 as a private institution by a few well-known people and became an intergovernmental organisation under the auspices of the League of Nations in 1929, the first of its kind in the field of education.

<sup>21</sup> Although the United Kingdom provided the chairman of the Commission, Gilbert Murray, one of the initiators and enthusiastic supporters of intellectual cooperation, London kept distant from the organisation, particularly from the Paris Institute, whose policy was considered means of "intellectual expansion" of France.

<sup>22</sup> e.g. in the field of folklore, French scholars could not gain a foothold, because in France the academic background of folklore was very weak and had no academic basis, whereas in German speaking countries the situation was quite the opposite. The League of Nations prohibited the "folklore" and "ethnography" (in French, arts populaires, not folk art or ethnographie) because of the fear that the scientific results could be used for political purposes, such as to support territorial claims (The International Commission on Folk Arts and Folklore (CIAP) established in 1932 was unable to fulfil its role because of the lack of consensus (scientific committee vs. the use of science for political purposes) and of insufficient financial support.)

<sup>23</sup> Italy was in constant rivalry with France (e.g. the International Educational Cinematographic Institute, which was formally affiliated to the League of Nations until Italy withdrew from the organisation).



Institute's projects, and an active national committee was set up in the country, based strictly on civil society organisations.

It can be concluded about this period that the universality and general commitment that had been envisaged did not become a reality. However, intellectual cooperation was given broader support than the political system of the League of Nations, since important states participated in it without being members of the League (like US) or after leaving the political organisation (like Japan). In opposite of a universalistic, Europe-centred approach to international cultural cooperation at the beginning of this period, in the 1930s the representation of national cultures came to the fore. Non-European countries (e.g. Japan, China) also became active and the idea of regional cooperation (e.g. Inter-American) was introduced. It can also be concluded that taking up a theme (e.g. film by Italy) is doomed to failure if there is a disproportionate national affiliation. There have been areas of cooperation fallen victim to rivalry among nations (e.g. folklore). But there are also themes that have lived on in the new institutional order of the new era (education, cooperation between museums).

Multilateral cultural cooperation reached a new level with the creation of UNESCO, an international organisation that brought together almost all the countries of the world and gave a comprehensive definition of culture. The horrors of the Second World War reawakened the need to find common solutions, and in November 1945, at the UN Conference in London, the decision was taken to create an educational and cultural organisation. Of course, conflicts of interest and divergent approaches have not disappeared and are still strong today, but the organisation has created the possibility of cooperation across a broad spectrum of culture and has made the institutionalisation of cultural relations evident.

The institutional system established in the first phase of multilateral cooperation survived, albeit with a number of modifications (exhibitions, copyright, telecommunications), while most of the institutions set up between the two world wars either disappeared or were absorbed into the universal system.

The new world order, based on antagonistic narratives, has left its mark on cultural cooperation, but the existence of UNESCO has shown that there is room for cooperation in this field. The Cold War, which developed on ideological grounds, and which explicitly treated culture as a battlefield, can be described as 'conflict cooperation' in the field of culture (see the withdrawal of the UK and the US from UNESCO).

In the next period the fall of the bipolar world order provided an opportunity for real cooperation reflecting national interests more effectively. But it is now a highly intertwined world with a variable geometry, since multilateral cultural cooperation has manifested itself not only in universal but also in regional cooperation, and influential international NGOs are also involved. Today it has become clear that there are many opportunities for multilateral cooperation in the field of culture linked essentially to national identities.

#### **4. Specialized Tools of Intergovernmental Organizations in Cultural Diplomacy**

Culture, by its very nature, is much more difficult to homogenise and influence than, for example, the economy, and is more resistant to unifying and integrating tendencies, so that internationalisation in the cultural sphere is taking place according to its own specific laws. Naturally, we cannot aim for completeness, not least for reasons of space, but will merely highlight examples of cooperation from the activities of given organisations.

In the field of culture, the Council of Europe is the absolute norm crusader, based on decades of intensive work, and the EU as a specific entity having recently published its external cultural relations strategy<sup>24</sup> can take differing actions. In the case of EU, the diversity of European approaches does not allow for the application of the Monnet method ("community method", supranational decision-making), or as Fohr<sup>25</sup> put it, "culture is not coal and steel". However, at the level of the EU institutions, there is the intent to promote European culture outside Europe, and a common European cultural foreign policy is taking shape.

Furthermore, there can be a division of labour between the two actors (e.g. in the field of film support (the Council of Europe prefers to finance films (Eurimages), while the EU supports their distribution), often the EU takes over an initiative from the Council of Europe (e.g. European Heritage Days) or even join forces with other organisations in a field (e.g. the Ljubljana Process<sup>26</sup>, which aims to preserve the cultural heritage of South-East Europe). Since the Council of Europe and the EU have achieved outstanding results in the field of culture, these are fundamentally not taken into account for generalization or for the determination of a common base in multilateral cultural diplomacy in this study.

Intergovernmental cooperation based specifically on language or culture is a special regime, these organisations can rely on the common language, the basis of communication and the vehicle of cultural identity or in the case of Türksöy the reminiscence of former empire provide the historical, linguistic and cultural background. These systems of cooperation provide a new arena for international cultural relations and allow the use of specific tools and forms.

The instruments of multilateral cultural cooperation vary greatly, they can correspond to the tools of national cultural diplomacy but provide also specific, different options. Looking at the activities of these organisations, we can highlight some examples that operate only in an international framework, the multilateral level creates an additional field for international cultural cooperation.

## **1. Institutions**

Multilateral diplomacy is evidently characterized by the possibility to establish regional institutions. The undermentioned specialised institutions with general scope have distinct budgets, governance structures, operational mandates and are open to all Member States, but membership is not compulsory. Its structure follows the UNESCO pattern<sup>27</sup>.

Already at the birth of the Arab League, culture was a major focus, such as the intention to preserve ancient Arab culture promoting it to the rest of the world or to improve education in the region. It can later be stated that it achieved much greater success in these fields than in the fields of politics or security policy. In accordance with the first regional treaty of the Organisation, the Charter of the Arab Cultural Unity signed in 1946 the establishment of the Arab League Educational Cultural and Scientific Organisation (ALECSO) was announced in Cairo on 25 July 1970. The organisation<sup>28</sup>, based in Tunis, aims

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<sup>24</sup> 8 June 2016, Towards an EU strategy for international cultural relations [eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52016JC0029](http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52016JC0029)

<sup>25</sup> Alain Fohr, director of Institut Français in Madrid cit HELLY, Damien: „From Who We Are to What We Do Together and How - Avenues for European External Cultural Relations” In: More Europe, [http://www.moreeurope.org/sites/default/files/paris\\_debate\\_report\\_and\\_thoughts\\_june\\_2012.pdf](http://www.moreeurope.org/sites/default/files/paris_debate_report_and_thoughts_june_2012.pdf). retrieved 1st August 2012

<sup>26</sup> European Union, Council of Europe, Regional Cooperation Council

<sup>27</sup> The legislative bodies of the organisation are the General Assembly, the Executive Council and the Secretary General (elected by the General Assembly).

<sup>28</sup> brings together all 22 member states of the League

to develop Arab human resources, to support the Arab language and culture in the Arab world and abroad, to promote the dialog between Arab culture and the other cultures of the world.

The second largest international organisation after the United Nations, the Organisation of Islamic Cooperation, as a religiously defined organisation, can be linked to culture on this basis but established<sup>29</sup> a specialized institution for cultural cooperation the Islamic World Educational, Scientific and Cultural Organization<sup>30</sup> (ISESCO) in 1981 in Rabat.

Obviously international organisations can set up institutions for a special area of culture as well.

### **Language**

A traditional area of cultural diplomacy is the dissemination and teaching of language, since the issue has long been not only cultural but also political matter (e.g. official and working languages in an IGO) and can even be a means of political and economic penetration. The measures taken to preserve national languages are also evident in the case of IGOs, where support for translations is also emphasised at regional level. For example, the Arab League is making a major effort to create a common Arabic language. Arabic is obviously not a uniform language, each region has its own dialect, which is not always understandable even to native Arabic speakers, but there is a so-called standard or literary Arabic, which is understood by all and is used by major news channels, films, press and academia. Khartoum International Institute for Arabic Language was established in 1974 within the framework of the Arab League to enable non-native Arabic speakers to learn the language outside the Arab world, especially in Islamic countries. In 1989, an institute was established by ALECSO in Damascus, the Arab Centre for Arabization, Translation, Authorship and Publication (ACATAP) to promote Arabic-language higher education, enrich Arab culture by translating of works of foreign authors and disseminate scientific and artistic findings in Arabic by translating them. The Arab League's academic and scientific body is the High Arab Institute for Translation (ISAT), an affiliated institution established in 2005 to promote translation from and into Arabic and to teach translation and interpretation. In the Islamic world, manuscripts and books are highly valued, and the idea was first mooted when the Arab League was founded in 1945, and the Institute of Arabic Manuscripts<sup>31</sup> was established in Cairo the following year.

As an example, we can mention here the African Academy of Languages<sup>32</sup> (ACALAN)<sup>33</sup>, set up by the African Union to promote multilingualism at all levels of education and to promote African languages and language policies as a factor in African integration<sup>34</sup>.

The International Portuguese Language Institute (IILP)<sup>35</sup> of CPLP headquartered in Praia aims "the promotion, the defence, the enrichment and the spread of the Portuguese language

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<sup>29</sup> In 1978, at the 9th meeting of foreign ministers, the idea of setting up the organisation was raised and in January 1981, at the 3rd Islamic Summit, the decision was taken to establish it.

<sup>30</sup> Of the 57 OIC member states, 54 are full members and 3 have observer status.

<sup>31</sup> e.g. the Institute has microfilmed manuscripts from public and private libraries around the world, making them available to researchers

<sup>32</sup> originally set up by the Malian government in 2001

<sup>33</sup> established in 2006, based in Bamako, Mali.

<sup>34</sup> The European languages associated with colonial administration often overshadow African languages and are preferred in many areas. It is not uncommon for African children to speak English or French at home, and many African adults speak their mother tongue but cannot write in it.

<sup>35</sup> created by the CPLP on 1 November 1989

as a vehicle of culture, education, information and access to scientific and technologic knowledge and of official use in international forums".

### **Heritage**

Heritage protection is naturally reflected in the activities of IGOs, even by the establishment of dedicated bodies. Islamic World Heritage Committee<sup>36</sup> can be given as example, an expert body established by the Ministers of Culture in the Islamic World in 2007<sup>37</sup>. The mandate of this intergovernmental commission aims to safeguard the cultural heritage of the Member States, in particular Islamic heritage disproportionately underrepresented on the UNESCO World Heritage List according to the ministers.

An exciting initiative is ASEMUS, the Asia-Europe Museum Network, set up in 2000. It is a network consisting of museums from the ASEM countries (51 Member States) with Asian collections, which enables and even encourages the sharing and use of museum collections (see virtual collection of masterpieces).

The OAS Art Museum of the Americas (AMA) is a contemporary art collection, a representation of the Western Hemisphere, established in 1976 by the OAS Permanent Council to commemorate the bicentennial of US independence. With a special regional focus, the AMA collects, preserves and studies the work of American artists and organizes exhibitions and related educational programs on a regular schedule.

In the framework of the African Union, initiatives have been taken to create the Black Civilisations Museum in Dakar or to renew the Institute of Black Peoples<sup>38</sup> in Ouagadougou. The AU is also planning to set up a single regional organisation for the protection of African intellectual property.

### **Science**

Scientific cooperation is now an essential part of international relations, influenced by both economic and political interests, and has also developed in regional organisations. The Arab League decided to establish the Institute of Arab Research and Studies<sup>39</sup>, even before the establishment of ALECSO<sup>40</sup>, to develop a generation of scholars<sup>41</sup> in Arabic languages in the sciences of importance to society (geography, history, politics, economics, sociology, law, linguistics and literature, media) and to disseminate and publish the results of their research.

Fifty years later, ISESCO also established<sup>42</sup> an institution to support and develop scientific research in Islamic countries, the ISESCO Centre for Promotion of Scientific Research (ICPSR), based in Rabat. But a body on the ethical approach to science and

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<sup>36</sup> The nine members of the Committee are elected by the Conference of Ministers of Culture in Islamic World from among the nominees of the ISESCO Member States, three from each region (Arab, African, Asian), for a period of 4 years.

<sup>37</sup> Tripoli, 21-23 November 2007

<sup>38</sup> Institut des peuples noirs, INP

<sup>39</sup> opened in Cairo on 1 November 1953

<sup>40</sup> since 1970, it has been under its control

<sup>41</sup> The institute is open to non-native Arabic speakers, but also to fluent Arabic speakers.

<sup>42</sup> proposed at the first conference of ministers of higher education and science in October 2000 and decided at the second conference in 2003, later confirmed at the 10th meeting of the Islamic Summit

technology<sup>43</sup> has also been established to examine these issues from an Islamic perspective. ISESCO is also working to establish a broad network of Islamic scholars<sup>44</sup>.

### **Broadcasting**

The exchange of news and programmes, the production of regional programmes is a specific tool at regional level and cooperation can also bring economic benefits (e.g. cheaper broadcasting rights). For example, The Arab League system includes the Arab States Broadcasting Union (ASBU) established in 1969 in Khartoum, with the aim of strengthening ties and encouraging cooperation between broadcasters in the Arab States to develop better productions and services. Member States not only receive broadcasting services from the organisation, but also support the exchange of radio and television programmes in the fields of news, entertainment or sport. The specialised body of the OIC<sup>45</sup>, the Islamic Broadcasting Union (IBU)<sup>46</sup>, based in Jeddah, promotes the religious aims of the organisation by producing and exchanging radio and television programmes, teaching Arabic and fostering brotherhood among Muslim peoples.

### **Special Media**

The more influential countries also have the means to broadcast abroad, even in several languages, and to shape the image of the country. Recognising it, several groupings are already building on this tool focusing on building identity within the region. The creation of a common media channel with regional (or global) coverage and content can be a useful tool to promote audiovisual co-productions, encourage creativity and strengthen public service television. In addition to meeting the need to produce educational, cultural and scientific content, the aim was also to promote technical convergence and strengthen social cohesion.

One of the most well-known channels, TV5 Monde, which has been in operation since 2 January 1984, is a francophone television network (and the world's third largest international TV network) with a global reach of 200 countries. The Ibero-American TV channel<sup>47</sup> for the first time presents the Community as a single entity and give visibility to cooperation<sup>48</sup>. Another example, the TV CPLP, an international television network of eight national TV stations broadcasting exclusively in Portuguese, was created in 1996 by CPLP and is supported by UNESCO and the Portuguese government.

So far, there have been only modest attempts in Europe, mainly in the field of news, such as Euronews or the cultural channel Arte. Obviously national regulations and language barriers may hinder this development, and the EU has so far tended to encourage the development of co-productions and to concentrate on the technical basis of broadcasting. In this context, the emergence of the Internet may have a special role to play, as provides worldwide coverage of news and opinion (see European Voice, EU observer).

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<sup>43</sup> Islamic Body on Ethics of Science and Technology, IBEST

<sup>44</sup> Islamic-World Science Net, IWSN

<sup>45</sup> resolution adopted at the 6th Islamic Conference of Foreign Ministers in Jeddah in July 1975

<sup>46</sup> formerly Islamic States Broadcasting Organization (ISBO)

<sup>47</sup> Canal Iberamericano

<sup>48</sup> In December 2014, at the Veracruz Summit, it was decided to launch

## Regional Competitions

Regional-level competitions are naturally specific tools within the framework of IGOs. Sports competitions can serve as outstanding examples of this, one of the most effective means of enhancing people-to-people relations. Cooperation in the field of sports is important because it contributes to regional development, peace and stability as well. Based on a similar concept to the Commonwealth Games, the Francophone Games<sup>49</sup> are a combination of artistic<sup>50</sup> and sporting events, held every four years since 1989. The Lusofonia Games<sup>51</sup> are also held every four years in Portuguese speaking countries, following the same model. The CPLP Games<sup>52</sup> like the Lusofonia Games have been held every two years since 1992, but only athletes under 16 years of age can take part.

It is noteworthy that the Riyadh-based Islamic Solidarity Sports Federation was established<sup>53</sup> within the OIC in 1985 to strengthen Islamic solidarity among young people in the Member States and to promote Islamic identity on the sports field<sup>54</sup>.

We can mention the Southeast Asian Games (SEA Games), ASEAN Para Games as well, but also ASEAN Basketball League, ASEAN Football League, Volleyball League too.

## 2. Funds, Special Programmes

The international organisations can set up funds or launch special programmes in regional framework. Like the ASEAN Foreign Ministers established the ASEAN Cultural Fund with the contribution of Japan, a key institution for building ASEAN identity in 1997. The Fund is managed by the ASEAN Secretariat<sup>55</sup>, which aims to promote ASEAN awareness, enhance relations among the peoples of the region, and encourage wider participation in ASEAN programmes. The ASEAN Science, Technology and Innovation Fund (ASTIF)<sup>56</sup> was established in January 1989 by the Ministers of Science and Technology to promote regional cooperation. Initially operating with a modest budget, but in 2014 the Ministers decided to expand the Fund's activities and in 2015 they changed the guidelines, increasing the capital contribution to it.

It is worth mentioning that the African Union and the African Member States of UNESCO established the African World Heritage Fund (AWHF) in 2006 for the effective conservation and protection of the continent's natural and cultural heritage, to which African States Parties to the 1972 UNESCO Convention can apply for financial support.

In a world that emphasises visuality, film and media play a very important role in regional identity building. In addition to regional film support and the promotion of coproductions, a specific tool is the collection and reviewing of regional film production, which reflects the specific vision of the people living in the region. A good example of it is the operation of the OIF fund<sup>57</sup> providing financial support for films and audiovisual

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<sup>49</sup> Jeux de la Francophonie

<sup>50</sup> since 2001 singing, storytelling, traditional dance, painting, photography, sculpture, street art

<sup>51</sup> Jogos da Lusofonia

<sup>52</sup> Jogos da CPLP

<sup>53</sup> On the basis of the resolution of the 11th Islamic Conference of Ministers of Foreign Affairs held in Islamabad in May 1980 (No.17/11-C) and of the resolution of the 3rd Islamic Summit held in Mecca in January (No.7/3-C), was established on 6<sup>th</sup> May 1985

<sup>54</sup> Obviously, the prohibition of discrimination or the participation of women in sport can only be interpreted in accordance with Islamic teachings.

<sup>55</sup> Only 80% of the annual profits are allocated to support projects, as recommended by the Committee for Culture and Information (COCI), with the rest being reinvested in the fund.

<sup>56</sup> former ASEAN Trust Fund for Science and Technology

<sup>57</sup> Fonds Image de la Francophonie (former Fonds francophone de production audiovisuelle du Sud) established in 1988

products from French-speaking developing countries (the Global South). In a similar manner IBERMEDIA<sup>58</sup> (Iber-American Assistance Fund)<sup>59</sup> supports film and audiovisual projects in the Ibero-American region since 1998 providing technical and financial assistance for coproduction projects submitted by independent producers from the Member States.

The launch of joint programmes is an obvious instrument at the multilateral level. For example, the Ibero-American states launched programmes (at least seven countries should be involved) and initiatives (at least three countries should be involved) as very successful means of intergovernmental cooperation. Like the Ibermúsicas programme<sup>60</sup>, launched in 2011, aims, among other things, to promote and raise awareness of diversity in the musical arts, including the promotion of Ibero-American music coproductions. Based on a proposal from Venezuela and the local tradition (El Sistema), the Iberorquestas youth programme<sup>61</sup> was launched in 2009 to promote social integration and crime prevention by encouraging young people, especially the disadvantaged, to make music in bands and choirs.

### **3. Education, Mobility**

The longest-established instrument used by national governments, support for the school system, is not mentioned in the context of IGOs; it is perhaps only in the field of higher education (creation of specialised universities, support for specialised courses). In 1987, the Federation of Universities of the Islamic World (FUIW) was established within ISESCO with membership open to public and private universities. Not only was the founding congress of the federation held in Rabat, but today it is also headquartered in ISESCO and its Director General is ex officio the Secretary General of the federation<sup>62</sup>. The Agence universitaire de la Francophonie (AUF) brings together higher education and research institutions from 94 countries and universities in the ASEAN region have also established their ASEAN University Network (AUN).

The plan to create a francophone university had already been decided at the Dakar summit in May 1989, but its implementation did not officially begin until 4 November 1990. The Senghor University<sup>63</sup> in Alexandria provides internationally renowned degrees on areas especially important for Africans. As a special feature, the AU's flagship projects and initiatives include the Pan African Virtual and e-University.

From the beginning, ASEAN has seen education as an essential part of identity building and has considered it important for students in the region to learn more about ASEAN in the classroom. ASEAN Studies<sup>64</sup>, introduced at postgraduate level in higher education from 2006, has been created to explore the economic, social and cultural forces driving the region's activities and to present the increasingly diverse policies.

One of the oldest and most traditional instruments is the building of cultural and educational links, often targeting young people, artists by providing scholarships of high quality, with the aim of reaching out to the future political and economic leaders and opinion-formers of the other country. Strengthening exchanges is also part of the toolbox of many international organisations, the establishment of scholarships also takes place at regional level. Mobility is important not only for the exchange of people and knowledge, but

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<sup>58</sup> Programa de Desarrollo en Apoyo a la Construcción del Espacio Audiovisual Iberoamericano.

<sup>59</sup> It was created in 1997 by nineteen Latin American countries plus Spain and Portugal

<sup>60</sup> Programa de Fomento de las Músicas Iberoamericanas

<sup>61</sup> Programa de Apoyo a la Constitución del Espacio Musical Iberoamericano

<sup>62</sup> Article 4(3) of the Statutes

<sup>63</sup> Université Senghor d'Alexandrie

<sup>64</sup> ASEAN study programme at postgraduate level (AEI-UM)

also for the development of a regional network based on direct contact. Bringing together educational institutions at regional level, coordinating curricula and studies serves to strengthen regional awareness. The Organization of American States Academic Scholarship Program was established in 1958 to support MA and PhD students, a separate programme<sup>65</sup> in 1983 for students from English-speaking Caribbean Member States and Suriname to support the last two years of their studies and in 1997 a separate Fund to support training.

The Erasmus Mundus supporting cooperation and mobility in higher education is a well-known instrument of the EU although European Union Visitors<sup>66</sup> Programme<sup>67</sup> is less known established by the European Parliament and the European Commission in 1974 to reach out to so-called multipliers/opinion leaders from non-EU countries to get first-hand information and experience of European developments.

#### **4. Symbolic Initiatives**

Regional international organisations also try to use symbolic tools typical of national cultural diplomacies, to represent unity and regional identity.

For the establishment of **institutions** that represent the region as a whole can be an example like ASEAN Corners set up in national libraries and national museums, or the ASEAN Cultural Centre opened in Bangkok in 2015.

The activities that strengthen the sense of belonging include **International Days**. It can be demonstrated, among others, by the International Day of Francophonie celebrated on 20 March since 1988. In 2010, the General Assembly of the African Union decided<sup>68</sup> that 3rd April of each year should be African Culture Renaissance (ACP) Day, to promote the long-closed and unknown African culture. Since the 2009 meeting of CPLP Ministers of Culture in Luanda, 5th May has been the World Portuguese Language Day<sup>69</sup>. On 10<sup>th</sup> March each year, ALECSO and its member states celebrate Arab Library Day, which raises awareness of the importance of books and libraries in preserving memory and cultural identity.

Several international entities have taken advantage of the tool of proclaiming a **thematic year** by focusing on an issue for a year. Since 1983, the European Union has organised thematic years, such as 2008 as the European Year of Intercultural Dialogue and 2018 as the European Year of Cultural Heritage. In 2011, the OAS has declared it the Inter-American Year of Culture, recognising the central role of culture in the economic, social and human development of hemispheric communities. The African Union also uses this instrument, for example 2006 was the Year of African Languages. At the 2006 Ibero-American Summit, participants decided to step up the fight against illiteracy and 2007 was declared the Year of Literacy. The Permanent Council of the Ministers of Culture of Turkic speaking countries has unanimously dedicated 2016, the 1000th anniversary of the birth of the famous poet, scholar and philosopher, as the Yusuf Has Hacib<sup>70</sup> Year. In 2011<sup>71</sup> the first

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<sup>65</sup> OAS Special Caribbean Scholarships Program (SPECAP)

<sup>66</sup> It recalls the name of the International Visitor Program (IVP), which was launched in the United States in 1952 for similar purposes.

<sup>67</sup> Initially hosting promising young American politicians for 5-8 days, hundreds of foreigners have since had the opportunity to meet with officials from the EU institutions in Brussels.

<sup>68</sup> first celebrated in 2011

<sup>69</sup> Dia da Cultura Lusófona

<sup>70</sup> His famous work, the Kutadgu Bilig, is a cornerstone of Turkish-Islamic culture and history.

<sup>71</sup> on 14<sup>th</sup> December 2011 in Jakarta, Indonesia



meeting of Sports Ministers<sup>72</sup> decided that 2013 should be the year of ASEAN Sports and it was decided that ASEAN should bid to host the 2030 Football World Cup.

The rotation of the **presidency** of the organisation puts the presiding country and its culture in the spotlight, especially the summits of the Heads of State and Government, but also the ministerial meetings. This period can be an opportunity for the presiding country to present the culture of the region abroad. The EU presidency can also be an opportunity to present European culture abroad in a special interpretation, to ensure diversity appearing in the name of a united Europe. A city or country hosting a meeting of ministers of culture can also give a special colour to regional identity.

The **awards** and **titles** also help to promote cultural values, several organisations are making use of the possibility of establishing regional awards. One example is the well-known European Heritage Label<sup>73</sup>, which aims to highlight the European dimension of buildings, monuments, parks and cultural assets that have played a key role in European history. Unlike other cultural heritage<sup>74</sup> criteria are not concerned with aesthetic or architectural values, but with significance in European history. To recognise the support for intercultural dialogue in the Mediterranean region, a prize<sup>75</sup> has been created by the Euro-Mediterranean Partnership countries and the European Commission and is awarded annually to an individual or organisation. For the protection of intangible and tangible heritage is awarded every year the Arab Heritage Award<sup>76</sup> established by ALECSO in 2012. Also, within ISESCO, various prizes related to education and culture<sup>77</sup> have been awarded since the launch of the Islamic Capital of Culture programme in 2005. Since 2008, the AU Commission has awarded the African Union Kwame Nkrumah Prize<sup>78</sup> for scientific excellence<sup>79</sup>, based on scientific achievements and valuable discoveries. To recognise a novel or short story that is not only unique but also enriches the French language, the Five Continents of Francophony Prize<sup>80</sup> was created in 2001. The TÜRKSOY Journalism Prize<sup>81</sup> is traditionally awarded each year at the opening of the "Cultural Capital of the Turkish World" event for activities contribute to the preservation and transmission of the rich cultural heritage of the Turkish world to future generations and to the building of cultural bridges between countries.

An **orchestra** can be a good symbol of regional unity, not only through music, but also through cooperation and playing together. The European Union Youth Orchestra<sup>82</sup> is made up of musicians aged between 16 and 26 who work together for a year, appearing at official EU celebrations as ambassadors of European culture. 20-25 young musicians are given the opportunity to perform together for six months in the European Union Baroque Orchestra from 1985, the Year of European Music. The TÜRKSOY Youth Chamber Music

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<sup>72</sup> proposed the establishment of a sports panel in 2010 (16th ASEAN Summit in Hanoi)

<sup>73</sup> The title was established in 2006 by 17 EU countries and Switzerland in the form of intergovernmental cooperation, but it was upgraded to EU level in 2011.

<sup>74</sup> UNESCO World Heritage List, Council of Europe's Cultural Routes, EU Prize for Cultural Heritage/ Europa Nostra Awards

<sup>75</sup> Euromed Prize for Intercultural Dialogue

<sup>76</sup> Arab Heritage Prize

<sup>77</sup> literacy, extracurricular education, talented teachers, researchers and artists

<sup>78</sup> African Union Kwame Nkrumah Awards for Scientific Excellence, AUKNASE

<sup>79</sup> The awards are open to young researchers at national level, women scientists at regional level and all scientists at continental level.

<sup>80</sup> Prix des cinq continents de la francophonie.

<sup>81</sup> The statue that symbolizes the prize is inspired by the legend of Oguz Khan, whose descendants are the Turkic people.

<sup>82</sup> created under a resolution adopted by the European Parliament in 1976 and has been financially supported by the European Commission since its inception

Association was founded in 2010 by the member countries and was launched in 2017 due to similar reasons.

It goes without saying that **festivals** at regional level also broaden the scope for cultural cooperation. Festivals such as the Best of ASEAN Performing Arts Series<sup>83</sup> or the ASEAN Festival of Arts<sup>84</sup> are great tools to showcase the ASEAN Member States' culture and arts, to promote better understanding of each other's cultures and to strengthen ASEAN awareness by showcasing the rich and diverse cultures of the region.

The regional IGOs also frequently establish regional film festivals, such as the biannual Pan-African Film and Television Festival (FESPACO) in Ouagadougou, the capital of Burkina Faso, the largest film event on the African continent. ASEAN has been hosting the three-day ASEAN International Film Festival<sup>85</sup>, a biennial event since 2013 to showcase the region's film art<sup>86</sup>.

TÜRKSOY has been organising the Nevruz Festival since 1995 starting on 21 March with the lighting of the Nevruz<sup>87</sup> fire in the Turkish capital and continue until the end of the month. Although the Turkish peoples have celebrated Nevruz for thousands of years, TÜRKSOY repeatedly emphasizes the universal nature<sup>88</sup> of the spring festival and the confluence of these two concepts makes Nevruz the contribution of the Turkish world (and consequently of TÜRKSOY) to the heritage of humanity<sup>89</sup>.

The **Cultural City/Capital of Culture programme** is a highly visible and prestigious initiative that brings to the fore the culture and diversity of a region. The Capital of Culture programme<sup>90</sup> was launched at the suggestion of Melina Mercouri, the Greek Minister of Culture, and the first 'City of Culture' was Athens in 1985. The effectiveness of the European programme is demonstrated by the fact that the initiative has been taken up by other regional organisations<sup>91</sup>, the first being the Arab League, when in 1996 ALECSO decided to host an Arab Capital of Culture in a different Arab country each year. The real "explosion" came in the 2000s, with four regional organisations launching the programme between 2004 and 2014. In the framework of the OIC, the Capital of Islamic Culture programme was adopted in 2004 and modernised five years later to strengthen Islamic solidarity. ASEAN has identified the Cultural Capital initiative, launched in 2010 and linked to the host city of the biennial Ministerial Conference on Culture, as a key element of community building in the region. In 2010, TÜRKSOY decided<sup>92</sup> to designate one city each year as the Cultural Capital of Turkish World. In 2014, the Ministers of Culture of the CPLP countries decided<sup>93</sup> to launch a similar programme. The European title has been a reference point for many organisers and the ECOC has become a brand. The one thing that the other regions did not follow was that

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<sup>83</sup> held in Jakarta since 2008 at the ASEAN Secretariat headquarters

<sup>84</sup> held every two years since 2002, in conjunction with the meeting of culture ministers

<sup>85</sup> ASEAN International Film Festival & Awards, AIFFA

<sup>86</sup> prizes are awarded in 12 categories

<sup>87</sup> Nevruz (Turkish), Nevrow (Kurdish), Nauryz/ Nowruz

<sup>88</sup> Midwinter is celebrated by nearly two billion people not only in Central Asia.

<sup>89</sup> At the initiative of TÜRKSOY, the UN has declared 21 March as International Day of Nowruz.

<sup>90</sup> In the 1980s and 1990s, cities were designated by ad hoc agreements in the framework of intergovernmental cooperation, and from 1995 onwards, the European Capital of Culture (ECOC) became an official EU programme. While initially it was an 'extensive arts festival', later the focus was on the cultural reorganisation of the city (see Glasgow), and today the emphasis is on improving the city's liveability and cultural infrastructure, combined with more effective involvement of citizens. In 2017, cities were selected up to 2022 and countries were given to nominate cities until 2030.

<sup>91</sup> Date of the first Cultural City/Capital: 1996 Arab League/ALECSO, 2005 Organisation of Islamic Cooperation/ISESCO, 2010 ASEAN, 2012 TÜRKSOY, 2017 CPLP

<sup>92</sup> at the 10th summit of the presidents of the Turkish-speaking republics in Istanbul

<sup>93</sup> 10-11 April 2014 9th meeting of CPLP Ministers of Culture in Maputo

the Europeans kept changing the programme, while the others stuck to their original objectives. Of course, each region expected the initiative to showcase and celebrate its culture, to enhance cultural cooperation between member states, but there were different emphases.

The idea of an Arab Capital of Culture programme was first mooted in the 1990s in the framework of the UN Decade for Cultural Development (1988-1997), but it was only in 1996 that ALECSO decided to launch it. The cities are nominated to ALECSO by their governments, and the final decision is taken by the LAS Ministers of Culture at their annual meeting a few years in advance. Initially, the title was given to the national capitals, but nowadays it is more the second or third most important cities. It should be pointed out here that the selection can be politically motivated (see for 2009 the title of Arab Capital of Culture was awarded to Jerusalem/al-Quds).

Regarding TÜRKSOY the city is selected on the recommendation of ministers of culture and approved by the Permanent Council. The political intent cannot be kept out in its activity either see declaring Shusha city for 2023 cultural capital in 2020, shortly after its liberation from nearly three decades of Armenian occupation.

The launching of the World Islamic Capital of Culture project was decided at the third meeting of the Islamic Conference of Ministers of Culture in Doha in 2001 and invited the 57 OIC Member States to nominate the cities from which ISESCO will select three capitals each year to represent the Arab, Asian and African regions. At the Baku conference in 2009, the ministers upgraded the programme, with the goal to disseminate the true values of Islamic culture, to promote Islamic civilisation to more people, but also to promote cultural industries and the development of new cultural products. It should be pointed out that the criteria for the selection of ISESCO (e.g. its role in historical past in Islam, a significant contribution to Islamic and universal culture) focus largely on Islamic history and status<sup>94</sup>. Interestingly, since the programme's inception, four designated cities have been withdrawn by their governments.

In the ASEAN framework, the concept of a City of Culture was first discussed and adopted at a meeting of Ministers for Culture and the Arts (AMCA<sup>95</sup>) in Myanmar in January 2008. Among the goals of the ASEAN City of Culture initiative were to support the growth of creative industries and to encourage people-to-people engagement. The title of ASEAN City of Culture is awarded for two years of the Chairmanship to the city that hosts the biennial conference of Ministers of Culture. The Philippines was first awarded the title in 2010-2011, which was held by 10 cities in rotation over two years, but only one city has been awarded the title since then.

Similarly, the CPLP presidency lasts two years and the presiding country can choose the municipality that will become the CPLP Capital of Culture<sup>96</sup> for these two years and will host the meeting of Ministers of Culture.

The objectives of the Capital of Culture programmes presented are very similar. In most cases, the titles are decided at ministerial level (heads of government or ministers of culture), but once the programme has been set up, they tend to outsource the administration to an "arm's length" organisation with an experience in managing cultural projects (see LAS, OIC). In cases where the next ministerial meeting is linked to the title (like ASEAN, CPLP), there is clearly no need for such a specialised body. In most cases, the cities rotate annually,

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<sup>94</sup> Currently, the list of cities is set until 2025 and every two years, a fourth city is added to the three regional capitals to host the ministers of culture.

<sup>95</sup> ASEAN Ministers Responsible for Culture and the Arts

<sup>96</sup> Capital da Cultura da Comunidade dos Países de Língua Portuguesa

in some cases there may be several cities in parallel (e.g. OIC) and somewhere the title is held by one city for two years (e.g. ASEAN, CPLP). There are several stages in the selection process. The order of the countries is decided in advance, so that political interests can be kept to a minimum, then the city is selected behind closed doors, based on applications or political decisions (e.g. the location of the next ministerial meeting). Interestingly, a wide range of cities, from little towns to national capitals, have been awarded the title, but never a global world city. It is also striking that the African Union does not use this instrument.

Mobility, language policy, heritage protection, science policy, sport, often used in the cultural diplomacy of nation states, are also in the repertoire of international organisations. But there are specific tools available only to multi-stakeholder entities, such as specialised institutions (e.g. universities), regional financial fund, regional cooperation in the media, the proclamation of thematic years, special tools for cohesion (regional-level competitions, awards and various symbolic expressions of solidarity), festivals with a regional focus, especially the Capital of Culture programme can be mentioned.

### **5. Multilateral Cultural Diplomacy Comparing to Bilateral Cooperation**

Governments are committed to international cultural relations mostly for political, not cultural, purposes, they consider culture mainly and primarily as a tool or channel for achieving their political goals, i.e. to increase their influence on the government, opinion leaders and public opinion of another country. In multilateral relations, however, there is no possibility to serve national interests in such a clearcut way, neither the dominant state is able to fully assert its will and influence in an IGO based on cultural grounds, e.g. even though the same language offers a great opportunity for cultural penetration. Just as at the bilateral level, the "closeness", "similarity" (cultural affinity) of cultures or certain cultural elements can facilitate cultural contact, multilateral cultural cooperation is also facilitated by ethnic or linguistic affinities, or by cultural traditions. The development of such links can also be encouraged by a common cultural milieu, by former coexistence in an empire (e.g. the Habsburg Empire and Central Europe, or the Ottoman Empire and its former territories) developing a certain affinity and creating common goal to preserve a common heritage.

The motivation for governments to cooperate can also come from a colonial past, which by its nature has a double effect: on the one hand, it can be a burden, an accusation of cultural hegemony, but it can also be an advantage, since historical connection can be the basis of cultural affinity. Former colonial powers usually seek to develop intensive and multifaceted relations with their former colonies, for example in the field of culture. However fraught with controversy, the colonial past is nevertheless a shared, common history, resulting a cultural heritage: archaeological sites, museum collections, archives, memoirs or specific literature, and the study, preservation and dissemination of this heritage form part of the international cooperation.

As cultural products, achievements and intellectual works have an impact not only through their cultural (scientific, aesthetic) value, but also directly or indirectly influence the image of the country of origin in the minds of the people, the positive influence of the latter can be an objective not only at national but also at international level. After the bipolar world during the rise of nation branding, cultural relations have gained a new emphasis at national level and appear in identity building of regional organisations in the new world order.

Nevertheless, all three classical elements of foreign policy (political, economic and military) have their limits, but the fourth element, culture can do things that they cannot do, i.e. refresh and make foreign policy more flexible. This effect can also be seen in the case of

international organisations set up primarily for political purposes, where cultural cooperation is extremely successful.

With the expansion of globalisation, the focus, strategies and geographical priorities of national diplomacies are obviously changing, as the interplay of previously non-contacting civilisations and the increase in migration have led to the emergence of new forms of cultural identity or even to a loss of identity (see the joining of young Western people to ISIS). At the multilateral level, these issues are also being highlighted, although the problem of indigenous peoples is more prominent.

At the end of the 19th century, the non-state actors, imbued with national sentiment, began to push for the creation of cultural institutions operating across borders, and soon the large international NGOs appeared as well. Just as cultural diplomacy in many countries of the developed world had to develop with regard to non-state actors, IGOs sought to involve large cultural international non-governmental organisations (INGOs) in their cultural activities and gave these entities a special status.

Although multilateral cooperation is much more difficult to manage than bilateral relations, the multilateral cooperation is growing dynamically, and several international organisations are setting up joint programmes and actions (see the heritage protection in the Balkans).

While at the national level, cultural diplomacy is in most countries seen as a "handmaiden" of foreign policy, a means of self-expression and a means of achieving foreign policy goals, at the multilateral level the emphasis is on cooperation rather than differentiation and confrontation.

In multilateral cooperation, the concept of culture has been interpreted in a broad approach from the very beginning, both because these international organisations were only set up a few decades ago and because many of their member states are newcomers adopting this new conception. It can be observed that international organisations also cooperate in new areas that meet the challenges of modernity. Most of the traditional elements of the rich toolbox of national cultural diplomacy are used in the frame of IGOs, but in regional cultural cooperation certain themes are becoming more prominent (such as fight against illicit trafficking in cultural property) and newer elements (e.g. support for cultural and creative industries, creation of regionally broadcasting media) are coming to the fore.

Sum it up, the reasons and motivations behind the development of multilateral cultural cooperation are very similar to national diplomacy considering it a specific opportunity. In this context, the emphasis is on the cooperative elements of relations, and value added can be created proved by the broader interpretation of the concept of culture and by the partly different toolkit. The size of the membership of international organisations and the economic and social heterogeneity of the participating countries has an impact on the cooperation creating a new arena for international relations. Based on the examples of the activities of the organisations, it can therefore be said that the development and expansion of the toolbox of regional cultural cooperation can be expected to continue, and the multilateral cultural diplomacy, even the interaction between different international organisations could strengthen.

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# The Novel *Tomorrow* by Graham Swift: Why Does It Have No Ending?

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## **Abstract**

The purpose of this paper is to analyse the way in which the novel *Tomorrow* by Graham Swift, a contemporary British writer, has no ending. The analysis is done based on a reader-response criticism, which relies on the background knowledge and emotional experience of the readers towards any text and the role these two play in its interpretation. The entire story of the novel takes place during one night, and it consists of the monologue of a 49-year old mother, addressed to her two teenage children, about the secret of their birth: they were born by artificial insemination, and she feels she needs to tell them this secret and she is concerned about their reaction to it, but also to their grandmothers' reaction, if they choose to tell them in their turn. The reviews about this novel had focused on the way in which it has no suspense, and no real surprise in the end. The novel also has no ending. Readers are prompted to wonder why, and make hypotheses. The novel's having no end shows that life is not arranged like a novel, echoing Virginia Woolf, and that the mother's life had not happened according to the usual structure.

**Keywords:** Reader-response criticism, literary studies, cultural studies, active reader

## **Introduction**

Graham Swift is a contemporary British novelist, born in 1949, in London, and currently living in the London suburbs, which he often uses as setting for his novels. The novel *Tomorrow*, originally published in 2007, has, as a setting, Putney, a district considered affluent located in the South-West of London, in the borough of Wandsworth.

The story is felt by the readers to have no action, at least at the present time of the story. This is because the novel takes place during one single night, on the day of Friday, June 16, 1995, and readers witness the reflections of Paula, a 49-year-old mother of teenage twins, a boy and a girl. While the twins and her husband, Mike, are asleep, the mother goes through the story of her life with her husband in their youth, starting with the time they had met during their student days when at first they also date other persons, yet soon decide they want a monogamous relationship. Then they start working, Mike becoming an editor of a science journal, and Paula an art dealer. After a while they decide they want to have children and, as they do not appear, they go for a medical checkup and realize that they can only have children if Paula gets an artificial insemination. The children never knew this, being kept a secret not only to them throughout their childhood, but also to their grandmothers. Paula is worried over the effects of the revealing of this family secret to her

children, and afterwards to their grandmothers, if they are going to decide to tell them the secret as well. Paula believes that her own mother would feel saddened or angered about the fact that she does not have grandchildren who are her daughter's biological children, while her mother-in-law may have already known the secret for many years, since she had a strong maternal instinct.

Since there is no actual action at present time, but readers are, instead, presented with a situation faced by a family, the readers are presented with the story of how the present time came to happen. It is as if they are listening to the story of someone's life, of someone they have just got to know accidentally. The secret of the artificial insemination is revealed to readers towards the end, thus this should be an element of suspense. However, reviews showed that the secret was not worth the waiting, as it did not seem shocking to the readers (Birch, 2007; Mars-Jones, 2007). Readers further on inferred that it may not be shocking to the twins either. More than this, reviews claimed that some details of the love story between Paula and her husband Mike were unsuitable to be told to teenagers, as they would not want to hear about how their parents were in love physically with each other, since they are, after all, their parents (Birch, 2007).

Further on, readers may wonder to whom is the monologue delivered by Paula addressed? Is it really addressed to her twins, and will she deliver this same monologue to them as well? The monologue seems more of a means for Paula to come to terms with this secret she has been hiding from her children and from their grandmothers, and it looks as if she has a strong need to confess it all.

Readers do not know how the twins and grandmothers, if they were told, actually reacted. The novel stops before the readers can witness the actual scenes. What is the role of the open ending in this novel?

### **Materials and Methods**

Endings can be understood as leading the way to the readers' interpreting of a text, as they can "both 'ravel' and 'unravel' the text" (Torgovnick, 2017: 4).

Swift appears to have in mind, through the open ending, a very active reader (Federici, 2009: 211-255). He prompts him or her to start imagining the outcome of the talk Paula gives to her twins, as well as the talk itself, as maybe Paula will not present unsuitable details to her son and daughter, such as the way she felt physical lust for their father. What is more, readers may think that, realistically speaking, the talk will not last as long as what they have witnessed in Paula's story. Mars-Jones (2007) suggested that Paula would be sadistic if she kept her teenage twins waiting to listen to such a long story to find out what she wanted to tell them. The talk readers have witnessed lasted, after all, for one night, and it is highly unlikely that it would last for her twins for an entire day. The talk Paula presents to readers during nighttime is more of a version for herself, which she needs in order to clarify matters for herself, and to accept the situation, first of all, for herself. The length of the nighttime speech can show how she hesitates in telling her twins the truth about their birth and about their father. The open ending may also underline her wish for never having to witness the reactions of the twins and not even having to tell them the secret, in the first place.

Due to the active role of the readers, Swift's novel's ending can best be analysed using reader-response criticism (Mart, 2019: 78-87). This approach shows how readers react emotionally to the novel, based on reviews, and how they also interpret it based on background knowledge.

Some readers felt cheated about their expectations of finding out a surprising secret, and believed the waiting was not worth it (Birch, 2007; Mars-Jones, 2007). To detail matters, Mars-Jones (2007), a representative of such readers, claims that suspense was not meant to be built by waiting to see what happens next, as we read the story; suspense is related, instead, to waiting what has happened and what started the entire confession of Paula to the readers, in fact, as much as to herself. From the point of view of interpretation, some readers use their personal experience to claim that the details related to physical lust of their mother towards their father are unsuitable for the teenage son and daughter (Birch, 2007). Yet, the readers of the reviews do not take their reader response approach further, to consider that for Paula the fact that she had her twins through artificial insemination had been and still is at present a source of personal dilemmas she has not yet found answers to. This was not the way she had imagined she would have a family and she likely wonders if, in this way, her family is any different from the expected family, with children had through natural conception. The open ending can be interpreted as the idea that the story has no end for Paula. To her, the story has no end, in order for Swift to transmit his readers her fears of the others' reactions towards the unrevealed details. The very fact that she had not revealed the secret to the grandmothers and nobody around shows that Paula herself cannot accept this reality. She had not been prepared for this and now she believes she should tell the twins in an urge to confess. The confessional mode is acknowledged by Benson (2011: 585). Why has she not told them before? In their case it is explainable, as they would likely have been too young before to understand what happened, why and how they had been conceived the way they had been.

For a couple, it can be difficult not to be able to have their own, biological children, as this wish is part of the instincts to preserve the species. This is the way all beings are biologically programmed. We can see the strong wish for couples in love to have children expressed in fairy tales in cultures from all over the world. We are familiar with the sadness of queens and kings, emperors and empresses, common persons, as well as of old women who are alone as they have no children. In these tales, magic solves the problem. A figure of the helper magically brings over a solution, e.g. under the form of magical potions, seeds, very small children born of flowers, such as Thumbelina, and so on. In the real world, in the past, there was the practice, which is still present, to adopt a child in such cases. In Swift's story, technology replaces both magic in fairy tales and adoption. Swift also replaces the effect over children experienced by them as a shock when finding out they had been adopted with the expected outcome, at least by Paula, of her revealing her secret of artificial insemination. Yet, readers are led to wonder, will it have such an effect over her children? The practice of adoption is well-spread and socially accepted on a large scale during these times, and artificial insemination has become a frequently sought for solution by couples who cannot have their biological children. Yet, as Rubin (1965: 121) draws attention, "artificial insemination with its research and therapeutic implications has stimulated such an intense emotional response." Fertility treatments are also a solution such couples turn up to.

Out of adoption and artificial insemination as alternatives to having biological children, artificial insemination is closer to having biological children. In the case of Paula, the situation is complicated as she is the biological mother of the children, yet not the man she would have wanted to be their biological father. While she had never even seen the other man, the one who was, through artificial insemination the father of her children biologically speaking, she would have wanted Mike, her husband, to be their biological father. To her, like for many women in a love relationship, having biological children is a sign of affection, as the bond between them becomes even stronger. Psychologically, stability in the relationship, as well as its durability, is suggested by a couple having children. As in fairy tales, giving children is symbolic of happiness together in a love relationship.



Paula had seen herself, in the past, conflicted between her wish to be a mother and being together with Mike, as they could not have children biologically speaking. One solution, which Paula, however, rejects from the start, was for her to have children with another man. This was unacceptable. The artificial insemination was a compromise solution.

Readers can witness themselves the dilemma regarding what makes someone a good parent and, after all, an actual parent, in the case of Mike: is it being a biological father, or a father who loves the children who are not biologically his, yet they are his wife's?

Such dilemmas are, of course, unsolvable, or, as the open ending of the story suggests, never-ending.

While the expected purpose of a story keeping readers from knowing a certain detail right away is suspense, and giving them a total, unexpected outcome, in the case of Swift's novel, the revealed detail defies these expectations. Readers have grown accustomed to finding out of the ordinary details and secrets. In the case of Swift's novel, shocking may not even have been the purpose. Readers are, instead, invited to reflect on the story from Paula's perspective, based on why this detail, in her view, might seem shocking to the others. The message is that it had been shocking for herself, when finding out how she could have children with the man she loved. She did discover that he had been a very good and loving father nevertheless, while not being a biological father.

Suspense is built by Swift by baffling his readers with an open ending. This shows that Swift wished to underline the reflective experience, not its actual outcome. Readers familiar with Swift's other novels know that his narrators are reflective narrators, facing various dilemmas at times of psychological crises in their lives. Through the open ending, Swift invites his readers to mirror the experience of the narrators, reflecting on the matters in their own turn

Readers can reflect on what makes a loving parent, biological relations or a kind heart. Is there a fatherly instinct beyond biological relations? is one questions that comes to the readers' minds. Readers are made active in an extreme way, to the point where they are invited to imagine the story further as they wonder about the reactions of the twins. In case readers feel that the twins would not be shocked by the news and would not find it hard to accept, readers may further wonder about the changes in mindset about biological parenthood or simply being a parent. Paula represents a half traditional mindset, while her twins may have already formed a completely open and accepting mindset towards the matter.

An open ending shows that a certain dilemma may not have been solved. It may also show the limits of the story, since it cannot include absolutely everything. At the same time, the story may end in a certain point to underline its significance. With fairy tales, it ends at the part of marriage, and of finding true love, with the formula: "and they lived happily ever after." In the case of Paula's story ending apparently abruptly, Swift highlights the uncertain situation she is facing.

While Swift's work overlaps partly with the Postmodernist movement, and afterwards with its aftermath, he cannot be totally described as an author belonging to this movement. Matters are, however, further complicated by the fact that Postmodernism, just like Modernism before it, is a very diverse and non-homogenous movement, if it can be called a movement at all. Postmodernism is not a movement in the usual sense in which Romanticism or Realism, or the Age of Reason were. While there were variations within all of these previous movements, they were not that non-homogenous as Postmodernism. We

can, however, see common tendencies among the writers who are influenced by the Postmodernist mindset.

From the point of view of cultural studies, Swift's work would be grounded in the historical context and influences of the society of the times he is writing in. Cultural studies relates culture to the "social and material settings" (During, 2004: 6) and the ways in which these influence it. The "social and material settings" consist, according to During (2004: 6), of "the economy, politics, education, technology and so on." It is in this context that the experience of the narrator, Paula, in the novel *Tomorrow*, can be placed. The presence of the process of artificial insemination and the various opinions on it – such as Paula's, showing concern for what the others would say, including how her children would react on finding out the way they were born, as well as the ones of present-day readers and the ones they project on the twins, considering that the twins would likely think like them, thus function of the age – belongs to the technology of the times described in the novel. Swift does not set this novel into another age than his and his present day readers', and even if he did go back to the past, he would describe it, according to cultural studies, based on the mindset and perspective we have towards a certain past age during the present times. During (2004: 6) defines culture as "a set of transactions, processes, mutations, practices, technologies, institutions, out of which things and events (such as movies, poems or world wrestling bouts) are produced [...]." This is the case of the character Paula in *Tomorrow*, and the way in which she interacts with the possibilities of technology of her times, towards which she expresses concerns, insecurities, as well as towards which she feels grateful for being allowed to have the twins in the first place.

The common features of the Postmodernist mindset present in Swift's novel *Tomorrow* can be regarded as explainable both by cultural studies, since Postmodernism is part of the culture of Swift's times and our own, as his readers, and by literary studies, the latter which can identify them in the text. An active reader is part of the usual expectations of a text written during Postmodernism, together with various moments when readers are baffled with respect to their expectations (Lindas, 2013: 1-60), which were formed based on their readings of previous texts, belonging to past ages and to their present day. Readers' response is based on the mindset formed by the culture they live in and with which they have everyday contact. A highly experimentalist technique can be seen in Swift's novel, based on the way in which the structure of the traditional plot is undermined. Knowledgeable readers have already seen this from Modernism (Stephens, 2012: 143-173), with their representative author, Virginia Woolf, whose novel *Mrs Dalloway* shows a similar type of plot, not based on chronological order, and taking place during just one day. In *Mrs Dalloway*, the title character tells readers her life story in a way similar to Paula's, only that she has no secret to reveal to anyone, like Paula. Readers do not wait in suspense to find out a certain detail, like in Swift's novel. Swift belongs to Postmodernism in the sense that he is one of the authors continuing the experimental technique set up by Modernism. Benson (2011: 585) recognized the "acrobatic storytelling" belonging to Postmodernism, which he considers in contrast with the "confessional mode." Swift continues the questioning mood which started with Modernism (Kahraman, 2015: 3991-3996) and was brought to extreme levels by Postmodernism. Swift, through the open ending, throws off doubts over the readers regarding how technology has changed our lives, by presenting the artificial insemination as having both positive and negative consequences, the latter being various worries and further questions. Modernism started questioning everything previously known due to the rapid advancement of technology and new discoveries upturning the old ones and making us doubt everything. Postmodernism brings further challenges, as artificial insemination overlaps the time of Postmodernism or after Postmodernism. An entire mindset and attitude of society towards parenthood and biological relations is visible in the

process of change in the novel *Tomorrow*, brought over by technological advancement. The way the families are created has also changed, showing the impact of technology over people's everyday lives even further.

The open ending of the story in *Tomorrow* is further questioning the way a story should be told, as well as the way in which lives should be lived. The ending remains open for readers to express their own views, making them engaged even more in the story.

## Results

The open ending of Graham Swift's novel *Tomorrow* defies the usually expected pattern of a story's ending and even of an open ending itself. Readers may feel that a large part of the story is missing, meaning the way in which the twins would react on hearing the way they were conceived, through artificial insemination, and that the man they had always called father is not actually their biological father. However, further on, readers can realize that knowing the twins' reaction is not actually the point of the story. The point of the story is to prompt readers to imagine the twins' reactions, and in so doing to see the matter from different points of view. They have been shown the mother's point of view, and further on readers are invited to express their own point of view towards this matter. The story follows the structure of interactivity, which is visible in online platforms nowadays, where we read an article and then we can find a comments section. Online social media is another example. Active participation nowadays is part of the individualist (Hofstede, 2011: 3-22) mindset formed by the society we live in, where personal opinion expression is encouraged, and disagreement is accepted if well argued for, as, for instance, in the classroom. Swift invites his readers to disagree on the way he presents the story, and with the views of Paula herself.

## Discussion

Knowledgeable readers are familiar with the frequency of metafiction (Currie, 2014), or reflections of the author of the text on the very process of writing and awareness of the fact that the author is writing the text can make them feel less engaged in the story. The action itself is put aside, in favour of the reflection the author of the text invites on the part of the readers over the conventions of the story, for instance. Once the process of writing the story is laid bare before the readers' eyes, they feel like taking a distance from the story and witnessing it as just a story, and not as authentic action, happening right before their eyes. Swift appears to counteract this reaction by inviting, indirectly, the readers to reflect on Paula's story by expressing their reactions at the end. While the secret may not seem, at least to all readers, worth the waiting, they remain engaged in the story and experience it as the authentic account of a 49-year-old mother of teenage twins. Readers can make analogies with similar cases when someone they do not know spontaneously starts telling them about an episode in their lives or sums up to them their entire life. In this way, emotional reactions are impossible not to appear, together with attempts at interpretation. Some stories of someone's life can be interesting, while others may not seem to be that much. Our reaction when meeting someone we do not know is of wishing to know what we call their story. We refer to story when we speak about someone's life, since we arrange events in our lives according to a pattern which seems to us to be coherent, or at least we search for that pattern. Knowledgeable readers can recall the views of Modernist writer Woolf (1988: 159) on the structure of the story: "Life is not a series of gig lamps symmetrically arranged; life is a luminous halo, a semitransparent envelope surrounding us from the beginning of consciousness to the end." The structure of the story reflects, based on a cultural studies approach, the mindset of the society during a certain time. In this case, traditional,

conventional views about the way in which our life course should go on are challenged starting with Modernism and continuing with Postmodernism. Enright (2007) offers a reading which suggests that Swift's novel reflects the way in which life happens and that readers should simply read for the experience presented in the story.

### Conclusion

The open ending of Swift's novel *Tomorrow* can be understood as a challenge for readers, in order to make the more involved not necessarily in the story, but in the matter of the artificial insemination, and its effects on the entire family. Questions related to the differences between biological relations between parents and children as necessary to have a loving family are raised. The answer given by Swift is a clear one, namely that what makes a family is, first of all, being a good and caring parent, regardless of biological relations. Both Paula and Mike make good parents, Paula being the biological mother and Mike the non-biological father of the twins. This story shows that there is no difference. The open ending of the story shows that we are dealing with a matter of debate in contemporary society which has, after all, no right or wrong answers. It is just a matter of personal opinions. Knowledgeable readers are reminded of one of the features of Postmodernism, and which started with Modernism, claiming that there is no single truth, but just multiple perspectives. Modernism started from questioning objectivity, while Postmodernism took matters further, reaching as far as considering everything an illusion.

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# The Short Story *The Duchess and the Jeweller* by Virginia Woolf: An Analysis

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## **Abstract**

The purpose of this paper is to analyse the short story *The Duchess and the Jeweller* by Virginia Woolf, a representative of British Modernist literature. The analysis is based on a reader-response approach, allowing knowledgeable readers to draw on their background knowledge of Woolf's works to compare this to her other one. The action surprises readers, since we are faced with characters that remind them of French writer's Guy de Maupassant's short stories, where jewellery items were part of the action, and fake vs genuine jewellery items were present. Social life, readers infer, based on their free associations with the image of the fake vs authentic jewellery items, is a matter of conventions and hypocrisy, as well as being cunning to achieve someone's self interests. We are never ourselves in society. In the end, the jewellery items make reference to both the past of the jeweller, who sold stolen dogs in his youth and cheap watches at a high price, thus deceiving the others, and to the future of the jeweller, who is sold by the duchess fake pearls, as he falls in love with Diana, her daughter, who can be a genuine jewel, figuratively.

**Keywords:** Reader-response criticism, literary studies, Modernism, free associations

## **Introduction**

As a representative of Modernism, Virginia Woolf is known to readers mostly as an experimental writer and as the creator of the stream of consciousness technique (Bezircilioğlu, 2009: 771-775). It is difficult for us readers to picture her telling a story that is close to the traditional plot, like the short story *The Duchess and the Jeweller* (1938) is. For knowledgeable readers, this short story is so different from the staple novels *Mrs Dalloway*, *To the Lighthouse* and *The Waves*, which are frequently present in literature textbooks.

What makes the difference between Woolf's style in the previously mentioned staple novels and this short story lies in the way in which the short story is more dynamic, more visual, with less details. Woolf seems to have gone through the use of the economy of style, pruning every word, so that the story is short and to the point, which does not leave much room for too many interior reflections, with unordered thoughts. The readers witness more action in this short story than in the previously mentioned novel, since the action is not apparently so static. There are stories in all the other novels as well, yet there is a lot of focus on thoughts and in this way the external action is paused, to the point where readers feel

that it is very much slowed down. In the short story, however, every unnecessary detail is pruned, and, while the action is not presented in a quite chronological manner, readers hardly realize this. The aspect of the moves backwards and forwards in time are going by almost unnoticed, since they do not occupy centre stage. Woolf does not focus as much on the lack of chronological order in this short story, and the action is there in a balanced proportion to the revealings about the jeweller's past. The humorous attitude towards the jeweler contributes to the dynamism of the story, as readers are faced with revealing various details about his past and, therefore, about his character.

Since so far we have noticed how much understanding this story is from the readers' perspective and reaction, a reader-response approach (Mart, 2019: 78-87) is considered the most suitable for analyzing this short story. It will be completed and further enriched by literary studies, based on knowledge about the Modernist movement in literature, as well as on psychoanalysis and especially the free associations method, based on patients in psychotherapeutic sessions saying anything that comes to their mind, no matter how disorganized their thoughts can be, related to an image or idea.

### **Materials and Methods**

Based on a reader-response approach (Mart, 2019: 78-87), readers experience emotions when reading any text, and they are also prompted to start interpreting the story based on their background knowledge. The background knowledge can include their personal experience, as well as cultural knowledge related to the content of the text.

First of all, how does the text feel when readers go through it? Readers can imagine the story right away, before their eyes, and do not feel that the action is paused for too much so that it feels that it becomes static. The short story begins with the description of the interior of the house belonging to Oliver Bacon. Therefore, readers are introduced right away to the main character and to his everyday life setting, picturing his room as if they were watching a play on the stage of a theatre. Each and every prop has its significance, so that the readers can add these details in their mental image of Oliver Bacon and his preoccupations. Everything is fashionable and a luxury item, and also the surroundings are ones associated to the areas in London where the rich live. Readers are told he has servants and that he starts his day in this rich setting and that he is also included in the circle of aristocratic ladies, from whom he received invitations. Further on, right after presenting us readers with these details of Oliver Bacon's situation at present, we are made aware of the fact that his life had not always been like this. On the contrary, readers are given to understand that Oliver Bacon had started off as a poor young man, and now he is a rich old man. Readers find out this detail as Oliver talks in his thoughts to himself, smiling at the way he had started off, by selling stolen dogs to aristocratic ladies, then by selling cheap watches for higher prices. He remembers how his mother had scolded him when he was doing this. Oliver Bacon looks over his past in a humorous way, showing readers that he is being completely honest about himself and about his past. Since only readers can hear his thoughts, they assume that they have access to the genuine Oliver Bacon, and that he confesses to them about how he had started off. Afterwards, based on Oliver's reflections as he remembers his past, he became a young jeweller.

Readers are given to understand, based on their free associations with elements in this situation, that Oliver is a type of the self-made man, by analogy with the American ideal. He has started off low and had reached very high, based, as readers are given to understand, on his own forces. Yet, this ideal seems questionable as readers begin to wonder whether he had managed to rise so high based on honest work, as we are told that he started

off by selling stolen dogs and then by selling cheap watches for a higher price. These seem to be tricks. The first case involving stealing and then selling what he had stolen is the most striking example of dishonesty. However, Oliver seems to have achieved his dream.

Knowledgeable readers can further make associations with the way in which before our modern and contemporary times, social order was not mobile. Once someone was born poor, he or she was supposed to remain poor. If someone was born rich, then that person was expected to remain rich all throughout their lives. Transition from one social class to another was considered to be achieved through dishonest means, and the case of Oliver can illustrate this mindset. As he remembers what his mother had said, as she was trying to draw some common sense in him, Oliver's story brings in a humorous aspect, and we readers can see how Oliver's mother was a realistic person. Even so, Oliver only partially listens to her advice, as he moves on from stealing towards making profit by selling cheap watches at a high price.

Further on, readers witness a memory of Oliver Bacon from the time he was a young jeweler and dressing better and better. Clothes are here a clear sign of social status. Good clothes are associated with personal success. To the clothes, a personal car was then added. Yet, readers are given to understand that he had lost the opportunity to marry a young girl who put roses in his buttonhole and who is at present married to someone else.

Readers are given to understand that, as Oliver Bacon fulfilled one of his dreams, of being rich and successful, he lost another dream, that of love. Knowledgeable readers can connect this situation with that of another novel, *Great Expectations* by Charles Dickens, from the Victorian Age, where Pip, a poor orphan boy, believes that, if he became a gentleman, he would be loved by Estella, a rich young lady. He does not get Estella's love, and neither does Oliver Bacon. In the end, Oliver Bacon buys fake pearls from a duchess he had been partner with for a long time, knowing that they are fake and knowing that he would actually buy one of her daughter, Diana, whom he likes.

When describing his memories, Oliver Bacon talks to the portrait of his mother, now no longer alive, and also when she makes him aware that the duchess is tricking him with the fake pearls. Readers are given to understand that Oliver Bacon has always lived in an imaginary realm, like Pip from *Great Expectations*, and has always been under the power of fantasies and, ultimately, of illusions. In this way, readers are led to wonder whether the jeweller's hope to have Diana are actually realistic, and if he is not again under some sort of illusion. Will Diana accept him? is a question about which readers are not sure that has a positive answer.

The intertextual connection with *Great Expectations* is created by the reader, based on a reader-response approach. A similar intertextual connection is made by readers based on the common elements, the fake vs genuine jewels in the short story by Virginia Woolf and other two short stories by 19<sup>th</sup> century French writer Guy de Maupassant, titled *The False Gems* and *The Necklace*. Preoccupation with whether the jewelry items are fake or genuine is clearly the topic of the short story *The False Gems*, where a man marries a young lady who is passionate about jewels. She tells her husband that all her jewelry items are fake. He looks on this situation disapprovingly, believing that she should wear jewelry only if it is genuine and only if she can afford genuine jewelry. The lady seems to live in a fantasy world, where she wears her fake jewels and enjoys going out with high society members, and especially she enjoys going to the theatre. The man, who works hard, is too tired to accompany her to the theatre in the evenings and tells her to go with her lady friends instead. After his wife dies following an illness, he decided to sell some of her fake jewelry, which he resents. He is surprised to be offered a huge sum of money for some items, and as a result readers,

together with the man, understand that his wife actually owned real jewelry items, not fake ones. The man ends up very rich, yet the lady he marries does not make him happy, although he expected her to. Readers are led to believe that jewelry, in this short story by Guy de Maupassant, is a symbol of the interplay between reality and illusions, which echoes the way life in society is going on. Social conventions and rules are all a matter of hypocrisy and make-believe. This idea is further reinforced by the short story *The Necklace* by Guy de Maupassant, where the main character is a young lady who would have liked very much to have been born rich, as she would own rich furniture, gowns, and jewelry items. Her husband, wishing to please her, gets an invitation to a ball given by a rich family, and also gives her money to buy herself a gown she believes is suitable for the occasion and he suggests her to borrow any jewelry item she likes from a rich friend. The lady is very happy at the ball, yet at the end she realizes she had lost the necklace. Her husband helps her replace it, by buying one that looks alike, which leads to their having to sell the house, give up their servants, and lead a life that is less than what the lady had before. After many years, on meeting her friend, she finds out that her necklace was actually fake. Social life is a matter of plenty of illusions, and jewelry items and material wealth are, as readers are led to believe, illusions related to being happy.

Jewelry items are related, through free associations (Schachter, 2018: 457-467), to something precious, and especially in Woolf's story they are placed in opposition to love. While the pearls the jeweler bought were fake, his feelings for Diana are real, and he may have displaced the value of the pearls on Diana, believing that, eventually, jewelry items and riches had no value compared to being surrounded by someone they liked. Another interpretation can be that the fake pearls hint at the illusions of the old jeweler. He may hope in vain to get Diana's love. The ambiguity and the many possibilities are further reinforced by the fact that the ending remains open. Readers are left not only with many questions, but also with many interpretations and with the opportunity to further reflect on the story.

Before the meeting with the duchess where he buys the fake pearls, Oliver Bacon was making free associations with certain jewelry items, or assigned them symbolic meaning and value, as follows: he associated the pearls with tears, the rubies with "heart's blood" (Woolf, 1938: 250), and diamonds with gunpowder. Readers can go over the meanings he assigns to the various precious stones and gems and consider that the association of pearls with tears and of the rubies with "heart's blood" (Woolf, 1938: 250) indicate that he has been and still is unhappy regarding love, and the association of diamonds with gunpowder can indicate that he is in a state of conflict, likely with himself, and regarding these two different wishes of his, or sets of values: material value and spiritual value, or being rich and being loved, or having the lady he loves. In the end readers can interpret, symbolically, that the jeweler gives up his idea of fortune, or that he considers that his dream of being rich is with no value if he cannot have the lady he loves. He has lost one lady he loved in the past, and he does not seem willing to lose another one during in the present.

Readers are also faced with a moment of uncertainty for the jeweler, who seems not to be sure whether or not the pearls are fake. Yet, readers had been led to believe from the beginning of the story that the jeweler can distinguish easily real from fake. At this time, however, they may be led to believe that love can make him feel less certain. The jeweler may project his uncertainties with respect to whether or not Diana would respond positively to his love on whether or not the pearls are fake. He may also express his wish that they would not be fake, in the sense that his hopes about having Diana's love are not simple illusions.

His mother comes, in his fantasies, to warn him that he is not making the right choice, and that he should not be a fool. Readers wonder whether she refers to the illusions



he has about having Diana's love or the illusions of the Duchess' pearls actually being authentic.

Further on, readers can consider the situation of the Duchess. She has had the power to make the illusion that she is rich and that her situation is stable, when in fact it is not. She has debts to cover and she hopes to receive help with money from the jeweler, yet she is also aware that she cannot trick him and promises him a weekend together with her daughter Diana. Readers are wondering whether or not this is just a trick, and if Diana is going to be honest if she responds positively to the jeweler's attentions. She may simply be doing a performance and create a world of make-believe for the jeweler.

Two sets of hopes seem to come together, those of the Duchess to cover her debts, and those of the jeweler to have what he is dreaming of: the love of a lady, in this case, Diana. Readers may wonder if Diana is not actually reminding the jeweler of the lady who in his youth would put a rose on his buttonhole. Readers can also associate the flowers with natural behaviour, with genuine feelings, and the world of jewelry with the world of illusions, marked by the opposition between fake and genuine. This opposition related to jewelry items is further on transferred to the intentions of the people around the jeweler. Likely, the jeweler is more preoccupied about whether or not the duchess is honest in her promising him the affection of her daughter, more than he is preoccupied about whether or not her pearls are fake, as he has the answer right away.

The jewelry items become means of indirect expression of the jeweler's feelings. He has suffered because of love and of his loneliness. Readers imply that he is lonely and sad, due to the free associations he makes with the precious stones and gems. By further interpretation, readers understand that love and having someone's feelings of love shared by the other person is the most precious aspect of life. As the gems and stones are precious and durable, readers infer that the longing of the jeweler for love has also been durable and has lasted throughout his life.

While the interpretation of Krueger Henderson (2008: 49-65) focuses on the way in which the short story by Woolf was considered anti-semitic, with the main character, the jeweler, portrayed in an ironic way, and having an ironic name. The story was published in *Harper's Bazaar* magazine, which provided the context of "fashionable materialism," in which readers can witness "Bacon practice familiar habits of consumption before he foolishly accepts the aristocracy at face value" (Krueger Henderson, 2008: 49). Krueger Henderson (2008: 49) underlines the following "Through her choice of narrative perspective, Woolf encourages her readers to identify with the Jewish protagonist." Thus, the main character, the jeweler, can be considered likeable and easy to put ourselves as readers in his shoes. What is more, "Woolf argues that a text's meaning is incomplete until a reader interacts with it (Krueger Henderson, 2008: 49), which further validates the use of the reader-response approach to this short story.

## Results

The short story *The Duchess and the Jeweller* by Virginia Woolf is an example of minimalist adoption of Modernist writing style, making readers get just enough of it. In this way, they see how the story advances while the character is also a reflective one, going from the present back to the past and then returning to the present time, and repeating the process over and over again throughout the story. This short story can offer readers an introduction to Woolf's stream of consciousness technique, since it is here presented in a minimal and easily accessible form. For knowledgeable readers, the effect is closer to the

traditional type of plot, since the story advances at a fast pace. Readers use the references to the past in order to understand the present situation of the main character, Oliver Bacon, the jeweler. The jewelry items are used as references towards a figurative meaning, as the jeweler assigns symbolic meanings to stones and gems. The jewels suggest to readers substitutes for what the jeweler considers precious in his life: love. The readers' reactions remain the connecting point between meaning making and literal meaning of the story.

### Discussion

The short story *The Duchess and the Jeweller* by Virginia Woolf shows intertextual connections with previous stories such as those by Guy de Maupassant, *The False Gems* and *The Necklace*, as well as *Great Expectations* by Charles Dickens, which can be used to interpret Woolf's short story. The jewelry items can be understood as symbols of the hopes, dreams, and fantasies of Oliver Bacon. As he becomes a well-known jeweler, readers can further interpret this profession through free associations as referring to a creator of dreams and various works of the imagination. After all, jewelry items can be understood as means of fulfilling wishes and fantasies. At the same time, readers are prompted to ask questions related to the meaning of life. Questions such as the following: What is the meaning of life? What is it that matters most in life: material goods, a good material situation, social status, or love? arise for readers of this story based on the free associations they make related to jewelry items. Jewelry items can be associated with something precious, and with something of value.

### Conclusion

Eventually, readers can reach the meaning, based on their free associations with the jeweler and jewelry items, that there are precious moments and landmarks in someone's life. We can mention, among these, professional achievements, as well as personal moments of happiness, related to finding the person we love. The jeweler becomes the symbol of the creator, and by extension of the way in which we are all creators of our own destiny. Life's meaning depends on what we ourselves make of it, and not of what society prompts us to consider valuable. This short story encourages us readers to look for what we value in life, and not to rely on society's expectations and pressures. Modernism is, after all, the time when individualism (Hofstede, 2011) flourishes, and when the individual is allowed to express him or herself freely, and to show independence from the conventions of society.

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# Preserving Human Dignity: The Impact of European and International Public Law on Managing Mass Graves

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## **ABSTRACT**

Mass graves, as one of the ghastly results of atrocities and times of crisis, pose very serious questions of law and morality intersected by European and international public law. This study examines how international humanitarian law, European human rights law, and the general principles of international public law respond to the respect due to the dead regarding the discovery, exhumation, and handling of mass graves. This study analyzes the duties imposed upon states by the Geneva Conventions, the European Convention on Human Rights, and customary international law regarding dignified treatment of the dead, identification of deceased persons, and proper burial ceremonies. By interpreting the nuances of European legislation on the function of forensic science and new technologies to meet legal thresholds of identification and exhumation while respecting cultural and religious traditions, the research would evaluate the challenges of balancing the evidentiary needs of war crimes tribunals with the dignity and privacy due to the deceased persons and their family members.

**Keywords:** mass graves, human dignity, post-conflict justice, genocide, migration, international law

## **INTRODUCTION**

Mass graves are the macabre testimony of human history, marked by wars, genocides, pandemics, and natural calamities. Such burial sites pose intricate questions at the juncture of law, morality, and human dignity that pose enormous challenges to their practical management and legal accountability.

All these issues need to be considered with an astute awareness of the legal, cultural, and ethical dimensions surrounding the discovery, exhumation, and management of mass graves. Indeed, mass grave management is considered an issue in many contemporary contexts, such as those related to war crime investigations, humanitarian responses, and natural disasters. The treatment of these sites is not only an operational concern but also a matter of value in the wider societal context. States are confronted with the challenging job of balancing respect for, and dignity of, the deceased against the needs related to the evidence required for judicial procedures. (Squires et al, 2019: 315-339)

The purpose of this research is to determine the extent to which European and international public law plays a role in regulating the treatment of mass graves, to ensure that the dead are treated with dignity. The work examines the various obligations imposed on states by the Geneva Conventions, the ECHR, and customary international law.

It therefore adopts a truly interdisciplinary approach, combining legal analysis with knowledge drawn from forensic science, cultural studies and ethics. The research first provides a historical overview of mass graves management and the development of legal approaches dealing with major international and European legal frameworks as increasingly defining such practices.

Relevant treaties, case laws and customary norms are studied in some detail. Additionally, the contributions of forensic science and technology to the identification and the equality of the evidence have been discussed.

The findings of this study contribute to the broader discourse on the interplay between law, morality, and human rights and provide valuable lessons on how legal frameworks can protect human dignity, even in difficult circumstances.

## **I. HISTORICAL AND LEGAL CONTEXT**

In ancient and medieval times, mass graves were the pragmatic response to wars and pandemics, among others, with the primary intention of quick disposal to avoid disease spread. The treatment of mass graves during these times reflects a mix of functional necessity and religious observance, influenced by the cultural and historical context of each event.

Dignity, as a human right or an inherent moral obligation, was largely lacking in the thought processes of ancient societies. In times of crisis, mass graves became a practicality, and the dead were regarded more as a public health problem than as individuals possessing dignity in and of themselves. This utilitarian approach is reflected in the historical precedents of mass graves, such as those created during the Peloponnesian War or the Black Death, where bodies were hastily buried in communal pits without markers or rituals (Green, 2015).

Archaeological findings, like the East Smithfield cemetery in London, reflect hasty and without ceremony burials, with communal graves lacking individual markers. Burials during the medieval period were guided by local customs and religious dictates, most of which buckled amidst pandemics (Kelleher, 2019). Although Christian doctrines emphasized burial rites, these practices became less central than the need for a speedy disposal of the dead. The Church, at times, retrospectively consecrated mass graves, although such efforts were indeed very inconsistent (Lewis, 2016: 777-780).

The management of mass graves epitomizes where history, law, and morality meet to ensure dignity for the dead and accountability. History can be drawn from wars, pandemics, and genocides that have thus far utilized mass graves. The most important sites from World

War II are to be found in Bosnia and Herzegovina. The ability to identify remains through advances in forensic science, including DNA analysis, has transformed such efforts toward closure for families and supported justice initiatives many decades later. (Marjanović et al., 2015: 259)

During the Nuremberg Trials of 1945-1946, mass graves played a critical role in evidentiary proof of crimes against humanity and war crimes prosecution that established key principles related to accountability and the "following orders" defense. Such precedents set the legal framework for post-war frameworks like the Geneva Conventions, which stipulated requirements in identifying the dead, respectful treatment, and preservation of evidence to hold those accountable and to respect human dignity (De Souza, 2022)

The post-war period saw significant developments in international humanitarian law, particularly through the adoption of a series of laws emphasizing the protection of human dignity post-mortem.

For the contemporary period, it is necessary to recall the discovery and investigation of mass graves in Bosnia and Herzegovina, relics that remain a major concern, given the significant number of people missing following the conflict in the 1990s. According to available data, between 1996 and 2020, the remains of over 25,000 people were exhumed from approximately 1,600 mass graves. In 2021, several mass graves were discovered and investigated, especially in the Prijedor and Srebrenica regions, where the remains of dozens of victims were exhumed (Balkan Insight, 2023).

In 2022, efforts to search for and identify missing persons continued, with notable discoveries in areas such as Korićanske Stijene and Vlasenica. In 2023, significant discoveries were reported in the Foča region, where the remains of over 20 people were exhumed (Nuhanović, 2022).

These efforts are coordinated by the Missing Persons Institute of Bosnia and Herzegovina, in collaboration with international and local organizations, using advanced technologies and scientific methods to locate and identify victims. It is important to note that the process of discovering and identifying mass graves is an ongoing one, and the data is updated as new information becomes available (Missing Persons Institute of Bosnia and Herzegovina, 2024).

The ongoing Russo-Ukrainian war has further highlighted the grim reality of mass graves because of modern conflicts. Since Russia's invasion of Ukraine in February 2022, several mass graves have been discovered in areas previously occupied by Russia, drawing international attention and condemnation. One of the most high-profile cases occurred in Bucha, a suburb of Kiev, where Ukrainian authorities discovered mass graves containing hundreds of civilian bodies following the withdrawal of Russian forces in April 2022. Many of the victims showed signs of execution, torture or violence. death, suggesting possible war crimes. (Amnesty International, 2022).

In September 2022, in Iziium, a town in the Kharkiv region, more than 440 bodies were exhumed from a mass grave site. Civilians and soldiers alike, many showed signs of violent death, and some graves were marked with makeshift crosses, indicating the chaotic circumstances of their burial (BBC NEWS, 2022).

Ukrainian authorities, in collaboration with international forensic teams and human rights organizations, are working to document and investigate these mass graves. Advanced forensic methods, such as DNA analysis and geospatial imaging, are being used to identify victims and collect evidence for potential prosecutions in international courts. The goal is to hold perpetrators accountable under international humanitarian law, for violations of the

Geneva Conventions and crimes against humanity.

We are thus faced with an immediate humanitarian crisis, which highlights the need for transitional justice (of societies undergoing a transition from a repressive regime or a period of conflict to a democratic or peaceful one) but also for historical memory.

This brief historical and legal picture emphasizes that past atrocities still have a living responsibility, and the pursuit of dignity for the deceased and justice for the living is an ongoing moral and legal obligation.

### ***1.1. International Humanitarian Law***

Geneva Conventions and their Additional Protocols establish comprehensive guidelines concerning the protection and management of mass graves during armed conflicts. These international treaties call for dignified treatment of the dead, demanding proper burial, identification, and recordkeeping to respect the dignity of the dead.

*Article 34 of Additional Protocol I, 1977*, specifically provides that parties to a conflict shall try to prevent the dead from being despoiled and that they shall, whenever possible, facilitate the return of remains to the families upon request, showing respect for the wishes of the deceased regarding the disposal of their bodies, if that is known.

This article underlines the duty to search for, gather, and remove the dead as quickly as possible and to ensure that the burial is carried out with honor, preferably with the rites of the religion to which they belong. It also calls for graves to be respected, appropriately marked, and maintained to make exhumation and identification possible later (GC and AP Commentaries, art.34, 1987, p.365).

The Conventions further label some acts connected with the treatment of the dead as "grave breaches," meaning the serious violations of international humanitarian law. These include willful killing, torture, inhuman treatment, and causing great suffering or serious injury to the body or health. Universal jurisdiction attaches to such acts; all signatory nations are duty-bound to legislate regarding the punishment of these crimes and to search out and prosecute any person accused of committing them (GC of 1949, AP of 1977, Annex 1).

International humanitarian law provides basic protections for mass graves during and after armed conflicts. Provisions under the Geneva Conventions, in particular Article 130 of the Fourth Convention and *Article 34 of AP I*, demand that the gravesites must be respected, maintained, and always marked, extending their applicability beyond the end of hostilities. These norms make someone accountable, easily help identify the remains, and acknowledge the rights of the families to know what happened to their kin (Krasniqi, 2023).

In non-international armed conflicts, however, protections are not as strong. Common *Article 3 and Article 8 of AP II* apply only during active hostilities and do not extend to peacetime or internal disturbances. This limited scope contrasts with international conflicts, where many obligations-such as grave maintenance and respect after a conflict is over since their purpose is to deal with the lingering effects of war (Petrig, 2009: 363-365).

Customary IHL might fill in these gaps, though, and provide at least some level of protection for mass graves in all conflict scenarios.

## ***1.2. International human rights law***

International human rights law plays an important role in managing and protecting mass graves, including considerations of dignity for the dead and justice for victims and their families. It requires states to investigate mass graves promptly, thoroughly, and impartially, among other things, for violations of the right to life and prohibitions against torture and inhuman treatment. These are obligations underpinned by instruments like the International Convention for the Protection of All Persons from Enforced Disappearance, which call for the location, identification, and dignified treatment of remains.

International human rights law imposes an obligation on states to investigate violations of rights, including the right to life (ICCPR, Article 6) and the prohibition on torture or cruel, inhuman, or degrading treatment (ICCPR, Article 7). Investigations into mass graves should be initiated without delay and should be independent, thorough, and transparent; the conclusions reached by them are to be based on objective analysis. Article 24(3) of the CED demands that states undertake the search for, respect, and return of the remains of disappeared persons; this is an ongoing obligation until the fate or whereabouts of such persons have been determined (Klinkner et al, 2020: 5-6).

Protection of mass graves is one of the most important aspects of international human rights law, particularly addressing gross violations that amount to international crimes. The UN's 2006 Basic Principles underline the *right to truth*, binding states to investigate mass graves as part of ensuring victims' rights to justice, reparation, and accountability. Principle 24 simply reiterates a victim's and representative's right to know the causes and circumstances of gross human rights violations (Klinkner, 2017: 56-57).

States are required to take affirmative actions, such as systematic investigations, evidence collection, and accountability measures, to uncover the truth about abuses, identify perpetrators, and understand patterns of violations.

## ***1.3. International criminal law***

The point of convergence between international criminal law and the treatment of mass graves reveals a tension between the humanitarian needs of the families and the evidentiary demands of the war crimes tribunals. Families of the missing seek closure, desiring the recovery and identification of remains for proper burial.

On the other hand, the international tribunals set up to try crimes that are genocide, crimes against humanity, or other international war crimes usually rely less on personal identification and instead make "categorical identification". Since proving such crimes requires proof of an intent to destroy a group on ethnic, religious, or racial grounds, forensic inquiries thus generally remain focused on proving the characteristics of such a group, along with the cause and manner of death. The remains of specific family members might never be known.

Under Articles 8(2)(a) and 8(2)(b) of the Rome Statute, willful killing or intentional targeting of individuals in case of armed conflicts is considered a war crime. By prohibiting violations of personal dignity, such as treating the dead in a humiliating way, Articles 8(2)(b)(xxi) and 8(2)(c)(ii) of the Rome Statute demonstrate even the dead are accorded protection under international law. These clauses express respect for the dignity of the dead and are in line with IHL, which prohibits the despoliation and mutilation of human remains (Klinkner, 2017).

The difficulties are multiplied by the practical restrictions. In cases such as Rwanda, the

numbers slaughtered have swamped the investigational resources available, whereas in the former Yugoslavia, clandestine methods of disposal have obstructed the process of recovery. And when remains have been recovered, the facilities to make intensive personal identification are often lacking (Humphrey, 2003: 500-503).

This balance of the different priorities, however, has been partial. Although the ICTY has worked to identify victims from several small massacre sites, for example, the resources required in large sites have kept them focused on short-term identification techniques. This points to yet another gap—a need toward greater integration (Garbett, 2016).

For example, the Croatian government's commitment to forensic analysis, including DNA testing and the most modern mortuary facilities, assisted the prosecution's case at Ovcara in making the processing of one mass grave possible much more quickly than would otherwise have been possible. 184 victims were identified and returned to their families thanks to this process, providing justice and closure.

By contrast, the investigation into the atrocity at Srebrenica was not without its challenges. Exhumations often had to be performed for many of the bodies, which were relocated to secondary graves to conceal evidence, and they were spread out over numerous locations (Karčić, 2015). When the ICTY decided that it would place greater reliance on establishing genocide through patterns of murder rather than individual identifications, many relatives were denied a sense of closure. Although they have improved identifications, further initiatives—such as the International Commission on Missing Persons' adoption of extensive DNA analysis—bring out the complexity (Stover, 2010: 89-94).

The investigation proved that Slobodan Milošević, and others were guilty of crimes against humanity in Kosovo with forensic tests. The work involved the establishment of patterns for systematic killings, and such work needed exhumation to corroborate witness statements and demonstrate command responsibility. However, due to a lack of time and resources, numerous dead could not be identified, which irked the relatives and agencies. (Stover et al, 2010: 92-94).

International criminal law frameworks, including the Rome Statute and IHL treaties, provide strong mechanisms for the prosecution of perpetrators, protection of the dignity of victims, and accountability. These frameworks emphasize the duty to investigate, preserve, and respect mass graves to uphold justice and human rights.

## **II. BALANCING JUSTICE AND HUMAN DIGNITY. TECHNOLOGICAL ADVANCEMENTS CULTURAL SENSITIVITIES**

Management and the preservation of mass graves thus require a delicate balance between maintaining the dignity of the dead on one hand and advancing justice considering cultural sensitivities on the other. Technological advances and shifting forensic practice have significantly enhanced the ability to investigate mass graves and identify victims. These efforts will need to be weighed with a deep understanding of the culture and religious traditions of the relevant communities lest further harm exacerbate their suffering and to be sure that their dignity post-mortem is respected.

As Alok Atreya and Ritesh G. Menezes (Atreya and Menezes, 2024) in their research, respecting the dignity of the deceased goes beyond humanitarian concerns and is crucial for societal healing, justice, and public health, based on several important reasons:



- *Respecting the customs of culture and religion about funeral rites and interment. The feelings of impacted communities are violated when bodies are carelessly disposed of or left unattended on the streets.*

- *Offering a bereaved family's emotional closure. After death, the body frequently belongs to the surviving family members or legal heirs. The inability to hold appropriate funerals and the presence of unidentified bodies prolong trauma and hinder healing.*

- *Reducing the dangers to public health posed by decaying bodies that, if ignored, could taint water sources and transmit disease. Simple safety measures are essential.*

- *Facilitating legal activities that are needed to prove the deceased's identification, such as handling insurance claims and inheritance distributions.*

- *Permitting forensic analysis to identify precise causes of mortality in epidemics or criminal cases. There are legal, medical, and societal ramifications to this.*

The administration of mass graves frequently involves the intersection of the two imperatives of justice and human dignity.

Municipal cemetery systems in countries such as the UK are reasonably transparent and accountable to the public. Burial policies, taxation, and maintenance lie ultimately at the discretion of local councils, to whom they are responsible via the ratepayers. Comparable democratizing processes may often not be present where the normal provision is through Church-controlled cemeteries, and this could create inequalities in both access and decision-making (Rugg, 2020: 8-10).

It remains challenging to include ethnic and religious diversity in funeral practices globally. The Swiss decisions on canton levels about sites for Muslim burials are localized strategies that attempt to balance national secular imperatives and community needs, exemplifying how crucial inclusive governance is for the cemetery systems (Outmany, 2016: 87-105).

In the context of mass burials, good cemetery management techniques would provide valuable lessons that would help in balancing justice and human dignity. Even in instances of mass graves, the systems need to be in a place that can pay respect to those buried and meet societal expectations through good governance with transparency, cultural sensitivity, and democratic accountability.

In the context of mass grave identification, it can be very challenging to refer to burial customs and respect for human dignity when attempting to reach an almost impossible "compromise" among many cultures, religions, and points of view. The employment of cutting-edge technologies in the identification and discovery of remains has alleviated these issues, but some people still believe that these techniques are an infringement on the right to the "rest of the soul."

For instance, the exhumation of mass graves in remote indigenous villages occasionally ran against to Mayan beliefs about upsetting the dead when they were discovered in the wake of the Guatemalan civil war (Bambury, 2017). Before exhumations could take place, customary rites had to be performed to placate spirits and honor local traditions. The Maori people of New Zealand view graves as sacred, or "tapu" (sacred and protected). There has been resistance to scientific attempts to exhume the remains for research, including DNA analysis (Hudson, 2020).

However, we cannot neglect the performance of advanced technologies in the process of protecting and uncovering mass graves.

## ***II.1. DNA analysis***

DNA analysis, while providing unparalleled accuracy in linking remains with families, has become integral in the identification of individuals in mass graves. Its application, however, raises critical moral and legal issues that must be weighed against general objectives of justice and human dignity.

The procedure raises ethical issues related to privacy and consent. For the remains to be matched against DNA from family members, sensitive personal information will need to be processed requirements of stringent safeguards against its misuse. There is an issue of cultural and religious sensitivities; hence, the DNA testing and exhumation may conflict with perceptions about the dignity of the dead (Caenazzo et al, 2013: 393-396).

Ethical dilemmas arise when there is a kinship mismatch. For example, identification becomes more complex and often requires additional DNA samples when it is ascertained that a claimed family member is not biologically related. This places investigators in a challenging position where they must decide whether to reveal private information or save families from suffering (Parker et al 2013: 221-229).

Informed consent is critical in solving this problem. Families should be informed about possible IFs and their consequences from the very start so that they can decide whether to participate. But equity does not come with consent alone. Policies must ensure fair access to the benefits of identification, such as justice and closure, and minimize risks by improving DNA techniques.

With the assistance of the Croatian government, which provided access to state-of-the-art technologies and DNA analysis, forensic investigations at Ovcara identified 184 victims (Ekštajn et al, 2021). In contrast, identifications at Srebrenica were complicated by scattered and altered graves; as of 2003, only 700 of the 7,500 deaths had been identified. The ICTY's decisions to focus on proving patterns of genocide rather than individual identifications frustrated survivors, who again saw a conflict between legal aims and family needs (Vanderpuye and Mitchell, 2020).

Effective management of mass graves demands collaboration among governments, forensic experts, and families to ensure justice, uphold human dignity, and address systemic violence transparently. Such efforts support both legal accountability and the healing of affected communities.

## ***II.2. Remote Sensing and Satellite Imagery***

Remote sensing and satellite imagery have emerged as critical tools for identifying mass graves, tracking human rights abuses, and documenting violations of international law.

Remote sensing systems, like hyperspectral imaging, have developed the capability to provide investigators with the location of burial sites through the discrimination of spectral signatures related both to disturbed soil and decaying bodies. For example, experimental studies have shown discrepancies in electromagnetic radiation reflected at grave sites compared to undisturbed landscapes. These technologies provide objective evidence and may be used in situations where denying the presence of mass graves is an issue, which has happened in conflicts of Guatemala, Iraq, and Rwanda (Kalacska et al., 2006).

This has very serious implications for people's right to privacy when satellite images are used to monitor private areas in conflict zones. For instance, monitoring civilian shelters, places of worship, or refugee camps without permission might violate the autonomy and dignity of the individuals being watched.

This issue has been dealt with by international criminal courts, mentioning the need for collaboration between local authorities and forces investigating war crimes and their consequences. Practical challenges, however, include the expensive and scarce availability of adequate high-resolution photographs, often collected by for-profit companies that have limited financial incentive to collect data in atrocity-prone areas; similarly, the ICC relies heavily on external analysts such as Human Rights Watch and Amnesty International, which have limited resources and may have objectives that are inconsistent with the needs of legal evidence. Remote-sensing techniques are far from professionalized and standardized, and judges often lack the technical knowledge to evaluate geospatial evidence (Kroker, 2015).

These challenges involve taking measures that ensure the admissibility, reliability, and probative value of satellite evidence: developing standard forensic practices, ensuring chain of custody, and educating the legal expert on how to understand and evaluate geospatial analysis. If the satellite images are to find appropriate use in courts, then judges must be knowledgeable about its technological underpinning.

### **III. MASS GRAVES AFTER THE RUSSIAN-UKRAINIAN CONFLICT**

Mass graves were discovered after the Russian-Ukrainian conflict, showing significant human rights abuses and thus raising an outcry for accountability across the globe. These graves show the systematic character of the atrocities perpetrated throughout the conflict; they hold both soldiers and civilians. They also raise several justices, humanitarian relief efforts, and dignity issues for the dead.

The investigation also revealed that mass graves that turned up in Bucha, Mariupol, and Izyum exhibit signs of execution, torture, and random brutality. The satellite images and forensic investigations done on the ground have essentially identified these sites. It is now high-resolution imagery that has come to disclose patterns of mass burial sites, corroborating reports about atrocities.

The discovery of mass graves near Mariupol, particularly at the Starokrymske Cemetery, has brought to light the horrific scope of human loss in the Russian-Ukrainian battle. Satellite images and forensic investigations by groups like the Associated Press show the extent of such mass burials, raising pertinent questions about the human cost of this conflict and the need for justice.

Satellite and drone imagery analyses show the Starokrymske Cemetery has expanded by more than 51,500 square meters between March and December 2022. At least 10,300 new graves were counted during the AP's investigation, but the actual number of people buried is likely far higher because multiple bodies were found in some sites. Many graves are marked by a wooden cross, hand-written numbers, and earth mounds; others are either left unmarked or hidden beyond the trenches dug with heavy equipment (Kivva, 2022).

Because mass graves obscure the evidence of violent killings, it is not known exactly what killed those buried. However, forensic examinations in other parts of Ukraine have found evidence of trauma-which included bound hands and gunshot wounds consistent with executions, bombings, and other violent crimes (BBC NEWS, 2024).

The AP methodology-roughly one grave per six square meters based on the average area per grave, then applied to the overall increased area of the cemetery. Mass graves were also dug up at other nearby burial sites in Mangush and Vynohradne, where similar examinations were conducted.

The Soviet authorities have long used mass burials as an instrument of ideological

repression, while the stories about unification and triumph will organically blend with this context.

A similar propaganda operation is also being carried out in Mariupol. Newly discovered mass graves that might contain civilian victims are reportedly being altered to conceal evidence of war crimes, according to sources. Like the Soviet practice of depersonalizing the dead, reports speak about hurried burials, insufficient documentation, and few identifications of the victims. The goal seems to be to camouflage the systematic basis of violence and to eliminate individual tragedies, making these sites tools of military and political deception (Ossowski et al, 2016).

For instance, mass burials were often combined for convenience and propaganda reasons into larger gravesites during the Soviet era. These practices frequently deprived the names, with graves starting to function as collective memorials that were supposed to be for the glorification of the state rather than a particular individual. To put it in perspective, some reporting has suggested that the Mariupol graves were possibly intentionally left unmarked or mislabelled, which was more about confusing anyone who ever tried to investigate further (Rugal, 2024: 62-64)

## CONCLUSION

Mass graves, at the point of morality, legality, and human dignity, pose a serious problem because they stand as sober reminders of the penchant that humanity has for violence. The following study underlines the important role international legal frameworks play in regulating the handling of mass graves to preserve the dignity of the deceased and ensure justice is delivered to the victims and their families.

Mass graves have traditionally been treated with little regard for dignity and often as an expedient response to emergencies. These procedures have evolved through the development of current judicial systems and forensic sciences to the extent that a victim could be identified, and an offender brought to book. Nevertheless, the challenges still arise in balancing operational requirements, cultural sensitivity, and ethical commitments. Mass graves that have been discovered during armed conflicts, such as those during the Russian-Ukrainian war, draw broader attention to systematic violations of human rights and call for stringent procedures to address this crime. Satellite photography and DNA analysis are just a few examples of technologies that have been very useful and effective in identifying the victims and finding evidence. However, these tools also must be used to respect the emotional needs of the affected families, cultural traditions, and privacy.

This research shows the importance of dealing with mass graves by combining legal, scientific, and cultural viewpoints. Interdisciplinary approaches of this kind will ensure investigations are thorough, victims are treated with dignity, and justice is truly served.

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# Performance of Capital Market at the Covid 19 Pandemic Period in Indonesia: Bibliometrics Approach

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## ABSTRACT

Covid 19 Pandemic is health crisis which cause economic crises. Many sectors of economy in Indonesia was affected by Covid 19 Pandemic include Capital Market. The development of Indonesian Capital Market has been tested through various events in history in Indonesian economy. One of these events is the global financial crisis. These challenges always have an impact on Indonesian Capital Market sentiment, including the shock of the Covid-19 pandemic. Challenges that must be faced by the Indonesian Capital Market. The government has made various efforts to protect the Indonesian Capital Market through regulation, improvement and reform of Indonesian Capital Market governance. The government is trying to improve the performance of the Indonesian Capital Market to recover and continue to increase investor confidence to maintain the confidence of investors, especially small-scale investors. paper has purposes to explain the performance of Capital Market in Indonesia at the Covid 19 pandemic period. This research uses methodology descriptive qualitative with literature review with bibliometrics analysis approach. The result of this research give comprehensive explanation about the performance of Capital Market at Covid 19 Pandemic period in Indonesia based on the explanation exposure based on the literature review which is described by bibliometrics approach.

**Keywords:** Performance, Capital Market, Covid 19 Pandemic, Indonesia, Bibliometrics

## INTRODUCTION

The development of the country's capital market has passed through varied important events in Indonesian economy the important economic events started from the colonial era, the struggle for Indonesian independence to during the global financial crises, as well as current COVID-19 pandemic and the war in Ukraine. "Indonesia's capital market must unquestionably face those challenges. Improving and reforming Indonesia's capital market governance are the key to success in dealing with various shocks. In the last five years, Indonesia's capital market has grown extremely fast, driven by the reform program that has been set, business process automation, investor protection, and accelerated market deepening. When the Composite Stock Price Index (IHSG) experienced turbulence to its lowest

point in March 2020 at the beginning of the COVID-19 pandemic, Indonesia's capital market could respond well with the support of joint policies determined by the Government and the Self Regulatory Organization (SRO), as well as the stakeholders (setkab.go.id)

The capital market plays an essential role in the economy of a country. The United States (USA), the country with the enormous economic power in the world, has four main indexes and eight additional indexes. Meanwhile, the bamboo curtain country with the second-largest financial strength globally has three main indexes and five additional indexes. Indonesia, a developing country, has one main index and four additional indexes (Indeks Indonesia - Investing.com, 2021) in (Priyono and Saraswati, 2022).

Concerns due to Covid-19 also hit global financial markets, indicating that during the spread of Covid-19, global financial markets experienced uncertainty at a high level. This uncertainty has an impact on financial markets in Indonesia. Table 1 shows that in the January-April 2020 period, there were capital outflows of 159.3 trillion rupiahs. Savings Bond Retail (SBN) amounted to 143.5 trillion rupiahs, shares amounted to 11.8 trillion rupiahs, SBI amounted to 3.3 trillion rupiahs, and corporate bonds reached 0.6 trillion rupiahs. Capital outflows from foreign investors cause high volatility in stock price index movements in the event of a crisis (Lestari and Kusumawardhana, 2020).

Ryandono et al (2021) have the research which have the purpose of this study is to explore the reaction of sharia stock in the Indonesian capital market to the global Covid-19 pandemic. The method used in this study is an event study with a Market Adjusted Model (MAM) approach. The population of this study is shares listed on the Indonesian Stock Exchange (IDX), with the sample chosen from the Jakarta Sharia (Islamic) Index. The result of this study found that the global Covid-19 pandemic is bad news, with the indicators as follows: a) the average expected return is negative; b) the average actual return is negative; c) the average abnormal return is negative, and d) the increase selling action of stock as a cut loss strategy. There is a negative abnormal return and significant Trading Volume Activity (TVA) before, during, and after the announcement of the global Covid-19 pandemic. However, this study found no difference in abnormal return and TVA before and after the announcement of the global Covid-19 pandemic. From these results, this study indicates that the sharia stocks in the capital market in Indonesia can respond quickly to the information that existed. Therefore, the capital market of Indonesia is a capital market with a semi-strong efficient form (Ryandono et al, 2021).

WHO's announcement about the Covid-19 pandemic is bad news for the Indonesian Capital Market. The indicators for bad news include; a) the negative average expected return (market revenue), b) the average actual return of Sharia stock in Jakarta Islamic Index (JII) is negative, c) negative average abnormal return d) Increased selling of Sharia stock in Jakarta Islamic Index (JII). In this negative market condition, it turns out that there are stocks that are not affected by bad news and a weakening economic situation because the issuers are companies engaged in the production of public utilities, industrial and consumer goods companies, food and beverage, and products, pharmacy especially medicines. Stocks that continue to perform positively on the market despite negative information (bad news) and are shock-resistant in the economic cycle are categorized as "resilient stock" or defensive stock. This reality shows that the law applies that; "Every adversity there is always luck" or every difficulty is always along with ease. There is a negative Abnormal Return and significant TVA on the Jakarta Sharia Index (JII) sharia stock before, during, and after the announcement of Covid-19 as a global pandemic. However, there was no difference between Abnormal Return and TVA in the Jakarta Sharia Index (JII) sharia stock before and after the announcement of Covid-19 as a global pandemic. These results indicate that Sharia stocks in the Indonesian capital market can respond quickly to the existing information so that the Indonesian capital market is a capital market in a semi-strong efficient form. The implication



is that investors in making investment decisions should not only consider technical market statistics and fundamental factors but must also consider non-economic events (Ryandono et al, 2021).

## RESEARCH QUESTION

Based on the above explanation it is important to conduct research Performance of Capital Market at the Covid 19 Pandemic Period in Indonesia with Bibliometrics Approach. The research question is how are the Performance of Capital market at the Covid 19 Pandemic Period in Indonesia with Bibliometrics Approach?

## LITERATURE REVIEW

Covid-19 pandemic provides a domino effect from health to social and economic problems, especially business actors. Central Statistic Body has noted that economic growth rate in the first quarter (January-March) 2020 grew only 2.97%. This number reduced from 4.97% in the fourth quarter of 2019. Moreover, this growth is far below the achievement of the first quarter of 2019 which is 5.07%. While in the second quarter of 2020, Indonesia's economic growth rate has been a minus 5.32%. This number is contrariwise proportional to the second quarter of 2019 at 5.05% (cnnindonesia.com, August 5, 2020) in Wuryandani (2020).

Liu et al., (2020) in (Priyono and Saraswati, 2022) in their research that evaluates the short-term impact of covid on 21 leading stock market indices including: Japan, Korea, Singapore, the United States, Germany, Italy, and England, etc. The finding shows that stock markets in the main affected countries and regions fell rapidly after the virus outbreak. Furthermore, countries in Asia experienced more negative abnormal returns than other countries. Meanwhile, on the Indonesian stock market, Dewi, (2020) in (Priyono and Saraswati, 2022) , in her study, uses the period from January 13th, 2020, to April 21st, 2020, on the Indonesia Stock Exchange to find that Covid had negative implications for the JCI. Similarly, research conducted by (Junaedi & Salistia, 2020) in (Priyono and Saraswati, 2022) finds that the Covid-19 pandemic and social distancing policies (WFH and PSBB) in the country have affected the stock market dynamics.

## Signaling Theory

Signaling Theory The absence of information equality/information asymmetry impacts the difference in the information held about the company between management and investors. Encourages the emergence of Signaling Theory, where management and shareholders expect to have equal input. Management will send relevant signals related to the condition of the company to investors. The information sent by the administration is an important signal for investors, and then investors will process the signal for decision making (Priyono and Saraswati, 2022).

Brigham et al., (2014) in (Priyono and Saraswati, 2022) explain, "Signal Theory is an action taken by the company's management that provides clues to investors about how management views the company's prospects." Meanwhile, Fahmi, (2014) in (Priyono and Saraswati, 2022) explains that signal theory is a theory that explores stock price fluctuations in the stock market so that it will influence investors. Furthermore, Jogiyanto, (2013) in (Priyono and Saraswati, 2022) states that the published information will provide a signal for investors in making investment decisions. If the published announcement contains a positive value, it expects the market to react when it receives the information. By the signal theory, companies that have high performance will give a signal about the conditions of

companies that are profitable and relatively not easy to go bankrupt and various other forms of financial distress, and vice versa for companies that have low performance. Based on this opinion, it can be concluded that the signal theory explains that companies have the urge to provide financial statement information to external parties (Priyono and Saraswati, 2022).

Two main factors influence the rise and fall of the index, namely internal factors, and external factors. The external factor currently whacking the volatility in the stock market is the presence of the coronavirus outbreak. The presence of the Coronavirus on this earth has caused panic in various parts of the world. The epidemic attacks multiple levels of society, especially for those who have congenital diseases. The presence of the virus was detected for the first time in the city of Wuhan, China, on December 31st, 2019, cases of pneumonia were found. Furthermore, on January 1st, 2020, the town was closed for sanitation and disinfection. However, the lockdown in Wuhan and other cities in China were unable to stem the spread of the virus throughout the world (WHO Timeline - COVID-19, 2020) in (Priyono and Saraswati, 2022).

#### **Comparison between Death Toll and Infection Toll Covid Epidemic with the Other Epidemic**

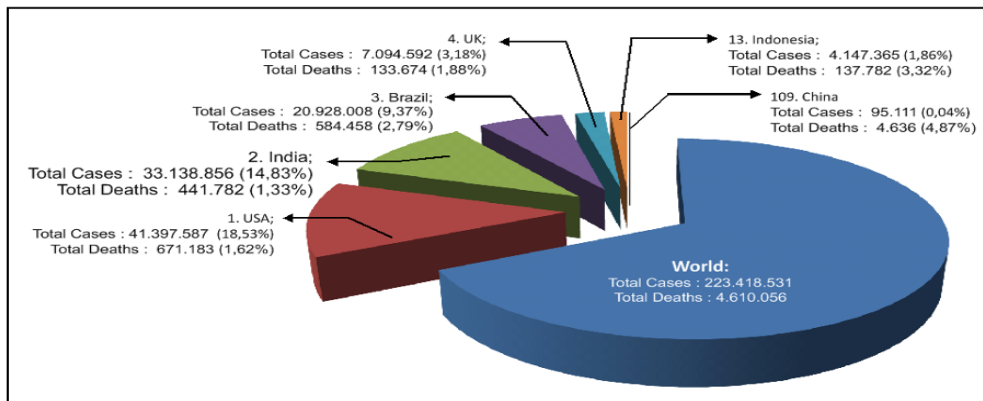
Epidemic	Mortality rate (Death/Case)	Infection rate (Per Infected Person)
Ebola	50 %	1,5 – 2,5 %
MERS	34,30 %	0,42 – 0,92 %
SARS	10 %	3 %
COVID-19	1 % – 3.4 %	1.5 – 3.5 %
Seasonal flu	1 % – 3.4 %	1.3 %

Source: (Abiad et al., 2020)

The risk of death due to being infected with the covid virus is very low compared to other viruses that have become pandemics. However, the effectiveness of the virus to spread is very high (Priyono and Saraswati, 2022).

The spread of the coronavirus has reached almost all countries in the world. The United States recorded its first case on January 21st, 2020, while Indonesia reported its first case on March 2nd, 2020. However, the spread of the virus continues throughout the world, reported being affected by the outbreak (Priyono, 2021) in (Priyono and Saraswati, 2022). The total number of Covid-19 cases globally has reached 223.4 million positive cases with a total death of 4.6 million. Of these total cases, America became the first largest center of the spread of COVID with 41.4 million positive cases and total death of 441,782 people. Meanwhile, Indonesia was ranked 13th of COVID cases, with 4.2 million positive cases and 141,826 dead people. However, China was reported as the source of COVID-19, ranked 109th of COVID-19, with 95,111 positive cases and total death of 4,636 (Worldometer, 2021) in (Priyono and Saraswati, 2022).

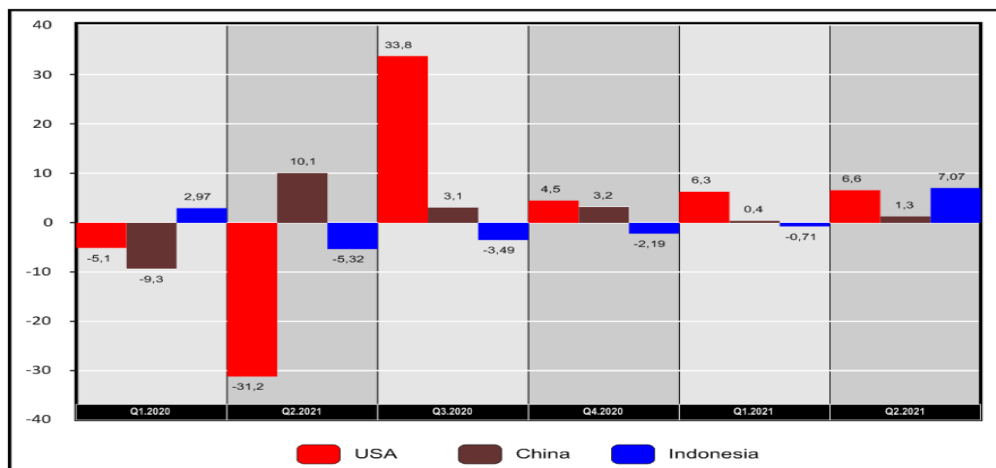
**World Number of Positive Covid 19 Cases**



Source: Worldometer, 2021

The spread of the virus did not stop there because the virus was able to mutate into new, more virulent variants. The World Health Organization reports that 11 new variants of the corona virus have a vaccine-resistant effect and are more deadly (Mediatama, 2020) in (Priyono and Saraswati, 2022). No drug is clinically able to treat the effects of the virus. Even the administration of a vaccine does not guarantee a person is immune to the virus. The vaccine's effectiveness is only around 62% - 95%, even some of the circulating vaccines have yet to be tested their effectiveness. For now, prevention is the alternative treatment for the epidemic (Gallagher, 2021) in (Priyono and Saraswati, 2022). Some of the affected countries have restricted social activities of the community through regional lockdowns and by implementing health protocols in social life to prevent the spread of the epidemic, The lockdown of the affected areas harms the limitation of community mobilization and the business world, impacting economic growth (Priyono and Saraswati, 2022).

**Gross Domestic Product, Current Prices (National Currency)  
(Billions U.S. Dollars)**



Source: <https://id.tradingeconomics.com>, 2021

The COVID-19 outbreak devastated the United States' economic growth in the first and second quarters of 2020. The first quarter the country's economic growth slowed by -5.1%, and in the second quarter, it fell by -31.2%. Meanwhile, China's economic growth in

the first quarter of 2020 experienced a slowdown by -9.3%, but in the next quarter continued to recover despite the uneven growth rate. The impact of Covid on Indonesia's economic growth will be felt in the second quarter of 2020 until the first quarter of 2021. In the second quarter of 2021, the Indonesian economy began to rise with an indicated growth of 7.07% (Priyono and Saraswati, 2022).

The slowdown in economic growth marked by the decline in the gross domestic product was intensely felt by various public sectors and the business world by this global event, including the worldwide stock market, including the stock exchanges in the United States and China, and even the stock exchange in Indonesia. The covid pandemic has had a severe impact on the performance of the capital market (Priyono and Saraswati, 2022).

### **Sharia Stock Reaction**

The reaction of the Indonesian Capital Market to Covid-19 took place at the beginning of 2020 or before it was declared by WHO as a global pandemic, even though at that time there were no positive cases in Indonesia. This reaction shows that capital market players in Indonesia are psychologically and informally connected to the global market such that what happens to capital markets in other countries will be responded to by Indonesia's domestic market. According to Widagdo et al. (2020) in (Ryandono et al, 2021), sharia stock investment in Indonesia has developed rapidly and is attracting many investors and market players. In this case, market players had the belief that the Covid-19 case will also occur in Indonesia. This belief was proven when Covid-19 was announced for the first time positive in Indonesia on March 2, 2020, namely the case of 2 people in Bogor. The market response was immediately volatile. The market reaction is increasingly apparent after March 11, 2020, when WHO declared Covid-19 a global pandemic. This market panic can be seen from the correction of the Composite Stock Price Index (IHSG) and more specific stock price indexes, for example, LQ 45 (45 blue-chip stock, both conventional and Sharia stock), JII (Jakarta Islamic Index: 30 blue-chip stock from sharia stock), and Pefindo25 (25 stock of small and medium-sized companies with good prospective business performance and development) (Ryandono et al, 2021).

The fluctuation fact of the capital market due to the Covid-19 incident proves that this economic sector is very sensitive to the existing information. Available information will be responded to immediately and will quickly be reflected in an increase in trading volume as well as an increase or decrease in stock prices. If the information is positive (good news), the market reaction will be positive, which is indicated by an increase in stock trading volume due to the action of buying stock so that stock prices will increase. Conversely, if the information is negative (bad news), there will also be a negative reaction, which is marked by an increase in stock selling so that trading volume will increase and stock prices will decline. Thus, the increase in trading volume and the decline in stock prices on the Indonesian capital market in the period around March 11, 2020, are thought to be negative reactions to the WHO's decision on Covid-19 as a global pandemic. This condition can be explained by signaling theory (Brigham & Houston, 2011) in (Ryandono et al, 2021) ; that information sourced from internal companies (financial reports, dividend distribution decisions, changes in company executives and other internal information) and external companies (government succession, political events, terrorism, major crimes, natural disasters, epidemics, etc.) affect the price of securities in the capital market. Therefore, investors in making investment decisions do not only carry out technical analysis of market movements and fundamental analysis but must know and respond to large and small events that will have a direct or indirect effect on price movements in the capital market (Ryandono et al, 2021).

How the capital market's ability to react toward existing events (information) is reflected by price movements and stock trading volume that will determine the level and form of capital market efficiency. An efficient capital market is a capital market that is able to react to information quickly and accurately. Efficient hypothesis capital markets were first raised by (Fama, 1970) in (Ryandono et al, 2021). Though the efficient market hypothesis as a whole theorizes that the market is generally efficient, the theory is offered in three different versions: weak, semi-strong, and strong (Ryandono et al, 2021).

The efficient market hypothesis posits that the market cannot be beaten because it incorporates all important information into current share prices, so stocks trade at the fairest value. Though the efficient market hypothesis theorizes the market is generally efficient, the theory is offered in three different versions: weak, semi-strong, and strong. The weak form suggests today's stock prices reflect all the data of past prices and that no form of technical analysis can aid investors. Advocates for the weak form efficiency theory believe that if the fundamental analysis is used, undervalued and overvalued stocks can be determined, and investors can research companies' financial statements to increase their chances of making higher-than market-average profits (Fama, 1970) in (Ryandono et al, 2021).

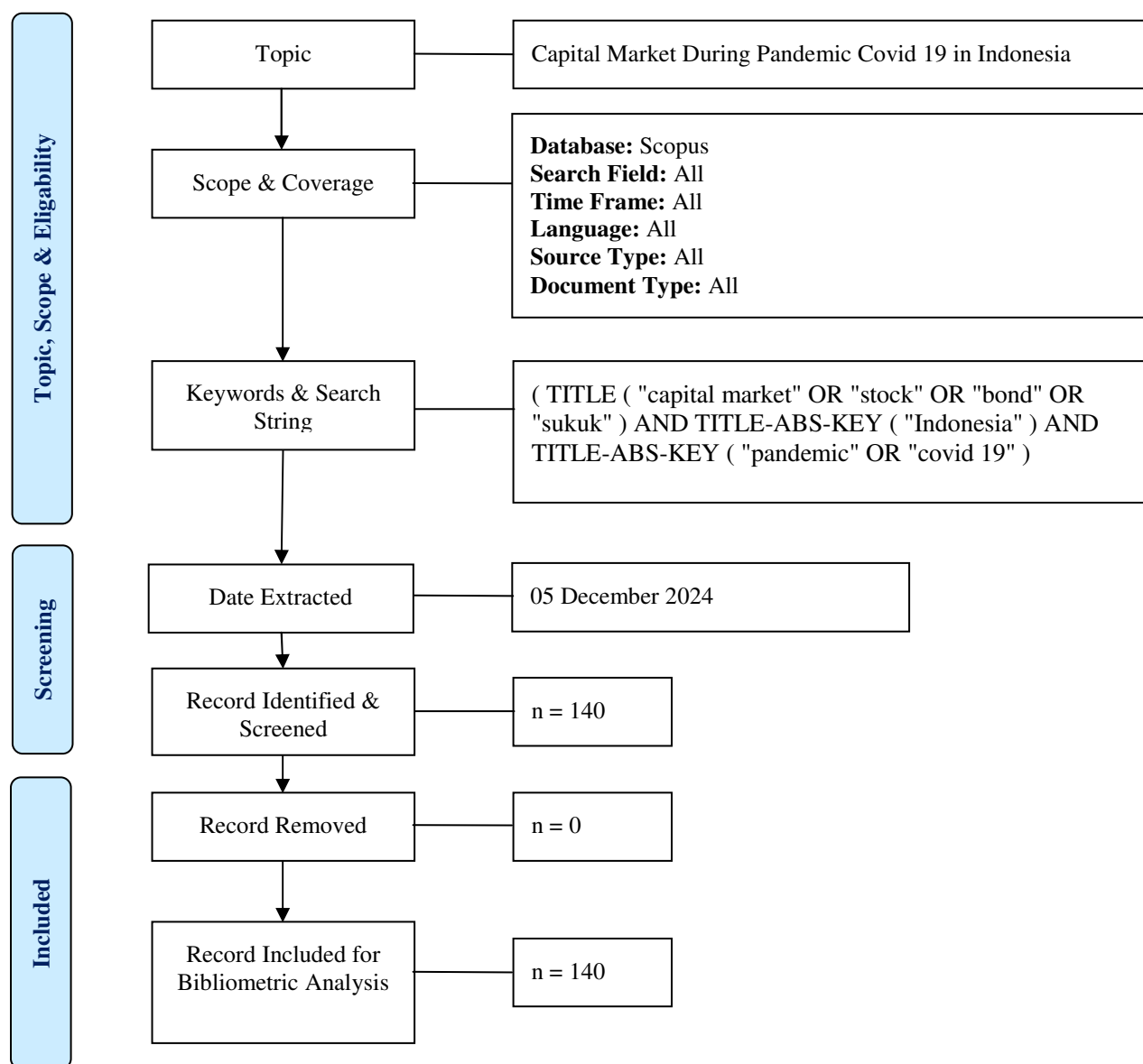
The semi-strong form submits that because public information is part of a stock's current price, investors cannot utilize either technical or fundamental analysis, though information not available to the public can help investors. Those who subscribe to this version of the theory believe that only information that is not readily available to the public can help investors boost their returns to a performance level above that of the general market. The strong form version states that all information, public and not public, is completely accounted for in current stock prices, and no type of information can give an investor an advantage on the market. Advocates for this degree of the theory suggest that investors cannot make returns on investments that exceed normal market returns, regardless of information retrieved or research conducted (Fama, 1970) in (Ryandono et al, 2021).

### 3. METHODOLOGY

The method used by the author is descriptive qualitative to describe the data used in this research. Journal data collection is based on research from publications related to the keyword performance Capital market in Indonesia at pandemic Covid 19. This article examines the performance in capital market literature in Indonesia during the COVID-19 pandemic. The bibliometric analysis used is new by providing the complexity of the area during the COVID-19 pandemic so that research gaps and new perspectives can be obtained in the research focus area by explaining the facts and details of research on certain issues. CSV and RIS file formats are used to export data from the Scopus database and then processed using Excel and Publish or Perish. The VOS Viewer tool is used in bibliometric analysis to visualise frequently used keywords and concepts associated with the study topic. A total of 140 papers were gathered from the outcomes of the prior literature selection.

To collect data, the author used Scopus references for research. In the application, authors can select relevant article or journal data from scopus which is used to conduct literature reviews on the selected topic. Therefore, a similar research database will be obtained. Journals related to the selected topic range. The collected data is then entered into VOSviewer. After the data is entered, it is processed to match the desired or selected keywords. VOSviewer then converts the input data into an interconnected data graph.

## RESULT AND DISCUSSION



**Figure 1.** Flow diagram of the search strategy.  
 Source: Customized based on Zakaria (2020) and Moher (2009)

This article examines the developments in capital market literature in Indonesia during the COVID-19 pandemic. The bibliometric analysis used is new by providing the complexity of the area during the COVID-19 pandemic so that research gaps and new perspectives can be obtained in the research focus area by explaining the facts and details of research on certain issues. CSV and RIS file formats are used to export data from the Scopus database and then processed using Excel and Publish or Perish. The VOS Viewer tool is used in bibliometric analysis to visualise frequently used keywords and concepts associated with the study topic. A total of 140 papers were gathered from the outcomes of the prior literature selection.

#### 4. RESULTS

**Table 1.** Document and Source Type

Document Type	Total Publications (TP)	Percentage (%)
<i>Document</i>		
Article	106	75.71
Conference Paper	27	19.29
Book Chapter	5	3.57
Review	2	1.43
<i>Source</i>		
Journal	108	77.14
Conference Proceeding	26	18.57
Book Series	4	2.86
Book	2	1.43

Source: Data Processed

Document type indicates the type of document, whereas source type is determined by the source title categories established in the previous section (Kushairi & Ahmi, 2021). Based on the types of documents above, the highest composition was articles with 106 publications (75.71%) followed by conference papers with 27 publications (19.29%), in the form of book chapter with 5 (3.57%) and reviews of 2 publications (1.43%). Meanwhile, based on the type of source, 108 publications came from journals (77.14%) which had the largest portion, followed by conference proceedings with 26 publications, book series with 4 publications, and book with 2 publications.

**Table 2.** Languages

Language	Total Publications (TP)	Percentage (%)
English	139	99.29
Arabic	1*	0.71
<b>Total</b>	<b>140</b>	<b>100.00</b>

\*one document has been prepared in dual languages

Source: Data Processed

Based on the dataset collected, 139 publications are in English. 1 publication is in Arabic entitled "Dawr al-*ṣukūk al-murtabiḥah bi al-waqf al-naqdī fī tatwīr mu'assasat al-rī'āyah al-ṣiḥḥiyah bi Banten*" published by Studia Islamika from Syarif Hidayatullah State Islamic University of Jakarta which is a bilingual (English and Arabic).

**Table 3.** Subject Area

Subject Area	Total Publications (TP)	Percentage (%)
Economics, Econometrics and Finance	77	55.00%
Business, Management and Accounting	54	38.57%
Social Sciences	26	18.57%
Decision Sciences	15	10.71%
Computer Science	14	10.00%
Physics and Astronomy	14	10.00%
Environmental Science	13	9.29%
Energy	12	8.57%

Engineering	8	5.71%
Earth and Planetary Sciences	6	4.29%
Mathematics	4	2.86%
Medicine	3	2.14%
Pharmacology, Toxicology and Pharmaceutics	3	2.14%
Arts and Humanities	2	1.43%
Biochemistry, Genetics and Molecular Biology	1	0.71%
Immunology and Microbiology	1	0.71%
Multidisciplinary	1	0.71%

Source: Data Processed

Based on table 3 above, the most subject areas in Economics, Econometrics and Finance as well as Business, Management and Accounting have been studied with a total of 77 and 54 publications. This is consistent with the fact that there are numerous studies examining the economic condition during the COVID-19 pandemic (Liu et al, 2021; Handoko, 2021). Then followed by social sciences with 25 publications (22.52%) and environmental sciences with 21 publications (18.92%).

**Table 4.** Year of Publications and Citations

	2020	2021	2022	2023	2024
<b>Publications</b>	3	24	32	48	33
<b>Citations</b>	9	440	169	121	14
<b>Cites/Year</b>	2.25	146.67	84.5	121	14
<b>Cites/Paper</b>	3	18.33	5.28	2.52	0.42
<b>Cites/Author</b>	3.61	164.57	51.52	40.23	4.62
<b>Paper/Author</b>	0.86	8.32	12.05	20.3	11.34
<b>Authors/Paper</b>	5	3.29	3.5	2.88	3.36
<b>h-index</b>	2	11	8	5	2
<b>g-index</b>	3	20	11	9	2

Source: Data Processed

The next discussion will be about research trends of Capital Market During Pandemic Covid 19 in Indonesia. Because the selection of the series is during the Pandemic, hence the new trend starts in 2020. Based on table 4, the largest total publication will be in 2023 with 48 publications followed by 2024 and 2022 with 33 and 32 publications. However, on the other hand, the total citations in 2021 were the highest at 440 citations compared to 2020 which was only 9 citations.

**Table 5.** Citations Metrics

Metrics	Data
Publication Years	2020-2024
Citation Years	4 (2020-2024)
Papers	140
Number of Citations	753
Citations per Year	188.25
Citations per Paper	5.38
Cites per Author	264.55



Papers per Author	52.89
Authors per Paper	3.25
h-index	14
g-index	24
hI,annual	1.75
hA-index	10

Source: Data Processed

Table 5 shows the citation matrix of 140 publications from 2020 to Desember 5th 2024. Overall, the total number of citations from 140 publications is 753. The average citation per year is 188.25 with citations per paper is 5.38. As for the impact or influential factors, the h-index is 14 and the g-index is 24.

**Table 6.** Most influential institutions with minimum of four publications

Affiliation	Publication	Citations
Bina Nusantara University	12	73
Universitas Padjadjaran	6	53
Universitas Gadjah Mada	5	25
Institut Teknologi Bandung	5	7
Universitas Mercu Buana	5	70
IPB University	4	10
Politeknik Negeri Pontianak	4	39

Source: Data Processed

Table 6 shows the most influential institutions in this topic. Because this paper takes the country of Indonesia, hence it only selects institutions in Indonesia with a minimum criteria of 4 publications. Bina Nusantara University was the one who issued the most publications with 12 publications and 73 total citations being cited. Then followed by Universitas Padjadjaran with 6 publications and 53 citations. The second most citations are from Universitas Mercu Buana with 70 citations

**Table 7.** Top 20 Highly cited articles

Cited by	Authors	Title
95	(Sadiq, 2021)	COVID-19 fear and volatility index movements: empirical insights from ASEAN stock markets
61	(Budiharto, 2021)	Data science approach to stock prices forecasting in Indonesia during Covid-19 using Long Short-Term Memory (LSTM)
52	(Yousaf et al., 2021)	Gold against Asian Stock Markets during the COVID-19 Outbreak
35	(Babar et al., 2023)	Returns and volatility spillover between agricultural commodities and emerging stock markets: new evidence from COVID-19 and Russian-Ukrainian war
33	(W Mensi, 2021)	Precious metals, oil, and ASEAN stock markets: From global financial crisis to global health crisis
32	(Endri et al., 2021)	Stock price volatility during the COVID-19 pandemic: The GARCH model
31	(Herwany, 2021)	The Influence of the COVID-19 Pandemic on

		Stock Market Returns in Indonesia Stock Exchange
30	(Nurhayati, 2021)	Impact of covid-19 on performance evaluation large market capitalization stocks and open innovation
28	(Naeem, 2021)	Quantile connectedness between Sukuk bonds and the impact of COVID-19
25	(Kumar et al., 2023)	Interconnectivity and investment strategies among commodity prices, cryptocurrencies, and G-20 capital markets: A comparative analysis during COVID-19 and Russian-Ukraine war
20	(Setiawan et al., 2021)	GARCH (1,1) Models and Analysis of Stock Market Turmoil during COVID-19 Outbreak in an Emerging and Developed Economy
20	(Goh, 2021)	Determinants and Prediction of the Stock Market during COVID-19: Evidence from Indonesia
16	(Melina et al., 2022)	Artificial Neural Network-Based Machine Learning Approach to Stock Market Prediction Model on the Indonesia Stock Exchange During the COVID-19
15	(Setiawan et al., 2022)	Covid-19 pandemic, asset prices, risks, and their convergence: A survey of Islamic and G7 stock market, and alternative assets
14	(Ali, 2021)	The impact of COVID-19 on Islamic and conventional stocks in Indonesia: A wavelet-based study
14	(Tanjung et al., 2022)	Stock Market Responses to Covid-19 Pandemic and Monetary Policy in Indonesia: Pre and Post Vaccine
14	(Ryandono, 2021)	Sharia Stock Reaction Against COVID-19 Pandemic: Evidence from Indonesian Capital Markets
10	(Walid Mensi et al., 2022)	Spillovers and diversification benefits between oil futures and ASEAN stock markets
9	(Kristanti et al., 2022)	A Stock Portfolio Strategy in the Midst of the Covid-19: Case of Indonesia
8	(Trisnowati et al., 2022)	The Effect of ESG Score, Financial Performance, and Macroeconomics on Stock Returns during the Pandemic Era in Indonesia

Source: Data Processed

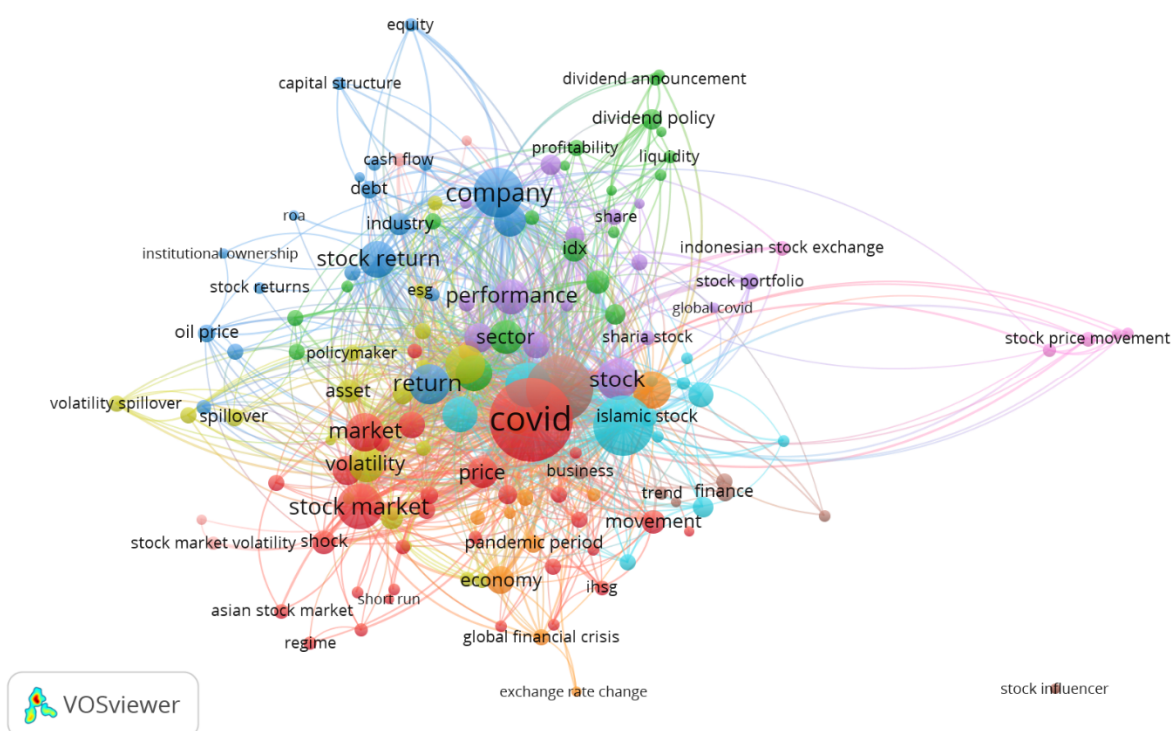
Then in table 7 shows the top 20 positions of the publications that are cited the most. In the first position, there is Sadiq (2021) regarding " COVID-19 fear and volatility index movements: empirical insights from ASEAN stock markets" with 95 citations, which was then followed by Budiharto (2021) regarding " Data science approach to stock prices forecasting in Indonesia during Covid-19 using Long Short-Term Memory (LSTM)" with a total of 61 citations. In third place is Yousaf et al. (2021) regarding " Gold against Asian Stock Markets during the COVID-19 Outbreak" with 52 citations. It can be analyzed that the most citations are on publications published in 2021 compared to other years.

**Table 8.** Top 10 Keywords

Author Keywords	Total Publications	Percentage (%)
COVID-19	47	9.25
Indonesia	31	6.10
Financial Markets	15	2.95
Stock Market	14	2.76
Covid-19	12	2.36
Stock Price	10	1.97
Stock Return	10	1.97
ASEAN	8	1.57
Investments	8	1.57
Commerce	7	1.38

Source: Data Processed

Table 8 present the top keywords about Capital Market During Pandemic Covid 19 in Indonesia. The most keywords in COVID-19 were 47 publications. Then followed by the keyword Indonesia as many as 31 publications, Financial Markets as many as 15 publications, Stock Market as many as 14 publications. In addition, several keywords related to the capital market, namely Stock Price, Stock Return, Investments.

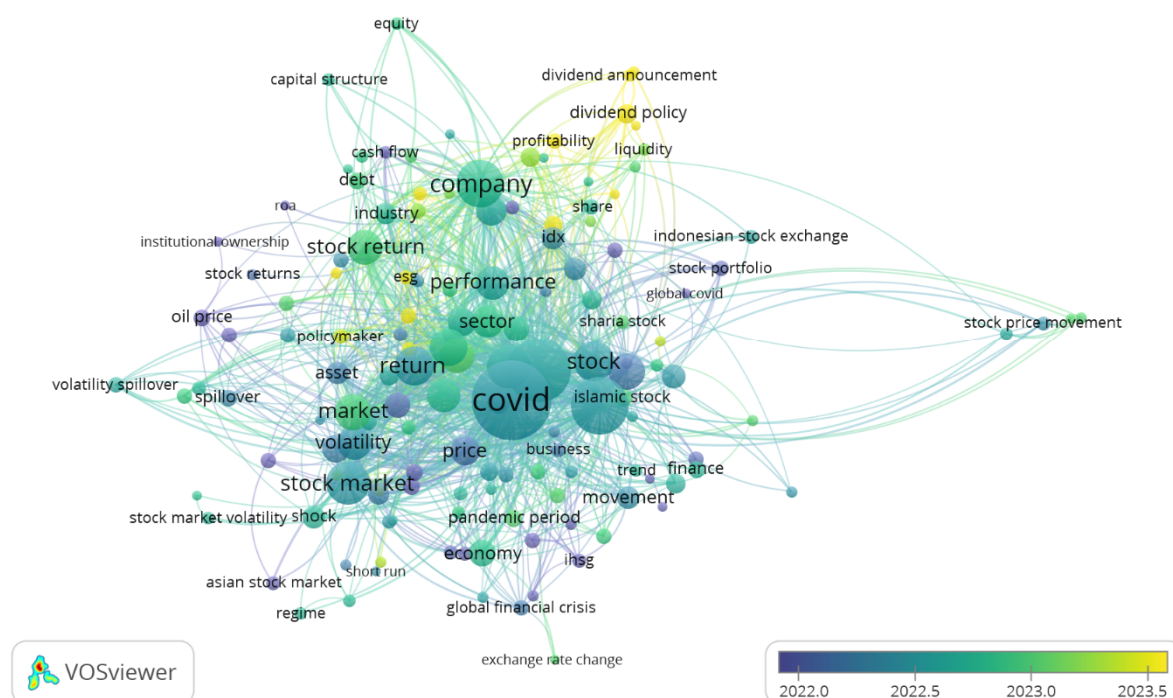


**Figure 1.** VOSviewer Network Visualisation of a term co-occurrence network based on title and abstract fields (Full Counting)  
 Source: Data Processed by VOSviewer (2024)

**Table 9.** Cluster-based grouping of Circles

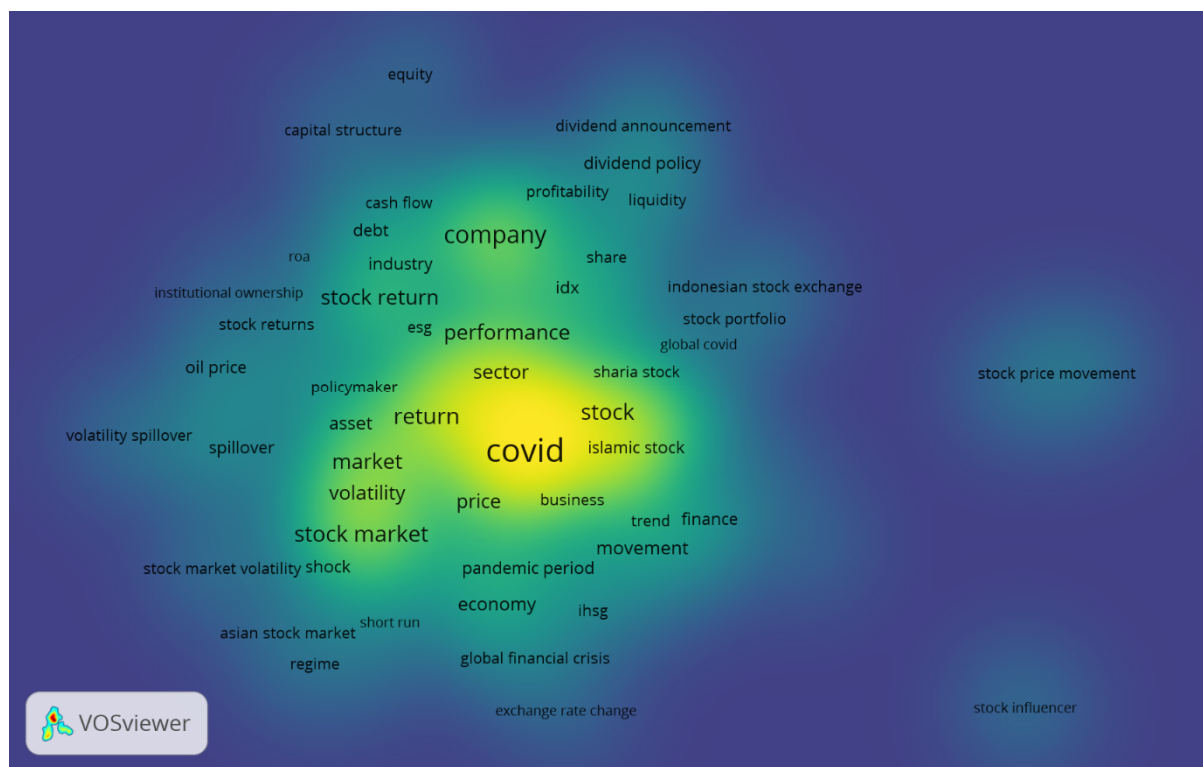
Clusters	Colors	Items
Cluster 1	Red	(32 items) Ardl, Arima, Asian Stock Market, Bad News, Behaviour, Composite Stock Price Index, Covid, Economic Fluctuation, Exchange Rate, Gold, Good News, IHSG, Inflation, Interest Rate, Islamic Stock Market, Jakarta Islamic Index, JII, Long Run, Market, Movement, Outbreak, Pandemic Covid, Policy, Price, Regime Shock, Short Run, Short Term, Stock Exchange, Stock Market, Stock Market Index
Cluster 2	Green	(20 items) Abnormal Return, Announcement, Asean Stock Market, Company Value, Crisis, Dividend Announcement, Dividend Policy, Event Study Method, Ex Dividend Date, IDX, Infrastructure, Investment Decision, Liquidity, Market Condition, Market Reaction, Policy Response, Positive Impact, Profitability, Sector, Stock Market Reaction
Cluster 3	Blue	(19 items) Capital Structure, Company, Crude Oil, Debt, Equity, Indonesia Stock Exchange, Industry, Institutional Ownership, Leverage, Negative Effect, Oil, Oil Price, Positive Effect, Profit, Return, ROA, Stock Return, Stock Returns, Trade
Cluster 4	Yellow	(19 items) Asset, Commodity, ESG, Garch, Global Economy, Global Financial Market, Increase, Index, Investor Sentiment, ISSI, Muslim Majority Country, Policymaker, Spillover, Stability, Stock Index, Stock Return Volatility, Sustainability, Volatility, Volatility Spillover
Cluster 5	Purple	(15 items) Financial Performance, Firm, Global Covid, Indonesian Capital Market, Investment, Islamic, Mutual Fund, Nonethical Stock, Performance, Portfolio, Resilience, Share, Sharia Stock, Stock Stock Portfolio
Cluster 6	Light Blue	(13 items) Capital Market, Government, Indonesia, Indonesia, Indonesia's Capital Market, Investor, Islamic Capital Market, Islamic Stock, Online Capital Market Investment Platform, Risk, Stakeholder, Stock Trading Volume, Trading Volume
Cluster 7	Orange	(11 items) Economy, Exchange Rate Change, Financial Market, Global Financial Crisis, Indonesian Stock Market, Jakarta Composite Index, Monetary Policy, Pandemic Period, Stock Price, Uncertainty, Vaccination
Cluster 8	Brown	(9 items) Bank Business, Finance, Long Short Term Memory, Pandemic, Stock Influencer, Stock Market Participation, Stock Price Fluctuation, Trend
Cluster 9	Pink	(5 items) Foreign Investment Flow, Indonesian Stock Exchange, Lockdown, Overconfidence, Stock Price Movement
Cluster 10	Peach	(4 items) Cash Flow, Global Pandemic, Stock Market Volatility, Stock Performance

The circle in Figure 3 above represents the relationship between keywords and document metadata, therefore the larger the circle, the more keywords are related and the smaller the circle, the less related it is to keywords (Nurhadi and Meilinda, 2024). The VOSViewer Visualization results show that there are 10 clusters with 147 items (see Tabel 8).



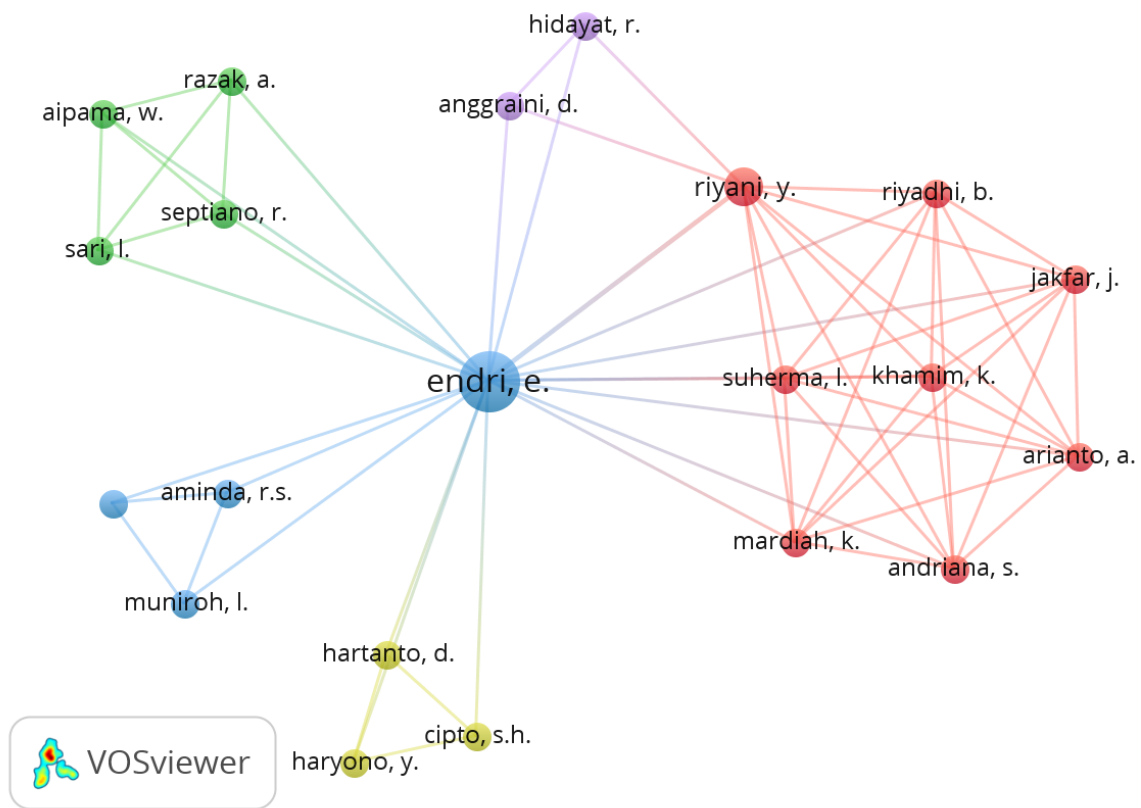
**Figure 2.** VOSviewer Overlay Visualisation of a term co-occurrence network based on title and abstract fields (Full Counting)  
 Source: Data Processed by VOSviewer (2024)

Overlays with darker circles indicate that the document is older and lighter circles indicate that the document is newer with blue-green-yellow hues representing publication impact, with blue having a score of 1 (lowest) and yellow having a score of 3 (highest) (Van Eck and Waltman, 2023; Nurhadi and Meilinda, 2024). Figure 2 shows the year the article was published. The year 2022 (dark blue) tends to have a least impact, with a score of one. In the second term in 2022 (tosca) has the most keyword documents with a score of two, indicating a moderate impact. In addition, with a score of 3, the second term in 2023 (yellow) has the strongest publication impact.



**Figure 3.** VOSviewer Density Visualisation of a term co-occurrence network based on title and abstract fields (Full Counting)  
 Source: Data Processed by VOSviewer (2024)

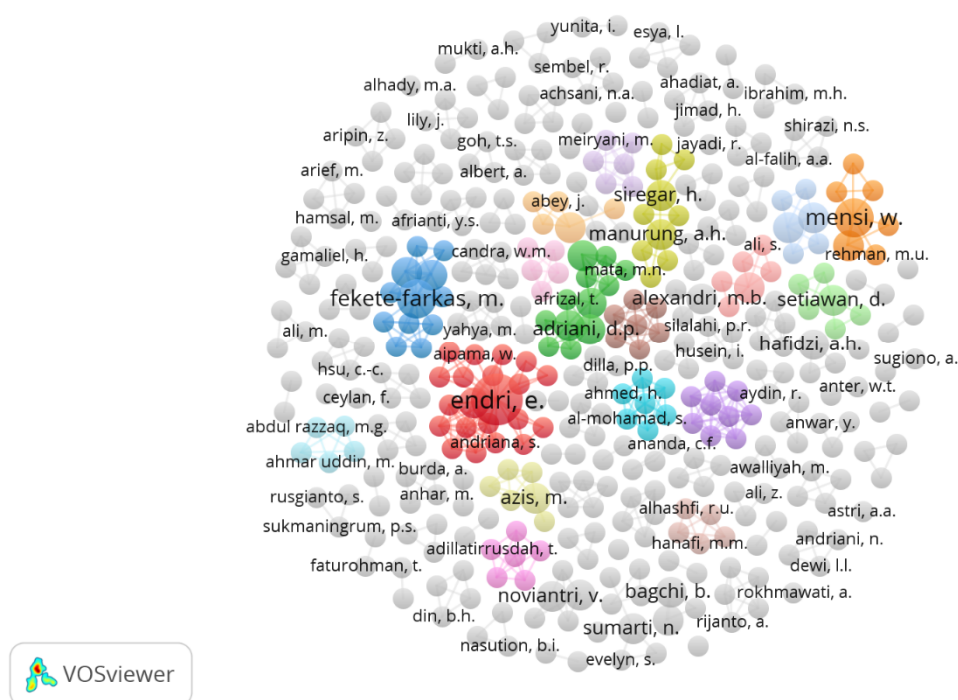
Figure 3 shows the density visualization. An item's colour indicates its density; the more yellow it is, the denser it is; the lighter the object, the closer it is to blue; and the more frequently a word is highlighted in the document, the clearer the text. (Van Eck and Waltman, 2023; Nurhadi and Meilinda, 2024). In several publications, topics like Covid, Islamic Stock, Stock, Sector, Return, Market Volaitiy are regularly discussed.



**Figure 4.** Vosviewer Network Visualisation Map of The Co-Authorship (21 items)  
 Source: Data Processed by VOSviewer (2024)

The network visualization map of the co-authorship can be seen in Figure 6. According to the author density map, each connected line indicates a co-citation, and authors who are closely associated are assigned to clusters of the same color (Ahmi and Mohd Nasir, 2019; Cheng et al., 2022). After setting an author's minimum number of documents of an author to 1, there are 424 items and the largest set of connected items consists of 21 items grouped into five clusters. The authors in Cluster 1 (Red) are Andriana, Arianto, Jakfar, Khamim, Mardiah, Riyadhi, Riyani, and Suherma. Cluster 2 (Green) comprises Aipama, Razak, Sari, and Septiano. Then in Cluster 3 (Blue) there are Aminda, Endri, Muniroh, and Nurhayati. Cluster 4 (Yellow) comprises Cipto, Hartanto, and Haryono. Additionally in Cluster 5 (Purple) consist of Anggraini and Hidayat. This indicates that these authors tend to conduct research together.





**Figure 6.** Vosviewer Network Visualisation Map of The Co-Authorship (424 Items)  
Source: Data Processed by VOSviewer (2024)

A comprehensive explanation of the strength of co-authorship links with other authors may be seen in Figure 6. According to van Eck and Waltman (2013), the components are gray and remain independently indicating that there is no connection between them. The larger circle with links and color indicates that the author's publications have a relationship and earn a considerable number of citations in comparison to other items. As can be seen from the image above, the red circle represents Endri, and the other colors indicate that the item is connected to others.

## CONCLUSION

The aim of this research is to examine bibliometric literature on the Performance Of Capital Market at the Covid 19 Pandemic Period in Indonesia. In the search process, the keyword performance Indonesia Capital market at pandemic covid 19 was used. "The mapping procedure at that time was completed using VOSviewer based on the results of analysis and mapping with VOSviewer, there are clusters identified in the period. From the network visualization results, gaps or loopholes are found that researchers can use to find new things to determine relevant research themes. So through Bibliometric analysis of the Performance of Capital Market at the Covid 19 Pandemic Period in Indonesia using the VOSviewer application, themes for novelty in research were obtained.

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# The Jaganmohan Community and the Influence of Their Akhara Culture in Habiganj, Bangladesh

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## **ABSTRACT**

Community-based religious practice is very common in the Indian subcontinent where a group of people practices a unique and distinct culture to spread their faith and belief system. These specific communities are distinct and unique according to their rituals and architectural ideology. The Jaganmohan Community in Habiganj, Bangladesh is considered the root of several spiritual theories. It's been a long time since they have preached from their main temple complex in Habiganj. Their influential culture and its impact on the main temple complex is a major issue of this research, for instance, how their traditions and spirituality shaped the entire temple complex is one of the major concerns of the study. Another purpose of this research is to investigate the Jaganmohan community, its impact on the surrounding infrastructure, and the influential Akhara culture in Bangladesh. The study deeply analyzes the lifestyle and cultural practices of the community. The study also discusses the community's impact on the local businesses and economy.

**Keywords:** Akhara, Jaganmohan Community, Culture, Temple-Complex, Brithangal Boro Akhara, Habiganj

## Introduction

The term "akhara," sometimes known as "Akhada," refers to an Indian center of practice that offers boarding, lodging, and training facilities. It can also refer to a Sampradaya monastery for religious renunciations following the Guru-Shishya tradition (Hinduism Today, 2007). Sylhet, in Bangladesh's northeastern area, is commonly considered to be the country's spiritual capital. Sylhet has historically been the home of two major religious traditions of the Indian subcontinent, 'Islam' and 'Hinduism'. Over time, Sylhet noted as the religious hub of Northeast India, embracing spiritual qualities and spreading their ideology throughout the region (Choudhury, 1910). This religious diversity has been expressed in indigenous writing, music, art, crafts, and architecture, but particularly in architecture. Several Hindu Akharas with high heritage value can be found in Sylhet and the surrounding areas. The Bithangal boro Akhara is one of them. The site is situated in a serene landscape in Poilerkandi Union, Baniachong upazila at Habiganj district. The entire temple complex holds 13 acres area and it owns the whole amount of land where the maximum commercial infrastructures have been built around the complex

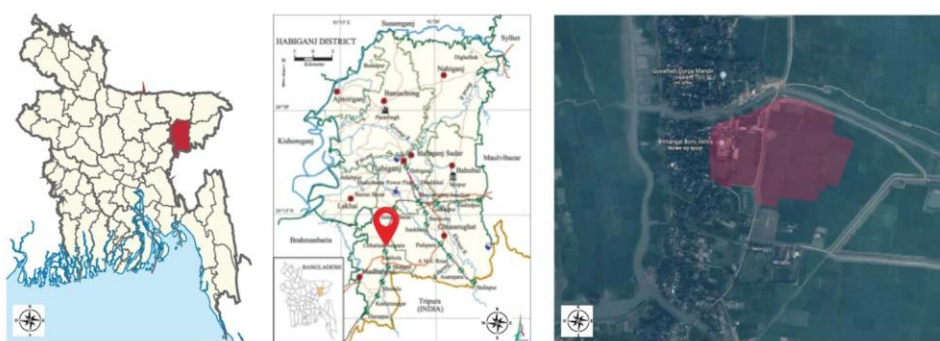


Figure 1 Location maps of bithangal Source:Google map

## Research Methodology:

The study is mainly based on field surveys. It finds nominal secondary information in books, journals and other sources to collect information. Since the community prefers to lead a distinctive life, a rigorous field survey is required to determine the research findings. The study prefers the snowball sampling method as an effective research process. Because the snowball sampling method connects all the informers related to a research topic. Since the study finds very little documentation about this community, the snowball sampling method helped to source the potential samples to collect authentic information. All the participants are chosen from the selected research area related to their community persons. There were two types of participants.

- Local people who are not directly connected to the community
- The practicing community people

Local people helped the research by providing information about the territorial infrastructural developments, local traditional fair, economic impact, social impact, and so on. The practicing community people are considered the most important and primary informers. Their information and participation highly drive the core part of this study.

Almost 200 local people and 30 community people participated in this research. There were two types of questionnaires. One set was for the local people to know about the community's socio-economic aspects and the other was for the community to address the internal community details such as private rituals, cultures, traditions, architectural information, history, and spiritual goals. Mainly the main priest were allowed to participate in this study as an authentic informer. The study collected their very private puthi (religious manuscript) to understand their life and assess the architectural importance of the temple complex. The main guru's confidential documents and verbal information ensured the maximum information was authentic and safe for this research. Although several private documents were collected, the community has full compliance to research them and publish them. Only general people are not allowed to get the documents without any purpose. They hold a very confidential mannerism to their temple complex and documents for religious purposes. The remote research area, people's lack of knowledge about architecture, the huge lack of conservation, and the limited secondary resources narrow the study to analyze the detailed structure of the temple complex. For instance, actual finishing materials and colors, actual interior, and landscape. Several specific steps have been considered to reach the goal of the research. The steps are clearly illustrated in a diagram given below.



### Literature Review:

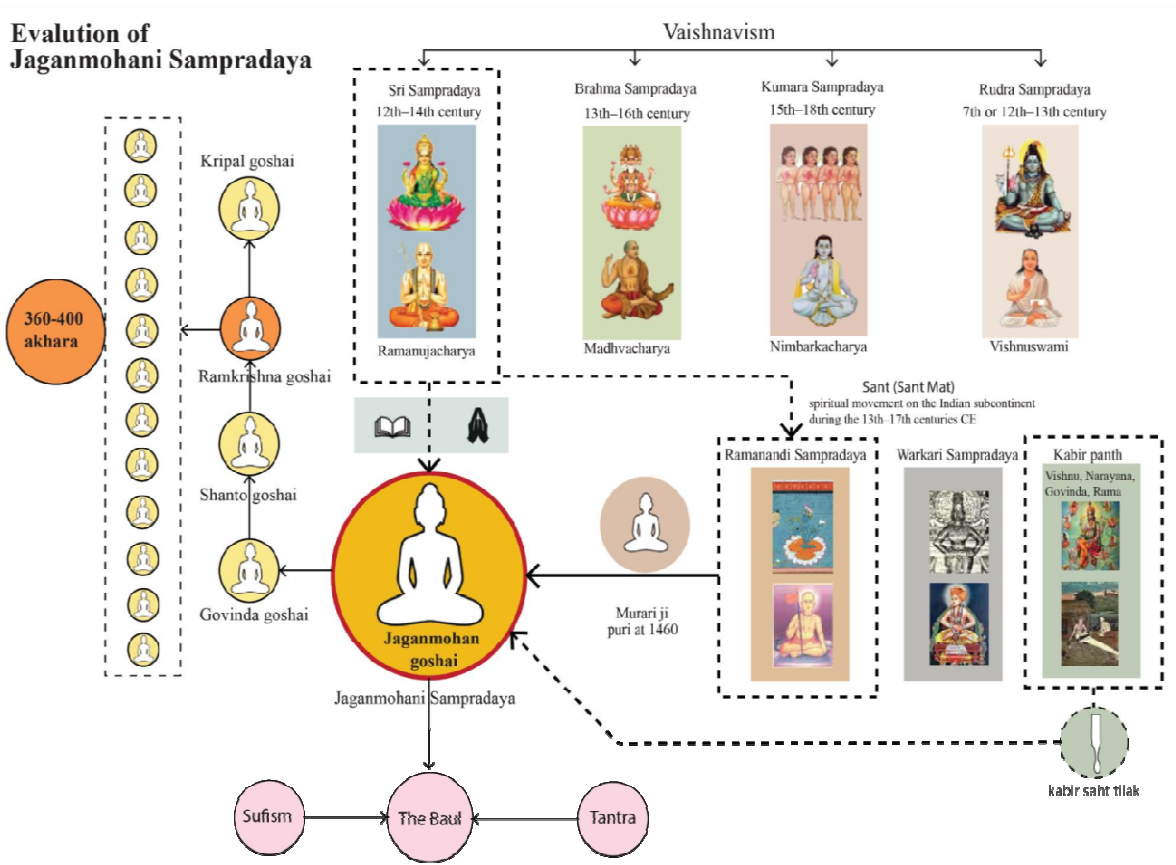
Despite being popular culture and practice, there is very little research conducted on this concept. Most of the research is based on a specific trait of the Akhara culture. Historically, Akharas were centers of spiritual, cultural, and physical training, often associated with both Hindu and Islamic traditions (Jones, 1991). Akharas are particularly known for their diverse practices, ranging from religious discourses to wrestling (Chakrabarti, 2013).

**Background:** The Bitangal Boro Akhara is one of the most important pilgrimage sites with a large temple complex for followers of the Jaganmohani Sect. It is located about 12 km away from the Baniachong Upazila Sadar, towards the southwest Haor (wetland) bank. The founder of this complex was Ramakrishna Goswami, who traveled to various pilgrimage sites in the region during his time (M.S.Rahman,2010). Later, in the 16th century, he established this temple complex. Over 400 years ago, Bithangal Boro Akhara gave birth to a new Vaishnava sect known as the Jaganmohoni sect. This particular Akhara was established with 360 to 400 akharas at that time. when All 360-400 akharas of Ramkishna (A.K.Dattah,1870) Akhara used it as their primary akhara. For devotees of the Jaganmohoni sect, the Bithangal Akhara is regarded as the most sacred location. Jagannath Goswami, the first and principal guru of the Jagannath Mohini community, received initiation from Murari Gupta (a saintly man from the Sri Ramnandi sect of India in the town of Sri Rampur). (P. N.

Bhattacharja, 2019) Originally, the community consisted of four consecutive male gurus (masters), and the fourth guru, Ramakrishna Goswami, gained popularity under the Mughal regime, expanding the community into the eastern region of Bangladesh and the states of Assam and Tripura in India. During turbulent times, most of the Akahras were destroyed, and the location of about 120 Akahras is still being considered. Most of the existing Akahras were established in the northeast part of the Indian subcontinent.

**Evolution of the Theology and its Emergence:**

Jagannath Goswami, the first and principal guru of the Jagannath Mohini community, received initiation from Murari Gupta, a saintly man from the Sri Ramnandi sect of India in the town of Sri Rampur. Later, following the order of his guru, during a turbulent time when many people were being persecuted and forced to convert to other religions, he came among them and propagated the new Jagannath Dharma and the service of the supreme Brahman, the guru of truth, to attain liberation of the soul. Jaganmohan took much of his religious beliefs from the "Sri" or "Ramanuj" sect (A.K.Dattah,1870). The baul sect is influenced by this sect (A.K.Dattah,1870) Originally, the community consisted of four consecutive male gurus, and the fourth guru, Ramakrishna Goswami, gained popularity under the Mughal regime, expanding the community into the eastern region of Bangladesh and the states of Assam and Tripura in India, establishing around 360-400 Akhara (religious centers), of which the most prominent was the Bethangal akhara . The first and principal four monasteries of the Jagannath Mohini community are the 1. Machhuliya Akhara in Habiganj, 2. The Jalsukha Akhara in Habiganj, 3. the Bethangal Akhara, Dhaka 4. the Faridabad Akhara, Dhaka.





### Cultural Identities:

**Naming:** The origin of this doctrine is said to have occurred in Habiganj, Sylhet, Bangladesh during the 14th century by a Baul Sadhu named Jagonath Goswami. He was referred to as "JagonathBaul" and his teachings were called the "Jagonath Baul Doctrine". He received initiation from a Vaishnava named Ramandandi (Ramandan) of Utkala (Orissa) and adopted the Bhek (dress) of a Vaishnava. Jagonath Baul had a disciple named Govind Goswami, whose disciple was Shant Goswami, and his disciple was Ramkrishna Goswami. According to the followers of JagonathBaul, thousands of people are involved in this community. They are known as "JagonathBaul Devotees"(S. S. Das Baishnob, 2019).

**Belief:** They are NirgunaUpasakas (worshippers of the formless) and do not worship any deity with a form. However, they accept their Diksha Guru as a manifestation of God. He is the embodied God and the savior of his disciples. During Diksha, they recite the phrase "Guru Satya" (the Guru is the truth) and accept and believe that the Guru is the direct deity. They follow their worship by chanting Brahmanama with the acceptance of broken salt. They also believe that the moon is the sign of the parmatma the supreme soul (.S. S. Das Baishnob, 2019) .They also sing a type of song which is called nimbarsangit, which is the medium of their worship. They are divided into two categories: the Udasi and Ghrishta, and the majority belong to the Ghrishta category.



**Nirvana Sangeet:** They have a book called Jaganmohan Bhagwat, written by Labani Das who was believed to be a follower of Jaganmohan. The book talks about Jaganmohan Baul'sLeeli and they follow Dharma Sangeet while pursuing it. This type of music is called Nirvana Sangeet and was introduced by Govinda Gosai, a disciple of Jaganmohan Gosai. They don't have any idols around, but they gather after dark to sing praises and glorify Hari while chanting his name.

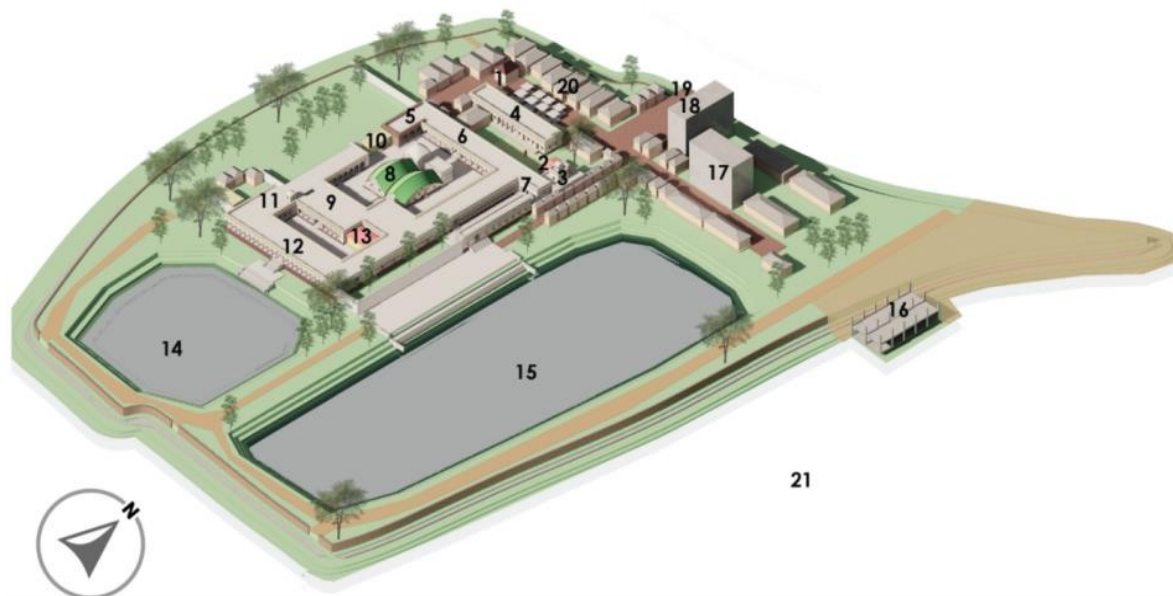
**Tilak:** The name of this tilak is Kabir Seth Tilak, Jaganmohan Gossai who took initiation from Ramananda, Kabir was a Muslim in his early life also later took initiation from Ramananda, because of his vast knowledge and great Vaishnava, this tilak is named Kabir Seth Tilak after him. And this Tilak Jaganmohan Panthi bowlers use on the forehead. this tilak is used on the forehead by Jaganmohan followers. Kabir and Jaganmohan Gossai were disciples of the same Guru (Character of Ramakrishna) Kabir composed the Ramakrishna Charitra Granth himself. However, in some cases, their tilak shape changes. Sometimes they wear a white scented tilak on their foreheads, this keeps them from doing their tilak work.

The temple conducts worship services five times a day and provides meals to impoverished followers of Ramkrishna Goshai. In addition, various religious ceremonies are performed at the temple. They include Ashtami Tithi of Chaitra, when devotees take a holy

bath, Bhola Sankranti on the final day of Kartik, Panch Dol Utsav on the fifth Dol Utsav after five days of Purnima, and Rath Yatra in the second week of Ashar month, which has been celebrated for more than 150 years. The head priest, or Mohanto, practices Ayurvedic medicine, and people of different faiths come to seek spiritual healing. Thousands of individuals from diverse religious backgrounds visit the temple to express their reverence and make offerings (P. N. Bhattacharja, 2019). Furthermore, an annual festival is held at the temple during a specific time of the year. The Bithangal temple plays the role of a complex cultural complex of the Bithangal village.

### Cultural Influence on their Architecture:

**Location:** According to their religious mythology they believed that the full moon is the symbol of nirvana (moksha). For this reason most of their akharas located in that isolated location far away from the urban city life which they celebrate the full moon light night. Like near the river or in haor area because the those type of isolated are waterside area is the best place to feel the moon light night.



- |                               |  |                                    |  |
|-------------------------------|--|------------------------------------|--|
| 1. Rath ghor                  | 6. Northern Part of the Complex            | 10. Kitchen                        | 16. Guest House ( under construction ) |
| 2. Durga Temple               | 7. Ananda Mahal                            | 11. South-West part of the complex | 17. Primary shool                      |
| 3. Dol Mancha                 | 8. Shamadhi Mondir Bhog Mondir Natt Mondir | 12. Andar Mahal                    | 18. High school                        |
| 4. bazar builing              | 9. Chodowari Raja-Ranir Bhaban             | 13. Crop Storage room              | 19. Ghat                               |
| 5. North-East part of Complex |  | 14. Andar Mahal Pond               | 20. bazar                              |
|                               |  | 15. Dighi                          | 21. Paddy field                        |

### Landscape:

In the case of the Jaganmohan Community's temple complex, the landscape is developed for spirituality, practicality, and cultural functionality. There are two major water bodies at the site which are situated orthogonally to each other and serve different functions. The bigger waterbody is meant to cater the local community and cultural activities and acts as a centre for congregation during festivals and fairs. On the other hand, the smaller pond is



meant for religious activities only in this case purification and offerings underlining the fact that it is a holy site. The perpendicular arrangement of these waterbodies is an embodiment of equilibrium and peace which are the two ideals of the architectural and spiritual philosophy of the community.

Carefully planned vegetations and flower gardens are found around these water bodies. These gardens serve a dual purpose of beautification and provision of flowers and herbs needed for the healing powers. Also, sacred trees like banyan and peepal are also grown to create areas free from sunlight as well as suitable for meditation and spiritual gatherings. These gardens facilitate the calmness and replace the chaos with serenity which enhances the meditative features of the temple complex.

At the fore of the temple complex, there appears to be a thriving local market with a vending operation that stands testimony to the co-dependence of the temple and the local economy.

### **Impact of the Temple Complex on Surrounding Infrastructures:**

The development of Habiganj is significantly influenced by the establishment of Jahanmohan Community temple complex because it transforms the area into a robust cultural and economic centerpoint. Although initially the region was isolated from the locality.

The area of Bithangal, in the past was separated from the mainstream locality of Habiganj. Due to the improvement of transportation by river route over time, people started to occupy the place more and more. Gradually it took a more vibrant overall appearance with market development and increased occupancy by the locals of Habiganj. The place is now a hub for a robust combination of cultural significance and socioeconomic boom. More and more people are starting to use Bithangal as a residential zone, the marketplace is also being able to accommodate the needs of the occupants due to the improved infrastructure and transportation.

### **Religious influence on existing commercial area:**

There is a notable religious influence on the entire community and their activities. The Bithangal Mandir receives a monthly remuneration from the community as well as monthly and early contributions are made based on the occasion. Usually there are more than 3 big events a year where people gather in Bithangal. This strengthens the communal relationship between the occupants and the people who visit the place even more. This is an indication of a prolonged sustenance through their mutual cultural and religious common grounds.

### **The Contiguous Areas Where the Religion Spread:**

The practice of Islam began with Sufi saint Shah Jalal in Sylhet. However, the local inhabitants of Bithangal and the surrounding villages opted to preserve and enhance their own religious rites and rituals instead of embracing Islam. In lieu of pulling the Islam towards them, they sought to retain and reinforce their age-old beliefs. Because of this the Jaganmohan Community, at this time, was very influential in the local people and the faith system. Consequently, about 300-400 Akhara complexes were founded in the area. The temples that exist today consolidate this development stage historically. All the below mentioned Akharas were founded during that time period.

1	Akhara Name	Address
2	Bihangal Bara Akhara	Baniachong, Habiganj
3	Machulia(old)Akhara	Jongolbohula, Habiganj City
4	Chandra Goshai Akhara	Nikli, Kishoreganj
5	Gurui Akhara	Nikli, Kishoreganj
6	Delhi Akhara	Mithamoin, Kishoreganj
7	Gojadia Akhara	Kishoreganj
8	Godor Akhara	Ghagra, Mithamoin, Kishoreganj
9	Lalgoshair Akhara	Atpara, Nikli, Kishoreganj
10	Chandra Goshai Akhaa	Baitdar, Kishoreganj
11	Chichrakhali (Isshor Goshai)	Kishoreganj
12	Koirol Akhara	Adompur, Oshtogram, Kishoreganj
13	Pagol Shonkor Akhara(2)	Laun, Kishoreganj
14	Pagla Akhara	Shotrumordon, Sunamganj
15	Ram-Krishna Goshai Akhara	Sunamganj City
16	Charanachar Akhara	Charanachar, Dirai, Sunamganj
17	Ghungiyagaon Dungra Akhara	Shalla, Sunamganj
18	Haridas Bainchabar Akhara	Chalarchar Bazar, Mudkobari, Uttarpara, Monohordi, Norshingdi
19	Ram-Krishna Goshai Akhara	Bishnopur, Shalla, Sunamganj
20	Kashipur Akhara	Richi Union, Habiganj Sadar, Habiganj
21	Shinghopur Akhara	Nikli, Kishoreganj
22	Goya Akhara	Goya, India
23	Jolsudha Akhara	Habiganj
24	Ram-Krishna Goshai Akhara	Jolpaiguri, West Bengal, India
25	Dharmanagar Akhara	India
26	Gumra Akhara	Assam, India
27	Bodolpur Akhara	Assam, India
28	ShiliguriAkhara	Assam, India
29	Ramkrishna Goshai Akhara	Chandripur, Katigora, Kachar, Assam, India
30	Gohati Akhara	Gohati, India
31	Hatigora Akhara	Kachar, India
32	Shyampur Akhara	Shilchor, Kachar, India
33	Ram-Krishna Goshai Akhara	Chandipur, Katigora, Kachar, Assam, India
34	Gohati Akhara	Gohati, India
35	Hatigora Akhara	Kachar, India
36	Shyampur Akhara	Shilchar, Kachar, India
37	Ram-Krishna Goshai Akhara	Noropoti, Katigora, Kachar, Assam, India
38	Shonbil Akhara	Shilchar, India
39	Ram-Krishna Gosai Akhara	Alipur, Dowar, Sutlipotti, West Bengal, India
40	Narayan Gosai Akhara	Kodali, Ratabari, Karimganj, Assam, India
41	Shonaton Gosai Akhara	Kodomtola, Shilchor(City), Kachor, Assam, India
42	Gopinath Gosai Akhara	Angarjur, Shilchor, Kachor, Assam
43	Ram-Krishna Gosai Akhara	Rajpur, Katigora, Kachor, Assam
44	Ram-Krishna Gosai Akhara	Kelma-Pancham, Katigora, Kachor, Assam
45	Ram-Krishna Gosai Akhara	Shoroshpur, Katigora, Kachor, Assam
46	Ram-Krishna Gosai Akhara	Rajoshyarpur, Katigora, Kachor, Assam
47	Ram-Krishna Gosai Akhara	Airongmara, Dholai, Kachor, Assam
48	Ram-Krishna Gosai Akhara	Shreekona, Aglapur, hailakandi, Kachor,

		Assam, India
49	Ram-Krishna Gosai Akhara	Dolu, Ratabari, Karimganj, Assam
50	Ram-Krishna Gosai Akhara	Pakua, Ram-Krishnanagar, Shilchar, Karimganj, Assam
51	Ram-Krishna Gosai Akhara	NowaNobin, Ram-Krishna nagar, Shilchar, Karimchar, Assam
52	Ram-Krishna Gosai Akhara	Postiraghat, Ratabari, Karimnagar, Assam
53	Ram-Krishna Gosai Akhara	Jalpaiguri, WestBengal
54	Madri Gosai Akhara	Nowabad, Sujatpur, Baniachong, Habiganj
55	Dumra Akhara	Shalla, Sunamganj
56	Kakailcheo Akhara	Ajmiriganj, Habiganj
57	Bahara Akhara	Shalla, Sunamganj
58	Tathia Akhara	Telghori, Baniachong, Habiganj
59	Shyam Bauler Akhara	Baniachong, Habiganj
60	Krishna Gosai Akhara	Krishnapur, Montola, Madhobpur, Habiganj
61	Dhonyal Akhara	Sadar, Habiganj
62	Baghashura Akhara	Madhabpur, Habiganj
63	Korcha Akhara	Baniachong, Habiganj
64	Shishu Gosai Akhara	Baniachong, Habiganj
65	Kanchan Gosai Akhara	Krishnapur, Montola, Madhabpur, Habiganj
66	Kobir Gosai Akhara	Bihongol, Baniachong, Habiganj
67	Jolshudha Akhara	Ajmiriganj, Habiganj
68	Jhilua Akhara	Ajmiriganj, Habiganj
69	Hilalnagar Akhara	Baniachong, Habiganj
70	Beri Doulatpur Akhara	Sadar, Habiganj
71	Sharakteki Akhara	Baniachong, Habiganj
72	Goshainagar Akhara	Baniachong, Habiganj
73	Shombhaspur Akhara	Baniachong, Habiganj
74	Monnorpur Akhara	Baniachong, Habiganj
75	Nandail Akhara	Nandail, Mymensing
76	Ghoshkripal Gosai Akhara	Netrokona
77	Dhaka Akhara	Faridabad, IGGate, Dhaka
78	Kosba Akhara	Kosba, Brahmanbaria
79	Goshaisthol Akhara	Akhaura, Brahmanbaria
80	Chandura Akhara	Bijoyagar, Brahmanbaria
81	Khagailla Akhara	Nasirnagar, Brahmanbaria
82	Vitadupi Akhara	Nasirnagar, Brahmanbaria
83	Hasamamudnagar Akhara	Kaliyajuri, Netrokona
84	Shashkhai Akhara	Shalla, Sunamganj
85	Chanpur Akhara	Dirai, Sunamganj
86	Chakua Akhara	Shalla, Sunamganj
87	Baushi Akhara	Dirai, Sunamganj
88	Anandpur Akhara	Shalla, Sunamganj
89	Chitla Akhara	Dirai, Sunamganj
90	Bherarhol Akhara	Shalla, Sunamganj
91	Shyamarchar Akhara	Dirai, Sunamganj
92	Muktarpur Akhara	Shalla, Sunamganj
93	Muchapur Akhara	BaharaUnion, Shalla, Sunamganj
94	Chokibaushi Akhara	Dirai, Sunamganj
95	Matabpur Akhara	Dirai, Sunamganj
96	Lachimpur Akhara	Dirai, Sunamganj
97	Khagaura Akhara	Dirai, Sunamganj

98	Hasha Ganganagar Akhara	Kaliyajuri, Netrokona
99	Patharia Akhara	EastSunamganj, Sunamganj
100	Mourapur Akhara	Shalla, Sunamganj
101	Narayan Gosai Akhara	Ditpur, Dirai, Sunamganj
102	Andabaj Akhara	Dirai, Sunamganj
103	PagolShankar Akhara(1)	Tetulia, Dirai
104	Bamnogao Akhara (Boiyabauri)	Dirai, Sunamganj
105	Abuni Thakur Akhara	Bishnunagar, Shalla, Sunamganj
106	Lalmal Pahar Akhara	Lalmal, Cumilla
107	Alongjuri Akhara	Itna, Kishoreganj
108	KamarNarayan Akhara	Shorarchor, Kishoreganj
109	Jurkandi Akhara	Itna, Kishoreganj
110	East Oshtogram Akhara	Oshtogram Akhara
111	32 Akhara	Sadar, Kishoreganj
112	Vatura Akhara	Oshtogram, Kishoreganj
113	Chanduakhali Akhara	Karimganj, Kishoreganj
114	Diurail Akhara	Karimganj, Kishoreganj
115	Vauval Akhara	Kishoreganj
116	Dhaki Akhara	Mithamoin, Kishoreganj
117	Ram-Krishna Gosai Akhara	Jolchatra, Modhupur, Tangail
118	Taltola Akhara	Taltola, Bikrompur, Dhaka

### The Contiguous Areas Where the Religion Spread:

The practice of Islam began with Sufi saint Shah Jalal in Sylhet. However, the local inhabitants of Bithangal and the surrounding villages opted to preserve and enhance their own religious rites and rituals instead of embracing Islam. In lieu of pulling the Islam towards them, they sought to retain and reinforce their age old beliefs. Because of this the Jaganmohan Community, at this time, was very influential in the local people and the faith system. Consequently, about 300-400 Akhara complexes were founded in the area. The temples that exist today consolidate this development stage historically. All the below mentioned Akharas were founded during that time period.

### Conclusion:

The study highlights the significant influence of the Akhara culture in shaping local infrastructure, fostering economic growth, and nurturing a unique cultural ecosystem. Through rigorous fieldwork and the engagement of local voices, this research reveals the profound impact of the community's belief systems on their environment, particularly in the design of their sacred spaces, landscape planning, and interaction with broader social dynamics.

The preservation and continued study of such cultural and architectural heritage are paramount, not just for maintaining the legacy of the Jaganmohan Community but also for fostering an appreciation of the diverse traditions that contribute to the rich cultural fabric of the Indian subcontinent. Future initiatives should focus on conservation efforts and inclusive dialogue to ensure the sustainable development of these sites while honoring their historical and spiritual significance.

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# The Effect of Macro-Economic Factors on Foreign Trade: The Example of Turkiye

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## ABSTRACT

In Turkey, foreign trade has a great share in the country's economy and development. The area and volume of foreign trade is expanding every day. However, today, the lack of necessary measures in foreign trade and inadequate incentives are narrowing the area of foreign trade. In periods of high inflation, the failure to cover costs and the failure to provide support to companies are also examples of these. In our study, the definitions of inflation, unemployment and economic growth, which are macroeconomic factors affecting foreign trade, were made, compared and the measures to be taken were specified. Foreign trade, which is expanding every day, is falling behind due to the lack of the necessary infrastructure. Macroeconomic factors are of great importance for foreign trade. Failure to take measures with the increase in inflation brings unemployment. With the increase in unemployment, sufficient production is not made in companies. In this case, serious problems arise for exporting companies. Economic growth is also affected in this way and harms the country's economy. Foreign trade and macroeconomic factors, which are interconnected like chain links, are all affected by each other. The recovery and improvement of these affected areas takes many years. Although they seem like simple problems at first, they negatively affect the country's economy, households, and companies, especially foreign trade. When we look at it today, although free trade and the lack of a quota system are ignored for easy trade, they bring with them serious problems and prepare the ground for a collapse for the country.

**Keywords:** foreign trade, inflation, unemployment, economic growth

## ÖZET

Ülkemizde dış ticaretin ülke ekonomisinde ve kalkınmasında büyük payı vardır. Dış ticaretin alanı ve hacmi her geçen gün genişlemektedir. Ancak günümüzde dış ticarete gerekli önlemlerin alınamaması ve teşviklerin yetersiz olması dış ticaretin alanını daraltmaktadır. Enflasyonun yüksek olduğu dönemlerde maliyetlerin karşılanamaması, firmalara destek sağlanamaması da bunlara örnektir. Çalışmamızda dış ticareti etkileyen makroekonomik faktörlerden enflasyon, işsizlik ve ekonomik büyümenin tanımları yapılmış, karşılaştırılmış ve alınması gereken önlemler belirtilmiştir. Her geçen gün genişleyen dış ticaret, gerekli altyapının sağlanamaması nedeniyle geri planda kalmaktadır. Makroekonomik faktörler dış ticaret açısından büyük önem taşımaktadır. Enflasyonun artmasıyla birlikte önlem alınamaması işsizliği de beraberinde getiriyor. İşsizliğin artmasıyla birlikte şirketlerde yeterli üretim yapılamıyor. Bu durumda ihracatçı firmalar açısından ciddi sorunlar ortaya çıkıyor. Ekonomik büyüme de bu şekilde etkileniyor ve ülke ekonomisine zarar veriyor. Zincir

halkaları gibi birbirine bağı olan dış ticaret ve makroekonomik faktörler birbirinden etkilenmektedir. Etkilenen bu alanların iyileşmesi ve iyileştirilmesi uzun yıllar alır. İlk bakışta basit sorunlar gibi görünseler de dış ticaret başta olmak üzere ülke ekonomisini, hane halkını ve şirketleri olumsuz etkiliyor. Bugün baktığımızda serbest ticaret ve kota sisteminin olmayışı ticaretin kolaylaşması açısından göz ardı edilse de ciddi sorunları beraberinde getirerek ülkenin çöküşüne zemin hazırlamaktadır.

**Anahtar Kelimeler:** Dış Ticaret, Enflasyon, İşsizlik, Ekonomik Büyüme

## Giriş

Ülkemizde önemi tartışılmayacak kadar büyük olan dış ticaret her geçen gün artan firmalar ve ülke ekonomisine olan katkılarıyla önemi daha da artmaktadır ancak gerekli tedbirlerinin alınmaması ve özellikle dış ticaret ile ilişkili olan makro ekonomik faktörlerinde etkisiyle de dış ticaret zor süreçlerden geçmektedir. Enflasyonun yükselmesiyle ve alınacak önlemlerin geç başlamasıyla uzun yıllar düzelemeyecek bir sürece girilmektedir. Çalışmamızda seçtiğimiz makro ekonomik faktörlerden enflasyon, işsizlik, ekonomik büyüme bir zincirin halkaları gibi birbirine bağlıdır. Enflasyon yükseldiğinde başta işsizliğin etkilenmeye başladığı daha sonra firmaların artan maliyetlerle işçi çıkarmak zorunda kaldığı ve dış ticaret için gereken mal ve hizmetlerin üretilmemesi daha sonra da ekonomik büyümeyi etkilemektedir. Çalışmamızda kavramsal olarak dış ticaret ve makro ekonomik faktörlerin tanımları yapılmış birbirleriyle karşılaştırılmış daha sonra da sonuç kısmına gerekli tedbirler ve alınması gereken önlemler tartışılmıştır.

## Dış ticaretin tanımı

Dış ticaret kavramı bir ülkeden diğer ülkeye mal satışı (ihracat) yada bir ülkeden başka bir ülkeye mal alışı (ithalat) olarak bilinmektedir. Farklı bir ifadeyle dış ticaret, ülke sınırları dışında yapılmış olan satış veya alış bedelinin toplamıdır (Arslan, 2017: 25)

Dış ticaretin uygulanabilmesindeki en önemli faktörlerin başında doğal kaynaklar, ekonomik büyüme ve kalkınma gelmektedir. Ancak dünya çapındaki ülkelere bakılınca doğal kaynaklar her ülkede bulunmamaktadır. Bazı ülkeler çok zengin doğal kaynağa sahipken, bazı ülkeler ise bu zenginlik bakımından fakirdir. Doğal kaynaklar bakımından zengin olmayan ülkeler doğal kaynakları zengin olan ülkelere bu kaynaklarını ithal eder. Ülkeler üstün oldukları bir üretimde, daha düşük maliyetlerle üretim yaparak ve uzmanlaşmadıkları bir üretim alanında, diğer uzman olan ülkelere düşük bir fiyatla ithal edip ihtiyaçlarını karşılayabilmektedirler. Bunlar dış ticaret ile gerçekleşir (Ataman ve Sumer, 1996: 1-5).

Günümüzdeki devletlere baktığımızda az gelişmişinden çok gelişmişine kadar hepsinin birbirleriyle aralarında ticari faaliyetler gerçekleşmektedir. Ve bu ticari faaliyetlerle ekonomik refahlarını yükseltmektedirler. Ülkeler arasında devam eden bu ilişkiler kimi zaman gereklilikten kimi zaman da mecburiyetten kaynaklanmaktadır (Arslan, 2017: 3-4).

Ekonomi literatürlerinde dış ticaretin hem ekonomik büyümeyi hem de kalkınmayı olumlu bir yönde etkilediği görüşü savunulur. Bu görüşü savunanlar arasında, Adam Smith, David Ricardo, J.S Mill gibi ekonomistler tarafından da savunulmuştur (Özsoy, 2013: 212).

## Dış ticaretin tarihi

Dış ticaretin tarihini incelediğimizde köklü bir geçmişi olduğu karşımıza çıkar. Bu köklü geçmişi dört farklı bölüme ayırarak inceleyeceğiz

**Ticaret Dönemi:** Kişilerin başka ülkelerde üretmiş oldukları ürünleri ve başka ülkelerden almış oldukları ürünleri avrupaya gönderip kar elde ettikleri bir dönemdir. Bu dönemde doğu ülkelerinden avrupa'ya değerli madenler olan porselen,altın,ipek gibi kıymetli madenlerinde ticareti yapılmıştır. Bu dönemde ticareti kolaylaştırmak için ipek yolu ve baharat yolu gibi ticaret ağları kurulmuştur. Bu dönemde Akdeniz limanlarında önemi ve ticaret açısından yeri farklıdır. Coğrafi keşiflerin yapılacağı bu dönemde keşifin yanında getireceği ayrı bir sömürgecilik olgusunda yeni bir dönemin başlangıcı niteliğindedir (Özalp, 2011: 8).

**Sömürgecilik Dönemi:** İspanya ve Portekiz'in öncüsü olduğu coğrafi keşifler ile ticaret yolları hem gelişmiş hem de önemi artmıştır. Ticaret yolları aracılığı ile taşınan mallardan en önemlisi olan baharat ve hububata sahip olmak isteyen Floransa, Ceneviz ve Venedik gibi ülkeler ellerindeki paralarını altına çevirmeye başladı. Ticarete ve finansta alın ihtiyacının artması sebebiyle coğrafi keşiflerin amaçlarının en başında yer almaya başladı. Bu keşifin etkisiyle Afrika, Asya ve Amerika'da bulunan hammaddeyi kendi ülkelerine getirmek isteyen devletler, sömürgeciliğin ilk adımını atmış oldu. Bu keşifler ile birlikte ticaret yolları yön değiştirmiş İpek ve Baharat yolları önemini kaybetmiştir(Arnold, 1995: 9).

Sömürgecilik döneminde uygulanmış olan Altın Standardı para sistemi, ticarete taraf olmuş olan ülkeler arasında ödemeler dengesizliklerinde ortaya çıkan sorunları gidermek ve ülkelerin paralarının bağlı olduğu bir sistem kurmak amacıyla bu dönemde uygulanmaya başlanmıştır. 18. Yüzyılda İngiltere'de başlayan ve tüm dünyaya yayılan sanayi devrimi ise yeni bir dönemin başlangıcı niteliğindedir. Batı toplumları sömürgecilikten ticari rant sağlamış, ve teknoloji ile ilgilenmeye başlayarak yeni bir dönem başlatmışlardır. Sömürgecilik dönemi 1.dünya savaşının başlangıcına kadar devam etmiştir (Özalp, 2011: 8).

**Ayrıcalıklar Dönemi:** 1.Dünya savaşı'nın başladığı dönem ile 2.Dünya savaşı'nın bitişini arasındaki süreçtir. Ülkeler savaş sebebiyle bozulan ekonomilerini düzeltmek için ulusal sanayilerini güçlendirmek istemişler ve sadece kendi ülkelerini düşündükleri bu yönde davrandıkları bir dönemdir (Kocalar,2019: 34).

1914 yıllarının başlangıcından itibaren yerel şirketlerin uluslar arası piyasalara yatırım yaptığı ve çok uluslu şirketlerin kurulmaya başlandığı tarih olarak bilinmektedir. Yapılan bu yatırımların sayesinde üretimde ciddi gelişmeler ve üretimde artışlar yaşanmıştır. Ancak bu süreç 1929 büyük buhran'ın ortaya çıkmasıyla ne yazık ki çok uzun sürmemiştir. Yaşanan büyük buhran ve çeşitli siyasi sorunlar sebebiyle 2.Dünya savaşı çıkmış ve ekonomisini toparlayamayan ülkeler yeniden savaşın yükünü çekmişlerdir (Arnold, 1995: 10).

1944 yılında Bretton Woods sistemi, ortak bir para düzeni kurmak için BM Para ve Finans Konferansı'nda uygulanmaya başlanmıştır. Yapılan bu sistem ile mevcut olan tüm para birimleri dolara, dolar ise altına endeksenerek uluslar arası ticaretin kolaylaşması planlanmıştır (Balcı ve Göcen, 2016: 12).

Bu dönemde yaşanan gelişmelerin en başında uluslar arası ticaret ve üretime katkı sağlayacak olan çok uluslu şirketlerin olmasıdır. Bu şirketlerin tarihi 1950-1970'lerden itibaren başlangıçları kabul edilse de tesisleri kurmuş olan margarine union şirketi ve İngiliz level brothers'ın birleşmesiyle 1930 yılında kurulan unilever ilk modern işletme olarak kabul edilir (Özalp, 2011: 9).



**Uluslararası Dönem:** 2.Dünya savaşının sona erdiği 1945 yılından günümüze kadar olan zamanı kapsamaktadır. Gerçekleşen bu savaş ile ülkelerin ekonomileri oldukça yıpranmıştır (Kocalar, 2019 :35).

1945 ve 1970'li yıllar çok uluslu şirketlerin güç kazanmaya başladığı ve üretimin artmaya başlamasıyla pazarlarında bu artışlarla birlikte genişlediği bir dönemdir. Ülkeler bu dönemde hem ülkeleri denetlemek hem de dengeyi korumak için dış ticarete sınırlamalar koymuşlardır. 1947 yılında Uluslar arası Para Fonu (IMF) ve Dünya Bankası (WB), 1960 yılında faaliyetlerine başlayan Ekonomik Kalkınma ve İşbirliği Örgütü (OECD) gibi kuruluşlar bu dönemde ticaret ve üretim alanında yapılan yenilikliklerde önemli katkılar sağlamışlardır. Bu yıllarda ülkelerin etkileşimleri ile birlikte uluslar arası örgütlerinde sayısının artmaya başlamasıyla ve bölgeselleşme faaliyetleri ile birlikte yakın ülkeler bir araya gelerek serbest ticaret antlaşmaları yapılarak ticaretin önü açılmış, bu şekilde hem ekonomik hem de siyasi olarak ülkeler birbirlerine yaklaşmıştır (Muzhdabayeva, 2006 : 29).

1970-1990'lı yıllara dışa açılma ve neoliberal politikaların etkileriyle ülkeler arasındaki ilişkiler gelişmiş ve ülkeler arasındaki rekabet artmıştır. Yaşanan bu gelişmelerle ülkelerin birbirlerine olan bağımlılığında artmıştır. 1980 yılından itibaren uygulanmış olan politikalar ve teknolojide yaşanan gelişmelerle, küreselleşme ve iki kutuplu dünya düzeni'nin sona ermesiyle uluslararası ticaret ve üretim farklı bir noktaya gelmiştir (Reitix, 2018).

### Dış ticaretin nedenleri

Ülkelerin dış ticaret yapma nedenleri şu şekilde sıralanabilir: (Dinler, 2012: 554-557).

- **Otarşi:** Ülkelerin coğrafi ve fiziki koşulları eşit olmadığından üretim miktarları da eşit değildir. Ülkeler bu sorunu dış ticaret yaparak aşmaktadırlar.
- **Üretimde yakalanan fiyat ve teknolojik avantajlar:** Ülkeler uzmanlaşmayla birlikte düşük maliyetli üretimlerle ürünlerin niteliklerini ve rekabeti arttıracak güce sahip olabilmek için farklı alanlarla kullanacakları kaynaklarını uzmanlaşmış oldukları sektöre kaydırırlar. Bu durumda Ürettikleri nitelikli ürünleri ihraç edip ihtiyaç duydukları ürünleri de ithal ederek bu sorunu aşarlar. Elde edilen üretim avantajı kısa dönemde önemli, ancak uzun dönemde bu avantaj kaybedilmektedir.

Dış ticaretin yapılmasındaki diğer nedenler ise şu şekildedir; (Antell ve Harris, 2005: 408).

- **Ülke içi üretimin yetersizliği:** Ülkeler doğal kaynaklardan dolayı farklı özellikler taşıdığı için bir ürünün üretilmesinde gerekli olan hammaddenin olmaması ülkeleri dış ticarete zorlar. Ülkelerin yurtiçi üretimlerinin yetersiz olması yada iç talebi karşılayamayacak durumda olması da dış ticareti yapılmasını zorunlu hale getirir.
- **Kalifiye iş gücü yetersizliği:** İşgücündeki maliyetler ve kalifiyelik üretimi doğrudan etkiler. Bu nedenle üretim yapabilecek kalifiyeli işgücünün bulunmadığı zamanlarda ülkeler dış ticaret yapmaktadırlar.
- **Ülkeler arası maliyet farklılıkları:** Ülkeler arasındaki teknoloji ve üretim faktörlerinin farklı olmasından dolayı bazı ülkeler avantajlı durumdayken bazı ülkeler aynı ürünün üretimi için daha fazla maliyet katlanmak zorunda kalır.
- **İhtiyaç fazlası ürünlerin değerlendirilmesi:** Yurtiçindeki üretilmiş olan ürünler, yurtiçi talebinden daha fazla ise ülkeler dış ticaret ile bu sorunun üstesinden gelebilirler.

- Farklılaşmış mallar: Başka ülkelerde üretilmiş olan ve aynı hizmeti veren ürünler, fiyat, dayanıklılık gibi farklı özelliklerden dolayı farklı kişiler ve tüketiciler tarafından tercih edilmektedir.
- Tüketici tercihleri: Tüketicilerin ihtiyaçlarını karşılayacak olan ürünler farklı ülkelerde üretilmiş olabilir. Bu durumda da ülkeler dış ticaret yapmak zorunda kalabilir.

### **Dış ticaret teorileri**

Devletler az da olsa zaman içerisinde birbirleriyle ticaret yaparak etkileşim içerisinde olmuşlardır. Yapılan bu ticareti bilimsel olarak ilk inceleyen kişi adam smith olmuştur. Ancak adam smith'den öncede devletler birbirleriyle dış ticaret yapmışlardır. Bu bölümde dış ticaret teorilerinden bahsedilecektir (Kocalar, 2019: 40).

### **Merkantalizm**

Adam smith'in oluşturduğu mutlak üstünlükler teorisinden önce geçerli olan merkantalizm bir teori değil bir düşünce akımıdır. Bu akım 16. Ve 17. Yüzyılın sonlarına kadar etkili olmuştur. Merkantalizm herhangi bir doktrin veya ekol değildir (Seyidoğlu, 2009: 24).

Merkantilistlere göre dış ticaretin en önemli amacı devletin sahip olduğu hazinenin stoğunu arttırmaktır. Bunun için ödemeler dengesinin fazlalık oluşturması zorunludur. Merkantilistlere göre bir devletin gücü sahip olduğu altın ve kıymetli madenlerdir. Bu düşüncenin en büyük nedeni uzun yıllar devam eden savaşların finanse edilmesi için altın ve değerli madenlere ihtiyaç duyulmasıdır (Aydemir ve Güneş, 2006: 144-157).

Merkantilist düşüncede yoğun bir devlet müdahaleciliği vardır. Ödemeler dengesinde fazlalık verilmesiyle iç ve dış faaliyetlerde baskın bir devlet müdahalesini öngörür. İhracatın artırılması önemlidir. İthalat bölümünde sadece hammaddeye müsaade edilmektedir. Bu şekilde ülke sadece hammadde ithal edip, ülke içerisinde işleyerek satışını gerçekleştirecektir (Aydemir ve Güneş, 2006: 144-157).

Merkantilistlere göre dünyadaki altın ve değerli madenlerin miktarı sabittir. Bu nedenle aralarında ticaret ilişkisi olan devletler arasında daima çıkar çatışmaları vardır. Ticaret yapılırken bir ülke kazandığında diğer ülke zarar görmektedir. Aynı zamanda merkantilistler sömürgecilik faaliyetlerinde etkin oldukları için sömürgeci kaynakları ve ülkelerinde ürettikleri malların satışını gerçekleştirebilmek için gelişmiş bir deniz filosu ve orduya ihtiyaçları da vardır (Seyidoğlu, 2009: 24).

Sanayi devriminin gerçekleşmesiyle liberal politikalar önem kazanmıştır. Yüksek miktarda üretim sağlayan buharlı makinelerle birlikte üretim sorunu aşılmış, Pazar arayışı başlamıştır. Bu sebeple merkantalist düşünce önemini kaybetmeye başlamış ve ülkeler ekonomilerinde devamlılık sağlamak için ithalata başlamıştır. 18. Yüzyılda adam smith tarafından yazılan ulusların zenginliği ile merkantalizmin yerini liberalizm almıştır (Neary, 2009: 218).

### **Mutlak üstünlükler teorisi**

Adam smith tarafından dış ticareti açıklama için geliştirdiği mutlak üstünlükler teorisine göre; bir ülkede diğer ülkeye ihraç edilen hangi malları düşük bir maliyetle üretebiliyorsa o alanda uzmanlaşmalıdır. Yüksek maliyetlerden dolayı üretmediği malları

da diğer ülkelerden ithal etmelidir. Adam Smith'e göre; bir ülke bir malın üretirken diğer ülkelerin ürettiği aynı malı üretiminde kullandığından daha az kaynak kullanarak üretebiliyorsa o ülke diğer ülkelere göre mutlak üstünlüğe sahiptir (Subasat, 2003: 148).

Mutlak üstünlükler teorisinin uluslar arası ticaretin nedenlerini bilimsel olarak açıklamadaki yeri önemlidir. Ancak Adam Smith tarafından oluşturulan model uluslar arası ticaretin hepsini açıklayacak yetkinlikte değildir. Yukarıda verdiğimiz örnekte bir ülkenin üretilen bütün mallarda diğer ülkeye göre üstünlüğü varsa üstünlüğü olmayan ülkenin üretim yapmaması gibi bir durum ortaya çıkar. Bu sebeple mutlak üstünlükler teorisi dış ticaretin açıklanmasında önemlidir. Ancak günümüz şartlarında yeterli olmayan ve kabul görülmeyen bir teoridir (Seyidoğlu, 2009: 29).

### **Karşılaştırmalı üstünlükler teorisi**

Uluslar arası ticaretin ilk teorisi olarak kabul edilen mutlak üstünlükler teorisinin, D. Ricardo tarafından geliştirilen karşılaştırmalı üstünlükler teorisi; ülkelerin kendi ürettikleri ürünlere göre nispi olarak fiyatların farklılığını baz alarak dış ticaret yapmalarını belirtmiştir. Karşılaştırmalı üstünlükler teorisi bir ülkenin bir mal yada hizmetin ihracatında uzmanlaşmış, diğer mal veya hizmetlerin ithal edilmesi gerektiği üzerinde durmuştur (Neary, 2009: 218).

Ricardo'ya göre, bir ülke ticaretteki yapısındaki ortaklara göre ucuza ürettiği malları ihraç etmeli, pahalıya üretmiş olduğu malları da ithal etmelidir. Bu durumda dış ticaretten elde edilen kazanç ülkenin refah seviyesini arttıracak, uluslar arası ticaret yapıldığı için dünya refahının da artmasını sağlayacaktır (Sharma, 2004:3).

Uluslar arası ticaretin en önemli belirleyicisi olan karşılaştırmalı üstünlükler teorisinde Ricardo, doğal ve fiziksel etkilere değinirken, kendisinden sonraki iktisatçılar daha çok teknoloji, insan faktörleri, ve faktör donatımları üzerinde durmuştur. Bu dönemlerde iktisatçılar serbest ticaret ile ülkelerin refahının artacağını belirtmiş, ekonomik büyümenin karşılaştırmalı üstünlükler sayesinde gerçekleşeceğine değinmişlerdir (Bernhofen, 2005: 2008).

### **Dış ticaret politikaları**

Dış ticaret politikaları ülkelerin ticari faaliyetlerinde saptanmış hedefler için tasarlanmış önlemler olarak kısaca tanımlayabiliriz. Ülkelerin uygulamış olduğu dış ticarete özendirme yada kısıtlandırma uygulamaları dış ticaret politikalarını oluşturmuştur (Köksal, 2016: 13).

Hükümetlerin dış ticarete yapmış oldukları müdahaleler dolaylı veya dolaysız'dır. Gümrük tarifesi, kotalar gibi kısıtlamalar dış ticarete doğrudan yapılmış olan müdahalelerdir. Farklı bir amaçla alınmış olan ve dış ticareti etkileyen tedbirler ise dolaylı müdahalelerdir.(Polat, 2020: 16)

Dış ticaret politikalarına baktığımızda genel ekonomide yer alan politikaların kayda değer bir aracıdır. Genel ekonomi politikaları, milli ekonominin düzenlenmesi için gerekli olan önlemlerdir ve iç ekonomideki bu politikalar ile dış ticaret politikaları birbirinden etkilenir. Bu nedenle politikalar arasında uyum sağlanmaya çalışılır (Seyidoğlu, 2003: 117).

### **DIŞ TİCARET POLİTİKASININ AMAÇLARI**

Hükümetler hem ekonomilerini canlandırmak hem de ekonomik büyümeyi hızlandırmak için yerli üreticileri dış rekabete karşı korurlar. Bu sebeple, hükümetler olumlu

yada olumsuz bir nedenin önüne geçebilmek için ekonomik ve siyasi politikalara müdahale ederler. Hükümetlerin ülkelerin dış ticaret ilişkilerine müdahale etme nedenleri şu şekildedir (Seyidoğlu, 2007, s. 139-140):

- Dış ödemelerdeki dengesizliklerin giderilmesi veya azaltılması
- Dış rekabetlerden koruma
- Piyasaki bozukluklar ve aksaklıkların giderilmesi
- Ekonominin serbest bir hale getirilmesi
- Ülke sınırlarındaki ekonomik istikrarın sağlanması
- Devlet hazinesi için gelirlerin elde edilmesi
- Monopol güçten yararlanmak
- Siyasi ve sosyal etkenler
- Otarşi
- Dış politikadaki amaçlara hizmet

### DIŞ TİCARET POLİTİKASININ ARAÇLARI

Hükümetler ekonomi politikalarına müdahale ettikleri gibi dış ticaret politikalarına da müdahale etmektedirler. Ancak yapılan bu müdahaleler diğer ülkeler ile yapılmış olan anlaşmaları etkilemektedir. Hükümetlerin müdahale için kullanmış olduğu en yaygın araçlardan biri de gümrük tarifeleridir. Hükümetler gümrük tarifesi dışı araçlarla serbest ticaret akımlarına müdahale ederler (Farahmand, 2019: 10).

Tarife dışı araçlar, yurt içinden döviz çıkışını kısıtlamak için devlet tarafından uygulanan bir müdahaledir. Bu başlığın altında tarife dışı araçlara değineceğiz (Farahmand, 2019).

- Miktar kısıtlamaları, ithalat kotaları, ithalat yasaklamaları ve döviz kontrollerinden oluşmaktadır. Hükümet bu önlemler ile ithalatı belirli bir miktarda sınırlandırmaktadır. Yani yurt dışından ne kadar ithalat yapılacağına hükümet karar vermektedir.
- Tarife benzeri faktörleri, devlet gümrük tarifelerinde olduğu gibi ithalat karşı yerli üretimin kazancını arttıran, ithalatı pahalılaştıracak önlemler alır. Yani yerli üretimleri korunması için ithal ikame endüstrilerine sağlanan desteklerdir.
- Görünmez engeller, ticaret yapacak olan yabancı kuruluşların bilinmeyen işletmelere uyguladığı hükümet önlemidir. Yani devlet görünmez engelleri sadece dış ticaret için değil, sağlık, güvenlik, gibi nedenlerle de uygulamaktadır. Günümüzde bu önlemler gün geçtikçe artmaktadır.
- Gönüllü ihracat kısıtlamaları, ithalat yapan ülkenin piyasasını bozan ihracatçı ülkeye ihraç edeceği bazı mallar üzerine uygulamış olduğu bir sınırlamadır. Ancak yapılan sınırlamalar her iki ülke arasında bir anlaşma ile yapılır.
- İhracatın desteklenmesi, devletlerin dış piyasaları kontrol edebilmeleri ve yardımcı olabilmeleri için ulusal ekonomide yer alan firmalara sağlamış olduğu bir yardım şeklidir. Bu işlemler az gelişmiş ülkelerin ihracata teşvik edilmesi için başvuru olan bir işlemdir.
- Bağlı ticaret, serbest olan yabancı para birimleriyle satılmayan malların, farklı mal yada hizmetlerle ödenmesidir. Yani satıcı'nın dövizle satılmayan mallarına karşılık alıcıdan bir başka mal ithal etmesidir. Bu tarz ticaretler genelde ülkelerarasında yapılan anlaşmalara bağlıdır. Az gelişmiş olan ülkelerin pahalı olan

malları satın alabilecek yeterli finansmana sahip olmadığında bu yola başvurulur (Seyidođlu, 2015: 78-79).

### **Enflasyon**

Enflasyon; belirli bir mal yada hizmetin tek taraflı olarak deđil fiyatlar genel düzeyinde sürekli bir artış olmasıdır. Yalnızca Tek bir malın fiyatının artması enflasyon olarak sayılmaz. diđer bir söylemle, piyasalardaki bazı ürünlerin fiyatlarının tek seferde artması yada bazı malların fiyatlarının sürekli artması enflasyon olarak değerlendirilmez. Enflasyon fiyat artışındaki hızı ifade eder. Fiyatlardaki yüksek seviyeler enflasyon olarak değerlendirilmemektedir (Mankiw, 2017: 114-115).

Enflasyon rakamsal deđil, oransal bir şekilde hesaplanmaktadır. Örneđin; enflasyon oranının %3 olduđu durumlarda, geçtiđimiz yıldan bu yana fiyatlar genel seviyesinde %3 oranında bir artış olduđuna işaret etmektedir. Enflasyon oranı yıllık, üç aylık ve aylık olarak da belirlenebilmektedir. Enflasyon oranının yıllık %30 olduđu bir durumda geçen yıl 2000 TL'ye alınan bir mal sepetinin, bu yıl 2600 TL'ye alınabileceđini ifade etmektedir (Kocalar, 2019: 5-6).

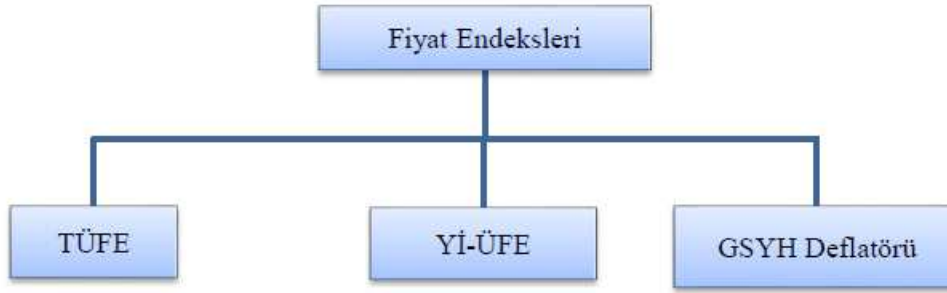
Enflasyon oranı, merkez bankasının uygulamış olduđu para politikasına doğrudan etki etmektedir. Para politikasını doğrudan etkileyen enflasyon oranı, ülkedeki diđer makro ekonomik göstergelere de etkilemiştir demektir. Enflasyon oranı döviz kuruna, faiz oranı gibi birçok göstergeye doğrudan etki etmektedir (Göçer ve Gerede, 2016: 27-28).

Enflasyon tanımında ismi geçen fiyatlar genel düzeyi ekonomide yer alan mal ve hizmetlerin ortak deđerlerdeki ölçüleri kullanılarak fiyata çevrildikten sonra ortaya çıkan fiyat topluluđuna fiyatlar genel düzeyi denilmektedir. Kısaca tanımı ise piyasalarda alım satıma konu olan mal ve hizmetlerin belirli bir dönemdeki ortalama fiyatları şeklinde tanımlanmaktadır. Enflasyon oranı ve fiyatlar genel düzeyindeki artış oranlarının ne olduđuna ise fiyat endeksleri sayesinde karar verilmektedir. (Chowdhury, 2002: 21-22)

### **Fiyat endeksleri**

Fiyat endekslerini saptamak için kullanılan iki yöntem Paasche endeksi ve laspeyres endeksidir. Paasche endeksinde, fiyat endeksleri deđişken mal sepetinden oluşmaktadır. Gsyh deflatörünün hesaplanmasında ise adı geçen ülkenin son bir yılda üretilmiş olan nihai mal ve hizmetler dikkate alınmaktadır. Bunun nedeni ülkede üretilen mal ve hizmetlerin her yıl farklı olmasıdır. Laspeyres endeksinde fiyat endeksi hesaplaması yapılırken, mal sepetinin sabit olmasıdır. Tüketici fiyatları endeksinde sepete alınmış olan mallar her yıl deđişmemektedir. Bu durumun temel sebebi ise fiyatlardaki deđişimlerin daha açık görünmesidir (Kehoe ve Ruhl, 2005: 760-765).

Fiyat endeksleri üçe ayrılmaktadır. Bunlar; Tüketici Fiyat Endeksi (TÜFE), Yurt İçi Üretici Fiyat Endeksi (Yİ-ÜFE) ve Gayri Safi Yurtiçi Hasıla (GSYH) Deflatörü şeklindedir (Kocalar: 2019: 6)



Şekil 1: Fiyat Endeksleri

Kaynak: TÜİK, 2008

TÜFE; Tüketici Fiyatları Endeksi ürünlerin nihai kullanıcıları olan hane halklarının tüketim harcamalarındaki satın almış oldukları mal ve hizmetlerdeki belirli dönemlerinde yer almış olan fiyatlardaki gerçekleşmiş değişimleri göstermektedir. TÜFE hesaplandığında belli bir mal sepeti oluşturulur. Bu mal sepetinin oluşturulma sebebi ise piyasada bulunan bütün mal ve hizmetlerin fiyatlarının takip edilmesi hesaplamayı zorlaştıracığından ve ortalama olarak bir hane halkının tüketeceği ürünler ve bunların harcamalardaki ağırlıkları belirlenip toplumdaki bütün hane halklarını kapsamaya amaçlanmaktadır. Tüketim harcamaları amaçlarına göre kendi içinde sınıflandırılıp diğer harcama gruplarına göre değerlendirme dışında kalmaması hedeflenmektedir. Hesaplanmalar yapılırken mal ve hizmetler hane halklarının tüketimine göre büyükten küçüğe doğru sıralanmaktadır. Belirli bir ağırlıkta olan tüketim sıklığında yer alan mal ve hizmetler endekse dahil edilerek hesaplanmaya dahil edilmektedir (TÜİK, 2008).

ÜFE; Üretici Fiyatları Endeksi ise maden, imalat sanayisi, tarım ve enerji gibi ülkede üretimleri gerçekleştiren malların üreticiler tarafından yurtiçindeki peşin satışlarda yer alan fiyatlardaki değişimlerin izlenilmesini sağlayan bir fiyat endeksidir. TÜFE’de olduğu gibi ÜFE’de de ekonomide üretilmiş olan malların fiyat takibinin yapılması imkansızdır. Bu nedenle ürünün toplam satış bedelinin, toplam satış gelirinden almış olduğu paya göre bir tercih yapılmaktadır. Ürün seçimleri sektörel ve alt sektörler olarak yapılmaktadır. Bunun başlıca sebebi ise üretim faaliyetlerinin kapsama alanının dışında kalmaması ve doğru sonuçların elde edilmesinin hedeflenmesidir. Hizmetler ise ÜFE’nin kapsamında yer almamaktadır (Seyidoğlu, 2009: 508).

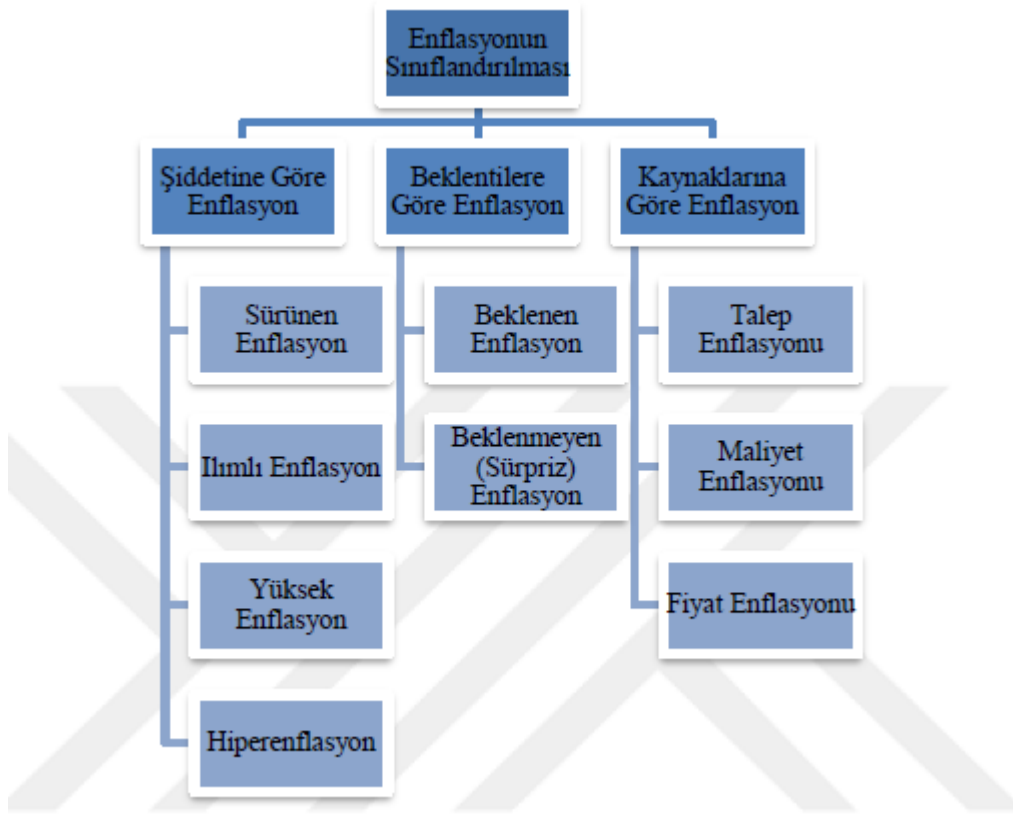
GSYH Deflatörü ise; bir ülkedeki, son bir yılda üretilmiş olan nihai mal ve hizmetlerin değerinin para birimi cinsi ile toplam bedeli şeklinde ifade edilmektedir. Diğer bir ifadeyle nominal GSYH’yı, reel GSYH’ya dönüştürerek, enflasyon gibi değişkenlerden arındıran ve üretimde yer alan değişimlerin daha net bir şekilde görülmesini sağlayan bir katsayıdır. Baz alınmış olan cari yılın fiyat endeksi değeri 100 olarak kabul edilmektedir. Sonrasında gelen yıllarda hesaplanmakta olan GSYH deflatörü 120 ise, fiyatların baz alınmış olan yıla oranla %20 arttığını göstermekte kullanılmaktadır. GSYH’nin formülü (Yıldırım, Kahraman ve Taşdemir, 2014: 372-373);  $GSYH \text{ Deflatörü} = (\text{Nominal GSYH} / \text{Reel GSYH}) * 100$  şeklindedir.

TÜFE ve ÜFE’nin GSYH Deflatöründen en büyük farkı ise; TÜFE ve ÜFE’de belirli bir mal sepeti bulunurken ve bu mal sepetinde sadece fiyat değişimleri incelenirken, GSYH Deflatöründe ekonomideki üretilmiş olan bütün mal ve hizmetler bulunmaktadır. Bu şekilde

ekonomide üretilen bütün mal ve hizmetler hesaplanırken tüketicilerin zaman içerisinde değişen hizmet tercihleri de hesaplamaaya dahil edilmektedir (Göçer ve Gere, 2016: 27-28).

### Enflasyonun sınıflandırılması

Enflasyonu incelemek ve anlamlandırabilmek için çeşitli şekilde sınıflandırmalar yapılabilir. Çalışmanın bu bölümünde enflasyonun çeşitlerinden bahsedilmektedir (Kocalar, 2019: 8).



**Şekil 2:** Enflasyonun Sınıflandırılması.

**Kaynak:** Yıldırım, Kahraman ve Taşdemir, 2014: 372-373.

Enflasyon şiddetine göre sınıflandırılmaktadır. Bu nedenle enflasyonu 4 başlık altında inceleyeceğiz. Bunlar; sürünen, ılımlı, yüksek (ya da dörtlü) ve hiperenflasyondur (Yılmaz, 2006: 36).

Sürünen enflasyon; enflasyon beklentisine girilmediği ve fiyatlardaki artışın düşük seyrettiği zamanlarda söylenilmektedir. Sürünen enflasyon için net bir oran belirtmemekle beraber içinde bulunduğu zaman ve ülkenin durumuna göre oran değişse de, ekonomide olumsuz bir etki oluşturmayan enflasyon türüdür. Ayrıca böyle bir enflasyonun olumlu sonuçlarından da söz edilmektedir (Yıldırım, Kahraman ve Taşdemir, 2014: 372-373)

İlmlı enflasyon; İçinde bulunduğu şartlar ne olursa olsun enflasyonun çift haneleri görmediği, Ancak hane halkında bir enflasyonist beklentinin gerçekleştiği ve etkilerini hissettiği bir süreçtir. İlmlı enflasyonda her ne kadar fiyat artışları gözlemlense de çok düşük bir seviyede ve tahmin edilebilir. İlmlı enflasyonun faydalarını dile getiren birçok

ekonomist bulunmaktadır. Bunların en başında gelen ise yatırımları teşvik etmesidir (Eğilmez ve Kumcu, 2004:125).

Yüksek enflasyon; ekonomiyi zarara uğratan, piyasa mekanizmasındaki işleyişi duraklatan, gelecekteki belirsizlikleri arttıran ve paranın değeri ile tasarruf edilmesini azaltan enflasyon türüdür. (Yıldırım, Kahraman ve Taşdemir, 2014: 372-373).

Yüksek enflasyonun yaşandığı dönemlerde enflasyon oranı %10 ile %100 aralığındadır. Yüksek enflasyon dönemlerinde firmaların ve bireylerin milli paraya olan güveni azalmış olur bu durumda sadece günlük işlemlerin yapılması için milli para kullanılır. Halkın çoğunluğu yüksek enflasyonun olması durumunda tasarruflarını (yatırım fonları, döviz, altın v.b.) çevirirler. Talep ve fiyatlarda oluşan dengesizliklerden dolayı piyasalarda bozulmalar meydana gelir (Seyidoğlu, 2009: 527).

Hiperenflasyon; yıllık olarak %1000'i aşım paranın değerini tamamıyla bitirdiği yüksek bir enflasyon çeşididir. Hiperenflasyon döneminde toplumun üzerine büyük bir yük yüklenir. Enflasyonun maliyeti yüksek enflasyona nazaran daha açık bir şekilde görülmektedir. Elde para tutmak maliyetleri arttıracığı için bireyler ayakkabı maliyeti olarak adlandırılan, işlemlerini yapabilmek için sürekli mali kurumlara gidip gelmesi gerektiği bir ekstra maliyetle karşılaşır. Firmalar nakit yönetimini kontrol altına almak için fazladan mesai yapmak mecburiyetinde kalırlar. Menü maliyetleri, firmanın fiyatlarını durmadan güncellemek zorunda olduğu, tüketicilerin ise karar verme aşamasında zorlanmış olduğu bir başka maliyettir. Ayrıca vergi sistemleri de hiperenflasyon tarafından tahrip edilmektedir. Verginin uygulandığı ve verginin tahsil edildiği süre zarfında sürünen ve ılımlı enflasyonun yaşandığı dönemlerde çok fazla bir öneme sahip değilken özellikle hiperenflasyonun yaşandığı dönemlerde devletin reel vergi gelirlerini olumsuz bir yönde etkilemektedir. Hiperenflasyon dönemlerinde paranın saklama,değişim ve ölçü birimi olması ortadan kalkar. Bu nedenle bireyler ticaret yaparken döviz,takas gibi yöntemleri kullanarak milli para biriminden tamamen kaçmaktadırlar (Mankiw, 2017: 114-115)

Enflasyon sınıflandırıldığında beklenti kavramı da kullanılabilir. Bu durumda beklenen ve beklenmeyen enflasyon kavramlarına ulaşılır. Bu ayrımın yapılması enflasyonun etkilerinin bulunması yönünden büyük bir öneme sahiptir. Beklenen enflasyon; fiyatlar genel seviyesindeki sürekli artışa , fiili gerçekleşen enflasyon denir. Beklenen enflasyon piyasalar, hane halkları ve devlet tarafından bilindiği için büyük sorunlar oluşturmamaktadır. Beklenmeyen enflasyon ise; firma, hane halkı ve devletin fiyatlar genel seviyesinde gerçekleşen artışı net bir şekilde tahmin edemeyip uygun pozisyon alamadığı ve bu ekonomideki birimlerin büyük zarara uğramasına sebep olan enflasyon türüdür (Eren, 2006: 202).

Enflasyon kaynaklarına göre üçe ayrılmaktadır. Talep enflasyonu; bir ekonomideki talep edilen mal ve hizmetlerin arz tarafından karşılanamamasıdır. Arzı artan bir talebin olması ile birlikte fiyatlar genel seviyesi artar ve bu durumda enflasyon ortaya çıkar. Talep enflasyonunun en önemli nedenleri; para arzının artması, stok yetersizliği, kapasite yetersizliği, kamu harcamalarındaki artışlar ve ekonominin yaşadığı dar boğazdır (Tunca, 2005: 108-109).

Maliyet enflasyonu; üretimde kullanılmakta olan girdilerin maliyetlerinin artması ile birlikte fiyatlar genel seviyesinin de artması sonucunda ortaya çıkan bir enflasyon türüdür. Maliyet enflasyonu söz konusu olduğunda toplam arz eğrisi sola kaymaktadır. Özellikle petrol alanlarında kullanılmakta olan hammaddelerin fiyatlarının yükselmesi ve ücretlerin artması gibi arz şokları enflasyona sebep olmaktadır (Paya,2007: 387-388).

Fiyat enflasyonu ise; bazı grupların ürettiği malları piyasadaki bedellerin üzerinde satarak gelirini arttırması ve bunun sonucunda talebin yükselerek enflasyona sebep olması



şeklinde tanımlanmaktadır. Yukarıda anlatılan enflasyon türleri birbirinden bağımsız değildir. Ekonomi enflasyonist sürece girmeye başladığında bu enflasyonlardan beslenerek fiyat düzeyi yükselmektedir (Yıldırım, Kahraman ve Taşdemir, 2014: 372-373).

### **İşsizliğin tanımı**

İşsizlik en geniş tanımıyla, şuan çalışmayan ancak aktif olarak iş arayışında olan bireyleri anlatmaktadır (Nickell, 1990)

Ülkemizde bilim adamları, hükümet, ve kuruluşlar işsizlik için farklı farklı tanımlar yapmaktadırlar. Tanımlarda yer alan kıstasların değiştirilebilmesi iktidarların iktisadi performans göstergesini değiştirmesinden daha önemlidir (Kurt, 2005: 4).

Türkiye’de kullanılan işsizlik tanımının çerçevesi, Devlet İstatistik Enstitüsü (DİE) tarafından belirlenmiştir. DİE’ye göre işsiz tanımı şu şekildedir (Kurt, 2005):

Referans dönemleri içerisinde istihdam halinde olmayan kişilerin iş aramak için son üç ayda iş arama kanallarından birini kullanmış ya da 2 hafta içinde işe başlayacak durumda olan ve kurumsallığı bulunmayan çalışma çağındaki tüm kişiler işsiz nüfusa dahildir. Ayrıca, üç ay içerisinde başlayabileceği bir iş bulmuş ya da kendi işini kurmuş veya iş başı yapmak için çeşitli alanlarda eksikleri bulunan ve bunları tamamlamak için bekleyen, 2 hafta içerisinde işe başlayacak kişiler de işsiz nüfusa dahildir (Die, 2005).

Uluslararası Çalışma Örgütü’nün (UÇÖ) işsizlik tanımı şu şekildedir: Kısa referans dönemlerinde bir saatten fazla çalışmamış fakat çalışmaya hazır ve aktif olarak iş arayanlar işsiz olarak adlandırılmaktadır (Higgins, 2000)

Bu tanıma dayanarak işsizlik tanımındaki ortak noktalar şu şekilde ifade edilebilir:

- Referans dönemlerinde ücretli ya da kendi hesabında çalışma olarak herhangi bir işe sahip olunmaması
- Referans döneminde işe başlamaya hazır olması
- Referans dönemi boyunca aktif olarak iş arıyor olması
- Referans döneminde geleceğe yöneliğe bir iş sözleşmesi yapmış yada geçici olarak işten çıkarılmış olanlar da işsiz sayılmaktadırlar (Lordoğlu, Özkaplan ve Törüner, 1999: 54)

### **Ekonomik büyümenin tanımı**

Dünya üzerinde bulunan her şey zamanla değişmektedir. Bununla beraber ülkelerdeki ekonomik büyüme göstergeleri de zamanla değişmektedir. Ekonomiler iyi gibi görünse de büyüme sürecinde ülkelerin sahip olduğu doğal kaynaklar, sermaye birikimleri, işgücü gibi faktörlerden etkilenmektedir. Ekonomik büyüme bir ülkenin yıllık bazında yada belirli bir yılda üretimde yaşanan artış veya bir ülkenin bir dönem içerisindeki üretim kapasitesinde yada reel gayri safi yurt içi hasılasında görülen ve sayısal olarak ölçülen reel artış olarak tanımlanmaktadır (Bocutoğlu, Berber, 2005: 414-416).

Ekonomik büyüme farklı şekillerde de tanımlanmaktadır. Ekonomik büyüme, mal ve hizmet üretim kapasitesindeki genişleme olarak da tanımlanabilir (Parasız, 2003: 10)

Ekonomik büyüme bir önceki dönemde reel gayri safi yurt içi hasılda meydana gelen net bir artış olarak tanımlanmaktadır. Buna göre ekonomik büyüme üretim yada kişi başına düşen gelirden artış anlamına gelmektedir. Bir ülkede mal ve hizmet üretiminde artış

varsa o ülkede büyümenin gerçekleştiği gözlemlenmektedir. Genel olarak ekonomik büyümeye yönelik değişik oranlar söz konusu olmaktadır. Bu oranlardan birincisi, gayri safi yurt içi hasılanın cari fiyatlar ile hesaplanmasıyla bulunan büyüme oranlarıdır. İkincisi, belirli bir baz yıl alınarak gayri safi yurt içi hasıla rakamlarının hesaplayarak elde edilen, sabit fiyatlı büyüme oranlarıdır. Ayrıca ekonomik büyüme, kişi başına düşen GSYH'deki yüze değişimi ile de ölçülebilmektedir (Moroianu, 2012: 136).

### **Dış ticaret ve ekonomik büyüme ilişkisi**

Bir ülkedeki üretim kapasitelerinde geçmiş dönemlere oranla meydana gelmiş olan artışlar o ülkedeki ekonomik büyümenin hızını göstermektedir. Ülkeler ekonomik büyümede refahı arttırmak isterken kaynak kıtlığı yaşamaktadır. Bu durumda kaynak arayışına girmektedir. Ülkelerin birbirleriyle etkileşim içerisinde olmalarının başlıca nedeni dış ticarettir. Ekonomik büyümenin en önemli mekanizmalarından olan dış ticaret, klasik iktisatçılardan bu yana üzerinde tartışmalar olan ve geliştirilen bir konudur (Şahin ve Durmuş, 2018: 1114).

Serbest ticaret ile dışa açılma bilgi ve teknoloji, rekabet, ve karşılaştırmalı üstünlükler teorisi gibi etkenlerle büyümeye katkısı olduğu söylenilmektedir. Dış ticarete liberal olmanın en önemli nedeni dışa açıklıktır. OECD'ye göre dışa açık olan ekonomiler, dışa kapalı ekonomilere göre daha üstündürler ve dış ticarete serbestleşmenin söz konusu olmasıyla ekonomik büyüme artış gösterecektir (Polat, 2020: 47)

Dışa açıklık ihracat ve ithalatın toplamıyla GSYH'ya olan oranı olarak belirtilmiştir. İhracat ve ithalat rakamlarının toplanması da dış ticareti ifade eder. İhracat, yurtiçindeki üretimlerin dışarıya doğru açılması ile ülke ekonomisine gelir sağlamaktadır. Dış ticaretin öneminin artmasıyla, ekonomideki göstergelerin ve uluslararası yer alan kuruluşlar içerisindeki önemi açısından ihracatın ithalattan fazla olması pozitif bir etki yaratmaktadır (Şahin, 2004: 6)

Büyümenin belirleyicisi olarak, 1960'lı yıllarda dış ticaret benimsenmiş ve ihracata yönelik ticaret politikaları uygulanmaya başlanmıştır. Ancak dış ticaret, modern büyüme teorisindeki büyümede yer alan kaynaklardan sadece biri olarak görülmüştür. Bu durumda dış ticaret ve büyüme arasında çift taraflı bir ilişki vardır. Yani dış ticaret büyüme üzerinde olumlu yada olumsuz bir etki yaratırken aynı şekilde büyüme de dış ticaret üzerinde etki yaratmaktadır (Gül, Kamacı ve Konya, 2013:3)

### **Enflasyon ve dış ticaret ilişkisi**

Enflasyonun dış ticarete nasıl bir etki bıraktığı araştırılmaya devam ederken ithalat ve ihracatın ayrı ayrı tanımlanması gerekmektedir. Bu durumda ihracat ve enflasyonun ilişkisini incelediğimizde enflasyonun artmasıyla, milli para değer kaybedecek ve ülkede üretilmiş olan mal ve hizmetler yabancılara ucuza gelecek bu durumda ihracatta artış yaşanacaktır. Ancak milli paranın değerinin azalmasıyla birlikte, dışarıdan alınan hammadde, mal ve hizmetler daha pahalı olacaktır. Bu nedenle ithalat azalacaktır (Göçer ve Gere, 2016: 27-28).

### **Dış ticaret ve işsizlik ilişkisi**

Dış ticaret ve işsizlik arasındaki ilişki hakkında incelemeler yapan teorik modeller genel olarak dış ticaret ve işsizlik arasındaki ilişkiyle ilgili olarak belirsizlik içermekte olan sonuçlar üretmektedirler. Dış ticaretin işsizlik üzerindeki etkileri ülkedeki sanayi, işgücü

piyasası ve sektörler göre değişkenlik göstermektedir. Bu durumda yapılmış olan analizlerde belirsiz sonuçlar ortaya çıkmaktadır (Belenky ve Riker, 2015:2).

Teorik çalışmalarda ortaya çıkan belirsizliklere rağmen ampirik olan çalışmalarda daha net sonuçlar elde edilmektedir. Ampirik çalışmalarda elde edilmiş sonuçlarda dış ticaretin genişlemesiyle bir ülkede uzun bir süre toplam işsizlik oranı düşmektedir

(Belenky ve Riker, 2015:2).

## SONUÇ

Sonuç olarak dış ticarete baktığımızda ülke açısından büyük bir öneme sahiptir. Ülke açısından büyük bir öneme sahip olan bir alanın boş bırakılmaması ve her geçen gün geliştirilmesi gerekmektedir. İhracata önem verilmeli, ithalat azaltılmalı yada kriz dönemleri söz konusu olduğunda yerli paranın değerinin korunması için ithalat olabildiğince azaltılmalı, ülkeye yabancı para girişinin azaltılması aynı zamanda dış ticaret konusunda firmalar bilinçlendirilmeli, eğitimlerin düzenlenmesi ve teşvik verilmesi alanlarında çalışmaların yapılması gerekmektedir. Günümüzde dış ticareti gelişmiş ülkelerin ürettiği mal ve hizmetlerde söz sahibi olduğu da görülmektedir. Dış ticaret tek başına yeterli olmayıp bu alanda etki eden makro ekonomik faktörlere de dikkat edilmelidir. Seçtiğimiz enflasyon, işsizlik, ekonomik büyüme zincirleme olarak birbirine bağlıdır sadece enflasyonu kontrol altına almak yada işsizliği kontrol altına almak yeterli olmamaktadır yani kısaca dış ticareti etkileyen makro ekonomik faktörlerde denge esastır.

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# Examining Cultural Values in Urban Conversation Areas: Burdur Urban Site as a Case Study

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## ABSTRACT

Historically, cities have been influenced by many factors, resulting in diverse socio-cultural, economic, and physical transformations. Activities facilitating cultural changes in urban environments have always been intrinsically linked to human activities. Consequently, urban conservation areas are shaped in both temporal and spatial dimensions, informed by the perspectives of the societies within which they are situated. Historical cultural sites serve as pivotal elements that confer identity to urban centers, nestled within new environments that often exhibit high degrees of similarity, along with their physical and social contexts. The implications of spatial and social transformations in urban historical environments on their inhabitants are of considerable importance. A reciprocal relationship exists between settlement areas and their users, characterized by mutual influence. In this regard, spatial interventions conducted within the Burdur urban protected area will be analyzed as illustrative examples of the impacts of these changes throughout the process. Ultimately, it is untenable to conceive of urban historical areas in isolation from the social dynamics that animate them. Thus, an evaluation of protected urban spaces through the lens of sustainable conservation practices is of paramount importance. This study aims to scrutinize the socio-cultural impacts of both former and current users on the Burdur urban protected area, facilitating an assessment of the transformations experienced by these urban protected areas from the perspectives of their users. The ultimate goal of this study is to provide valuable insights into the relationship between urban spaces and their communities, which can inform future urban planning and conservation efforts.

**Keywords:** cultural values, urban conversation areas, urban, Burdur

## 1. INTRODUCTION

Cities are places where numerous individuals with different social structures, cultures, and economic activities live together. Due to various formation processes and factors, cities have undergone constant change. Urban spaces constitute the fundamental structure of cities. Cities can be regarded as living organisms from both physical and perceptual perspectives.

From forming the first cities to contemporary urban areas, cities have continuously developed structurally and culturally. Cities, examined through diverse approaches, have been defined according to their respective periods' structural, spatial, and cultural values. In urban conservation areas, the necessity of preserving historical values is paramount. However, ensuring compatibility between the changing urban structure, contemporary technologies, needs, and conservation areas is increasingly challenging.

The history of Burdur Province extends back to the period when the first settlements were established. Today, the Burdur Urban Conservation Area, which is preserved as an Urban Protected Area, is a region that has undergone various processes since its initial development. The research examines the effects of spatial developments alongside the changing cultural fabric in the Burdur Urban Conservation Area. Users from different cultures and income groups continuously define and select this area through interactions and interventions. Consequently, this has led to the deformation of the historical values that must be preserved.

## 2. DEVELOPMENT OF CITIES AND URBAN CONSERVATION AREAS

### 2.1. Definition and Change of Cities

The word "city" derives from "kind," and it is known that the root of this word is Turkish. Examples can be seen in Central Asian Turkish settlement centers such as Semizkend (Samarkand) or Taşkend. In Arabic, the equivalent is "vilayet," while in Persian, it is "şehir." This word has numerous equivalents in Western languages as well. In English, "city" and "urban" have similar meanings. The word appears as "citta" in Italian, "cite" in French, "Ciudad" in Spanish, and "Stadt" in German. Its Greek counterpart is "polis" (Kılıçbay, 1993).

As perspectives change, so does the definition of a city. Sociologists, historians, urban planners, economists, anthropologists, and literary scholars construct city definitions based on their respective understandings. Definitions are made using criteria such as population size, administrative status, population structure, division of labor and specialization, forms of organization, differentiation in functional areas, sectoral distribution of labor, heterogeneity, physical fabric, and the nature of production (Kaya, 2003, p. 4).

According to Aytaç (2012), contemporary cities are complex areas with various political agendas, showing intricate and conflicting associations of space, people, time, identity, culture, image, and signs. Cities, as products of their surrounding regions and influenced by them, develop to meet economic and social needs. They can be categorized based on the functional characteristics of settlements relative to the labor force and economic criteria, such as industrial cities, port cities, recreational and tourist cities, university cities, and tourist destinations.

Cities are defined by the continuous evolution of their general characteristics. While there are myriad definitions, a city can be summarized as "the environment where human action transforms into culture." It is the structural environment where people sustain their shared lives, the essence of communal existence, and the cocoon of life.

According to Hatt and Reiss (2002), cities began to emerge around 6000 BC and fully revealed themselves by 4000 BC. The first cities were small due to low agricultural output and high transportation costs. As agriculture developed, populations congregated, and technological factors such as railway systems were improved, cities began to grow. In addition to these effects, the development of cities, mainly observed in Western Europe, was characterized by functional specialization in production within a society that became reliant

on efficiency. This indicates that cities began to specialize more in economic activities than trade and transportation. Industry and commerce were developed as fundamental functions in many cities during the medieval period, transforming these cities into workshops.

Cities have grown organically since their inception. Economic developments have brought about socio-cultural structuring and diversity, leading to the creation of various urban spaces. In continuously growing and changing cities, interventions made in urban areas have been shaped by the conditions brought by time and technology. The chronological developments of the Burdur city center, based on the research conducted, are outlined below.

#### **Early Cities (6000 BC - 3000 BC);**

- Agricultural Production
- Trade and Barter
- Small Settlements and Related Communities
- Small Cities Established in Fertile Lands, Near Rivers, and Water Sources, and at Important Major Road Junctions

#### **City-States (1500 BC - 5th Century);**

- Agricultural Production
- Trade and Barter
- Small Settlements and Related Communities
- Small Cities Established in Fertile Lands, Near Rivers, and Water Sources, and at Important Major Road Junctions

#### **Pre-Industrial (9th Century - 18th Century);**

- Trade
- Bourgeoisie and Subgroups
- Development in the Field of Art
- Specialization and Diversification in Professions
- The Kinship of Groups Living in Cities and the Initial Formation of Neighborhood and Community Units
- Houses within the City and Guilds Closely Associated with Them (Developing with Craftsmen and Artisans)

#### **Post-Industrial (18th Century - 19th Century);**

- Production-Oriented Industry
- Rapid Increase in Urban Population
- Coexistence of Unrelated Individuals in Cities
- Emergence of the Working Class
- Establishment of Randomly Placed Factories and Meeting the Housing Needs of Workers in Factory Surroundings
- Creation of Unplanned Settlement Areas
- Insufficiency in Transportation Systems

#### **Present Day**

- Emergence of Global Economic Systems
- Development of the Service Sector
- Increasing Poverty and Visibility of Homelessness
- Polarization of Society into High-Income Groups and the Poor
- Modern and High-Rise Buildings
- Developments and Diversity in Modern Transportation Systems

- The Prominence of Squatter Areas and Derelict Zones

Despite the preservation of the spatial structure in urban conservation areas alongside the development of cities, it is unavoidable that they will be affected by social and cultural developments.

## 2.2. Urban Conversation Areas

When preservation first emerged, religious buildings, tomb monuments, and functional buildings were primarily deemed worthy of protection. Over time, everyday structures with functional purposes, which are less monumental, have also been included in preservation efforts due to their historical significance. Preservation areas are evaluated differently as archaeological sites, natural areas, and areas of cultural importance. In urban areas, conservation sites and protected areas emerge.

**Conservation Areas:** The concept of conservation is included among the values considered worthy of protection as defined in the Law of Antiquities. This definition defines a conservation area as "where natural, man-made, or jointly produced cultural heritage assets worthy of protection are located" (Kamacı & Ömercioğlu, 2016). A conservation area is the product of various civilizations from prehistoric times to the present, reflecting the social, economic, architectural, and similar characteristics of the periods in which they lived. It includes urban and urban remnants that have been the subject of social life rich in cultural heritage or places where significant historical events have occurred, along with identified natural features that necessitate protection (Ekinici, 2009).

In the definition of conservation areas, ICOMOS (1990) noted in the agreement made at the "International Conference on the Management of Archaeological Heritage" that archaeological heritage encompasses all traces of human existence and includes all spaces that reveal all activities carried out within their time frame, including abandoned structures and all movable cultural materials related to them:

- The structure formed by the city's parcels and road networks,
- The relationship between buildings, green spaces, and vacant areas,
- The internal and external appearances of buildings are shaped by structure, style, scale, mass, construction, material, color, and decoration,
- The relationship between the city or urban area and the natural or artificial environment,
- The different functions that the city or urban area has acquired over time are included in this definition (Şahin, 2004).

**Historical Conservation Areas:** There is another definition of historical conservation areas on a European scale. According to this, areas within old towns and settlements, the historical towns and settlements themselves, or parts of them, if they reflect the urban or rural life of that settlement and possess value due to their urban, historical, architectural, artistic, ethnological, etc. characteristics, are defined as historical conservation areas (Madran & Özgönül, 2011).

**Archaeological Sites:** Archaeological sites are areas and settlements that contain all kinds of cultural heritage reflecting the social, economic, and cultural characteristics of ancient civilizations that have survived from the existence of humanity to the present day, including products found underground, on the surface, and underwater (principle decision No. 658 of the Cultural Heritage Preservation Law) (Ekinici, 2009).



Urban Sites: According to Ahunbay (2011), urban sites are streets, neighborhoods, and areas that have preserved the harmonious layout, architectural integrity, and amenities of cities. According to Şahin (2004), urban sites are defined as entities formed by the presence of structures that carry historical, archaeological, or artistic value due to their architecture, togetherness, and homogeneity:

- Centers of historically significant settlements,
- Urban complexes surrounded by walls,
- Monumental complexes, including arrangements containing various monuments, religious structures, and associated open spaces,
- Rivers and city canals where historical houses and/or monumental structures are located,
- Structures that form a whole due to their homogeneity, buildings that are products of different architectural periods, and structures that show similarities due to their functional characteristics,
- The silhouette of an old city or town,
- Organized parks and green spaces, which are designated as urban sites.

The purpose of preserving archaeological remains or the areas formed by their combination, considering their various scales and qualities, is to reveal the city's past while integrating the traces of this past with the city without disturbing it, rather enriching it, and, when necessary, redefining their roles within contemporary life (Madran & Özgönül, 2011).

Complex Sites: Complex sites are those where urban sites are considered alongside their natural environments; islands where settlements are located, along with historical cities and towns, can serve as examples of such sites (Şahin, 2004).

Conservation Areas: Conservation areas are mandatory where the preservation of immovable cultural and natural assets is necessary for safeguarding or maintaining them within historical environments. The characteristics of conservation areas and their values make them significant areas for protection. The rapid population growth and urbanization in Turkey, the phenomenon of migration from rural to urban areas, the unplanned expansion of cities, and land speculation have considerably adversely affected the housing fabric requiring preservation. Historical city centers and traditional urban fabrics located in city centers are influenced by the rapid growth of cities, increased density, and the destruction and reconstruction of high-rise buildings. Despite all efforts and legal restrictions, traditional urban fabrics gradually disappeared in some areas (Tunçer, 2004).

According to Bildiş (2006) and Ahunbay (2011), the difficulties encountered in the preservation and transmission to future generations of urban conservation areas and monumental-civil architecture examples that need protection are attributed to various issues, including the building's location, the characteristics of the ground it rests upon, errors in the initial design, the use of faulty materials and techniques, and poor craftsmanship. These issues include:

- Damage Due to Building Location: The site of the building (such as a slope or riverbed) can increase its susceptibility to climate-related impacts.
- Ground Characteristics: A low strength or non-homogeneous ground beneath a structure can cause movements within the building over time, leading to visible deterioration.
- Errors in Structural Design: Dimensional errors inherited from the original design of building load-bearing systems can cause severe damage.

- Use of Faulty Materials: Traditional architecture uses natural materials such as stone, adobe, brick, and wood. The poor quality of these materials accelerates the deterioration of the structures.
- Poor Craftsmanship and Detailing: Properly joining the components that make up the structure with suitable binding materials and techniques is crucial for their durability. Mistakes in this process can reduce the structure's lifespan and lead to deterioration.

Throughout history, the old fabrics of cities have begun to deteriorate due to the development of new technologies, and these fabrics have become incapable of providing living conditions for the people who inhabit them. Rapid population growth, migration from rural areas to cities, unplanned urban growth, and land speculation have significantly negatively affected the housing fabric that requires preservation. Historical city centers and traditional urban fabrics in city centers are affected by the rapid growth of the city, increased density, and the destruction and reconstruction of high-rise buildings. Despite all efforts and legal restrictions, traditional urban fabrics gradually disappeared in certain areas (Hatami, 2013).

### **3. BURDUR URBAN CONSERVATION AREA**

#### **3.1. History of Burdur and the Urban Conservation Area**

Between the beginning of written history for Burdur and its surroundings and the period of Seljuk domination in the region—specifically, between 2000 and 500 BC—Burdur was influenced by the civilizations of Arzava, Hittites, Phrygia, and Lydia, as well as by the periods of the Persian Empire, Roman Empire, and Byzantium. Burdur has been used as a settlement area since the Early Bronze Age, coming under the control of Pisidia, Hittites, Phrygia, and Lydia, and later under Persian administration.

Beginning in 1071, the region fell under Turkish rule, and in the 14th Century, the Hamidids principality thrived there. In 1300, Dündar Bey, the founder of the Hamidids, built the Ulu Mosque, marking the development of Burdur. Shortly thereafter, despite the Hamidids recognizing the Ilkhanids, the region was captured by Ilkhanid ruler Timurtaş. In 1344, significant architectural development occurred in this part of the city with the construction of the Muzafferiyeh Madrasah next to the Ulu Mosque by Muzafferüddin Mustafa Bey. In 1391, Yıldırım Beyazıt incorporated the Hamidids principality into Ottoman territory (Burdur Municipality, 2015).

During the Hamidids period, the Ulu Mosque was constructed in 1300, and after being destroyed by earthquakes, it was rebuilt in 1935 and 1971. Other known structures from this period include the Selimzade Mosque and Tomb (1304). There are several monumental Ottoman-era structures whose exact construction dates are unknown, but many of which were destroyed in the 1914 earthquake and later rebuilt, such as the Hıdırlık Tomb (14th-15th centuries), Tabak Bath (1523), Kayışoğlu Mosque, Taşcami (1782), Divan Baba Mosque (1775), and Şeyh Sinan Mosque (1776). The clock tower, built in the 19th Century, was destroyed in an earthquake and reconstructed in its current location in 1944.

The urban conservation area is paramount and remains central to the district, which began around the Ulu Mosque and Clock Tower, the city's first settlement areas. It has been designated as an urban conservation area. The surrounding residential fabric and some commercial functions, formed by the area encompassing Burdur Stream, Gazi Street, and Cumhuriyet Street, have been identified as a transition area (Conservation-Oriented Zoning Plan, 2009) (Figure 3.1).



**Figure 3.1** Boundaries of the Burdur Urban Conservation Area and Transition Impact Zone

The Burdur urban conservation area encompasses the commercial district and the Arasta that developed around the Ulu Mosque, which has not survived in its original form. This urban conservation area, predominantly composed of single- and double-story buildings, is surrounded by a wide transition area that possesses the characteristics of an urban conservation area with a registered building stock.

Burdur Province's historical significance stems from its prehistoric and archaeological values, monumental structures from the principalities and Ottoman period, and the historical residential fabric that survived from the late 19th Century to the first half of the 20th Century.

### 3.2. Cultural Change in the Burdur Urban Conservation Area

The traditional fabric is expanding around the Ulu Mosque and Clock Tower and becoming denser toward the south. This area is also where commercial development is most intense, with growth noted to the north and northwest. After the municipal building on Gazi Street, the commercial fabric gives way to residential structures as one moves westward.

During the Ottoman period, the residential fabric was characterized by forming neighborhoods based on religious and cultural differences and settling on slopes, resulting in predominantly sloped streets. The fabric has an organic structure that utilizes the topography, developing around structures typical of Seljuk and Ottoman elements, such as mosques, masjids, and churches (Burdur Municipality, 2015).

Between 1600 and 1900, the area around the Ulu Mosque began to expand, leading to the compact development of the city's macro form. Notable structures were built by local lords and governors in the 16th and 17th centuries, extending to the construction of Taş Oda and Baki Bey's mansions, which date back to the 18th Century.

In 1851, Burdur, designated as a district, had a population of approximately 5,000. Crafts such as carpet and rug production, leather tanning, oil production, and blacksmithing were commonly practiced, with trade units organized according to these groups.

In 1914, an earthquake and a fire damaged the urban fabric around the Ulu Mosque. After World War I, Italy occupied the city, and it began to recover during the Republic period.

During the Republic period, the commencement of railway transportation services to Burdur in 1923 initiated development surrounding the train station, directing the city's growth northward.

In 1955, the arrival of the Military Regiment in Burdur and the establishment of the Sugar Factory led to the construction of "worker housing" to meet the housing needs of the factory workers. The city maintained its compact macroform. After the 1971 earthquake, many new residential buildings were constructed, and the city began to expand along the east-west axis, with new multi-story buildings replacing the destroyed older houses. Another reason for the city's development in the east-west direction was the establishment of the Dairy Factory in 1975 and activating the Small Industrial Site (KSS) and Organized Industrial Zone (OSB) in 1979.

Due to the developments that occurred in the city between 1970 and 1990, a linear macro form showing east-west expansion was formed. Between 1990 and 2007, the city grew in the west and north directions. The density of predominantly single-story commercial shops, which consist entirely of arched and vaulted small spaces, has been preserved to this day despite new constructions (Figure 3.2). Outside the commercial center, the historical residential fabric surrounding the Ulu Mosque has developed in all directions.



**Figure 3.2** Status of the Residential Fabric within the Urban Conservation Area

The urban conservation area is primarily composed of single-story commercial structures. A small number of two—and three-story buildings were constructed for residential purposes, and the ground floors of these buildings also serve commercial functions.

Traditionally, the urban conservation area was a center where the shops of tradespeople and artisans clustered based on specific characteristics (Figure 3.3). These included hardware stores, tailors, fabric sellers, miscellaneous goods shops, jewelers,

coppersmiths, shoemakers, butchers, etc. This clustering has led to naming certain streets according to commonly practiced trades.



**Figure 3.3** Commercial Structures within the Urban Conservation Area

#### **4. CONCLUSION**

The Burdur urban conservation area has lost its character as a traditional city center. However, during the Republic's early years, it preserved its historical and cultural features with a sense of vitality (Figure 4.1). The significant change in the central function of the area can be associated with the urbanization and urban growth that occurred after the 1950s. This growth manifested itself through the construction of new modern streets and the establishment of new housing areas that met contemporary needs. There has been a continuous change in users within the urban conservation area, so cultural continuity has not been maintained. Efforts have been made to sustain the commercial and social structure suitable for the Burdur region.



**Figure 4.1** Street View of the Urban Conservation Area (1936)

In the 1950s, with the redevelopment of Cumhuriyet Square, Gazi Street, and İstasyon Street, shopping activities were directed toward these streets and areas, particularly the middle class. Although these developments have negatively affected the traditional



commercial center, some traditional activities continue in their original form, while others are being carried out alongside modern functions (Figures 4.2 and 4.3).

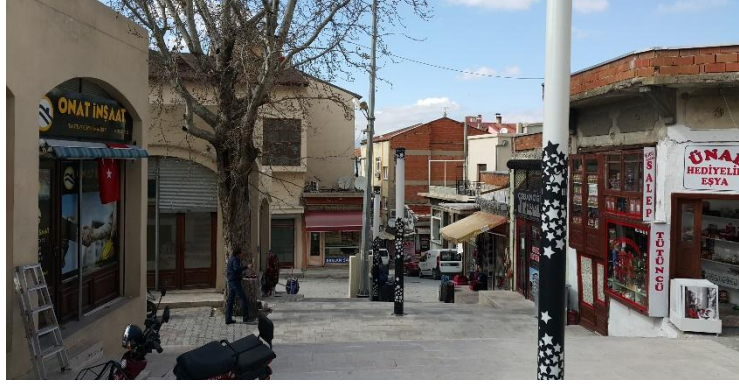


**Figure 4.2** Gazi Caddesi Street View (1967)



**Figure 4.3** Gazi Caddesi Street View (2016)

The development of Burdur city center, along with the urban conservation area and the modern urban development process, has produced conditions that are also socio-culturally distinct from the city center. Due to the active fault line passing through the urban conservation area, an important historical site, it has continuously experienced migrations. In the early days of settlement, high-income groups engaged in different cultures and trades resided in the area. Over time, the urban conservation area, which functioned as a city center, has been continuously reconstructed due to the earthquakes. Furthermore, modern developments have led low-income groups to choose locations within the conservation area as the quality of urban residential areas was inadequate to meet their needs. The urban conservation area located in the center of Burdur aims to enhance its commercial center status and to structure the tourism sector through the implemented Conservation-Oriented Zoning Plans (Figure 4.3).



**Figure 4.3** Areas Developed for Commercial Structures within the Urban Conservation Area

Due to the constantly changing users, the urban conservation area has been unable to preserve its cultural and structural characteristics fully; today, it is perceived merely as a historical site. Spaces culturally meaningful to former users are now being utilized for different purposes, leading to their degradation.

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# Similar Approaches to Woman in Talmud and Hadith Narratives

## *Talmud ve Hadis Rivayetlerinde Kadına Dair Benzer Yaklaşımlar*

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### ABSTRACT

We know that the oral religious tradition, both in Jewish and Muslim societies, has taken its place immediately after the Holy Books as the primary sources for interpreting revelation. In practice, the narrations in these sources have mostly found a solid place in the religious tradition without the need to question their accuracy. When we look at the narratives on women in particular, we see that - despite the unity of essence in the creation of man in the Quran and In the Holy Bible, despite the unity of purpose in the creation of man, we see that women are repositioned in the background, not from the perspective of the Creator, but from the perspective of men. Here, we present a comparative study aimed at correctly understanding the fundamental sources of religion that make humanbeing, women and men, responsible for the construction of a good world together.

**Keywords:** woman, religious tradition, Talmud, Hadith

### ÖZET

Sözlü dinî geleneğin gerek Yahudi gerek Müslüman toplumlar içerisinde, vahyin yorumlandığı temel kaynaklar olarak Kutsal Kitapların hemen ardından yerini aldığını biliriz. Uygulamada ise çoğunlukla bu kaynaklardaki rivayetler, doğruluğu sorgulanmaya ihtiyaç duyulmadan dinî gelenek içinde kendisine sağlam bir yer bulmuştur. Bunların içerisinde özellikle kadın konusundaki anlatımlara bakıldığında -Kur'an'da insanın yaratılışındaki öz birliğine ve Kutsal Kitapta insanın dünyaya indirilişteki amaç birliğine rağmen- kadının Yaraticının değil de erkeğin gözünden adeta yeniden ve geri planda konumlandırıldığını görürüz. Burada, İnsanı kadın ve erkek birlikte iyi bir dünyanın inşasında me'mur kılan dinin temel kaynaklarını doğru anlamaya yönelik karşılaştırmalı bir çalışma sunuyoruz.

**Anahtar Kelimeler:** Kadın, Dini Gelenek, Talmud, Hadis

### Giriş

Dünyada ve ülkemizde her gün şiddetin her türünün örneklerine tanıklık ettiğimiz ve insan haklarına dair söylemlere, cinsiyete dayalı ve diğer her türlü ayrımcılığın son bulmasına dair farkındalık oluşturmak için yapılan çalışmalara tezat bir kararlılıkla şiddetin dozunun arttığını üzülen bir gözle izlediğimiz bir gündemimiz mevcut. Araştırma alanımızı



ilgilendirdiği için dinlerde kadınla ilgili, İlahî dinlerde ve özeldede Yahudilik ve İslam'da kadınla ilgili çeşitli çalışmalar yaptık ve bu sempozyum gibi vesilelerle konuyu gündemde tutmaya devam ediyoruz.

Halk dinî geleneğinin kadına yaklaşımında yer alan birçoğu olumsuz söylemde dayanak noktası olarak kabul edilen "dinî kökenli" anlatılara baktığımızda dinin ana kaynağına dayalı bir temeli bulunmadığını, kaynağın yorumlanmasından ve bu yorumlarda önceki dinî geleneklerin büyük ölçüdeki etkilerinden kaynaklandığını görmekteyiz. Özellikle söz konusu kadın olduğunda dinî kaynaklarda hurafelerin çoğunlukta olduğu yanlış bir din algısının egemen olduğunu söyleyebiliriz.<sup>1</sup> Bu durumda bildirimize konu olan iki İlahî dinin sözlü yorum geleneğinin ürünleri olan Talmud ve Hadis külliyatında kadına yönelik ikincil, kısıtlayıcı, aklı ve dinî açıdan eksik ve dolayısıyla daima erkeğin egemenliğinde kendisine bir varlık alanı ve kimlik tanıyan bazı rivayetlerin, toplumda kadın algısına nasıl bir zemin hazırladığını göz önünde bulundurarak bir değerlendirmesini yapmaya ve Kur'an ve Tevrat'ta konuya esas teşkil edecek pasajların referansı ile izahlarda bulunmaya gayret edeceğiz.

### Sözlü Tevrat (Talmud)

İlahî dinlerin ilki olarak Yahudiliğin özellikle Ortodoks Yahudiliğin üzerinde şekillendiği Talmud ve Rabbanî gelenekten kısaca söz etmek gerekir. Süleyman Mabedi'nin M.Ö. 586 ve M.70 yıllarında iki kez yıkılması ve Yahudilerin önce Babil'e ve son yıkımda 1948'de bir devlet kurana kadar Filistin topraklarından sürgün edilmesiyle dünyanın dört bir yanına dağılarak bir diaspora sürecine girmişlerdir. Mabet etrafında merkezleşen bir dinin mensupları olarak artık mabedin ve dolayısıyla onun içinde ve çevresinde gerçekleştirilen ibadetlerin yapılamayacağı bir durumda kalmak yüzyıllardır şifahî olarak sürdürülen dinî yorumların kayıt altına alınmasını, dünyanın her yerindeki Yahudi topluluklara ulaştırılarak Yahudi şeriatının gereklerini buldukları yerlerde muhafaza etmelerini sağlamak üzere zorunlu hale getirmiştir. Sözlü Tora (Tevrat) olarak nitelendirilmiş olması bile Talmud'un Yahudi dinî literatüründe ve geleneğindeki önemli yerini göstermektedir.<sup>2</sup>

### Talmud'da Kadına Dair

Prof. Dr. Liliana Vana<sup>3</sup>'nın Türkçe'ye de çevrilmiş olan *Yahudilik'te Kadın* adlı kitabında Tora döneminde ve antikitede kadınların sahip olduğu haklar ve özgürlük alanlarının daha sonra dinî gerekçelerle ortadan kaldırılarak kısıtlamalar getirildiği konular yer almakta ve kadınların haklarının korunmasına yönelik şerî kurallara rağmen uygulamada bunların yok sayılmasının örnekleri sergilenmektedir.

Bunların ilki kutsal kitap kaynaklı olmayan bir hukukî pozisyonla ilgili olarak mülkiyetin yönetimi konusunda kadınların hak sahibi olmalarına dair kuralları ve uygulamaları içermektedir. Antikitede Yahudi kadınların mülkiyeti idare etmek üzere hak sahibi olduğu örnekleri zikreden yazar, bazen de koca tarafından karısı miras mahrumiyeti yaşamamasın diye vasiyetle bunu tayin ettiğini dile getirmiştir. Zira kadın, Yahudi hukukuna göre kocasına mirasçı olamamakta ve kız çocuk da erkek kardeşler olması durumunda baba

<sup>1</sup> Cihangir, 2016, s.7

<sup>2</sup> Babil (Bavli) ve Kudüs (Yeruşalmi) Talmudu olarak iki önemli Talmud mevcuttur. Ortodoks Yahudilik, kutsal metnin açıklamalarını içeren sözlü vahiy olan Talmud'un da yazılı vahiy olan Tora ile birlikte Musa peygambere Tur dağında Tanrı tarafından verildiğini kabul etmektedir.

<sup>3</sup> Paris Sorbonne Üniversitesi Doğu Dilleri Bölümü profesörü olarak görev yapmış olan Liliana Vana, *Yahudilik'te Kadın* adlı Fransızca kitabı Selçuk Üniversitesi İlahiyat Fakültesi Dinler Tarihi A.B.D. Prof. Dr. Mehmet Aydın tarafından Türkçe'ye çevrilmiştir.

mirasından pay alamamaktadır. Ancak bugün anayasal olarak hak sahibi olmalarının önünde engel bulunmamaktadır.

İkincisi dinî görevlerde kadının eksikliği konusudur ki yazarın da dikkat çektiği üzere dünya üzerinde Ortodoks akımların genelinde gözlemlenen bir durumdur. Başlıca örneklerinden birisi minyan (on kişiden oluşan yetişkin erkek) adı verilen, toplu ibadet için gerekli olan cemaat içerisinde yer alamamaktadır. Bir erkeğin eksik olması halinde ibadet için toplanan onlarca kadın olması bir şey ifade etmemekte ve toplu okuma veya ibadet gerçekleşmemektedir. Sinagoglarda kadınların bulunduğu tamamen ayrılmış bölmeler ibadeti takip etmelerini zorlaştıran ve yazarın deyimiyle onları bu haktan mahrum eden küçük düşürücü uygulamalardandır. Bu konuyla ilgili olarak *Ağlama Duvarı Kadınları* başlıklı bir çalışmamız bulunuyor. 1980'lerde Kudüs'te bir grup Yahudi kadının bir araya gelerek Ağlama Duvarı'nda erkeklerin yaptığı gibi Ortodoks inancına ve uygulamalarına göre hem dua giysi ve aksesuarlarını kullanarak hem de yüksek sesle ibadete katılmak için başlattıkları bir harekettir. Oysa kadınlar orada kendilerine ayrılmış alanda sessizce ve bireysel olarak Tora okuyabilir ve dua edebilir. Uzun yıllar süren hukuki, siyasi mücadeleler neticesinde seslerini duyurmuşlar ve her ayın ilk günü Kotel ha Maaravi'de (Ağlama Duvarı) toplanarak ibadet etmektedirler. Reformist ve Muhafazakar akımlar içerisinde kadınlara yönelik bu kısıtlayıcı kurallar kabul edilmemekte, kadınlar hahamlık görevini dahi icra edebilmektedir. Ancak buradaki feminist hareketin Ortodoks Yahudilik içerisinden çıkmış olması onu farklı bir yere koymaktadır. Hareketin karşılaştığı tepkiler de en çok Ortodoks ve Ultra Ortodoks çevrelerden ve özellikle de bu çevrelerin kadınlarından gelmekte olduğu ifade edilmektedir.

Günümüzde İsrail'de başta evlilik ve boşanma konuları olmak üzere Talmud'a dayalı dinî kuralların uygulamada olduğunu görmekteyiz.<sup>4</sup>

Kadının dinî eğitim görmesi konusunda da Talmud yasalarında hahamların olumsuz görüşlerine rastlamaktayız. Kadının aslı görevi ev içerisinde koca, çocuklar ve ev işleri ekseninde belirlenmiş olduğundan fazladan din tahsiline de gerek yoktur hatta caiz olmadığı belirtilmiştir.<sup>5</sup>

Üçüncü olarak nişanlanma ve evlenme konularındaki ergenlik yaşı, küçük yaşta ebeveynleri tarafından evlendirilmeye dair hususlar, evlilik akdinde kayıt altına alınan hususlar ve tek ya da çok eşlilik konularında uygulamalara dair örnekler ve açıklamalar yer almaktadır.

Bu konuda dikkat çeken bazı uygulamalar şöyledir: Bakire kızın tecavüzcüsüyle evlendirilmesi gereği<sup>6</sup>, boşama yetkisinin sadece erkeğin elinde bulunması,<sup>7</sup> kocası ölen kadının kocasının erkek kardeşiyle evlenmesi zorunluluğu<sup>8</sup>, sadakatinden şüphelenilen kadın için uygulanan sota adı verilen bir acı su içirme ritüeli vb. bunlar arasındadır.

### Hadis Rivayetlerinde Kadına Dair

Hadis rivayetleri içinde de kadınla ilgili olarak kaburga kemiğinden alınarak yaratılması dolayısıyla düzeltilmeyecek bir eğriliği olduğu, akıl ve din yönünden eksikliği<sup>9</sup>, uğursuz sayıldığı, regl ve lohusalık dönemlerinde kirli kabul edildiği, cehennemin çoğunu

<sup>4</sup> Cebe, 2020, s.222

<sup>5</sup> Doğan, 2023, s.216

<sup>6</sup> Delaletül Hairin, s.601-602

<sup>7</sup> Gürkan, 2008, s.176

<sup>8</sup> Delaletül Hairin, s.602

<sup>9</sup> Şahitlik konusunda bir erkeğe karşılık iki kadın bulunması şartı akıl yönünden eksiklik olarak, regl döneminde bazı ibadetlerden muafiyeti de din bakımından eksiklik olarak görülmüştür.

kadınların oluşturduğu bunun da kocasına itaatsizlik, nankörlük gibi özellikleri sebebiyle olduğu vb. olumsuz ifadeler bulunmaktadır.<sup>10</sup> Neredeyse tamamı (peygamberin sadece kadın topluluğa hitapta bulunduğu ifade edilenlerde bile) erkeklerden aktarılan ve sağlam bir kaynaktan gelmeyen bu rivayetler zaman zaman kendileriyle çelişen tam zıddını ifade eden bir şekliyle de karşımıza çıkabiliyor. Örneğin Allah elçisinin eşi Aişe'den aktarılan bir rivayette, peygamber namaz kılarken kendisinin onun karşısında uzanıyor olduğu ifadesi var. Ancak namaz kılarken önünden köpek, eşek ve kadın geçtiği takdirde namazın bozulacağına dair hadis olarak yer verilen anlatımlar da mevcuttur. Bu rivayetin hemen aynısını Talmud'da da görüyoruz.

### Kutsal Metinlerde Kadın ve Yaratılış Bahsi

Kadın konusunda her iki dinî geleneğin kadını günaha teşvik eden, erkeğe göre eksik, kusurlu vb. yaklaşımlarının referans noktasının Tevrat'ın Yaratılış bahsinde insanın yaratılışının erkek ve kadın olarak uzanıyor görünmektedir. Esasında Yaratılış bölümünde iki ayrı pasajda konunun iki farklı versiyonuna rastlıyoruz.

Tanrı, "Görünümümüzde ve benzeyişimizde insan yapalım. Deniz balıklarına, gökyüzünün kuşlarına, çiftlik hayvanlarına ve tüm yeryüzüne hükümlerin" dedi. Tanrı adamı Kendi görüntüsünde erkek ve dişi olarak yarattı. Tanrı onları mübarek kıldı.<sup>11</sup>

Tanrı, "Adamın yalnız olması iyi değil. Ona, kendisine uygun bir yardımcı yapayım" dedi.... Tanrı, adamdan aldığı kaburga kemiğini bir kadın şeklinde inşa etti ve onu adama getirdi. Adam "Şimdi bu, kanım ve canımdır. İsmi kadın (İşa) olsun; çünkü adamdan (İş) alındı" dedi.<sup>12</sup>

Alıntısını yaptığımız pasajlarda görüldüğü üzere birinci kısımda insanın erkek ve kadın olarak Tanrı suretinde, varoluş amacına hizmet etmek üzere yaratılması ve ikisinin birlikte kutsanması ifadeleri yer almaktadır. İkinci pasajda ise erkeğin yalnız kalmasının iyi olmaması nedeniyle erkeğe bir yardımcı olarak, onun kaburga kemiğinden kadının inşa edilmiş olmasından bahsedilmektedir. Ortaçağ meşhur Yahudi filozof ve teologlarından Maimonides (ö.1204) More Nevuhim adlı eserinde, hahamların kadının Âdem'in kaburga kemiğinden yaratılmasıyla ve işlenen ilk günahla ilgili olarak açıklamalarında şu bilgiler yer almaktadır: İlk olarak Âdem ve Havva'nın birlikte yaratıldığı, sırtlarının bitişik olduğu, daha sonra bunların ayrılmasıyla yarısından Havva'nın meydana geldiği belirtilmiştir. Hahamlara göre kaburga kemiği ifadesi Âdem'in bir parçası ya da bir yanı olarak anlaşılması gerekir. Nitekim Âdem de "benim kemiklerimden bir kemik, etimden bir et"<sup>13</sup> demiş ve erkek ve kadın için aynı kökten olan İş ve İşa kelimeleri kullanılmıştır.<sup>14</sup> Burada Maimonides'in dile getirdiği önemli bir konu da şeytanın Âdem ile hiçbir şekilde muhatap olmadığı buradaki diyalogun şeytan ve Havva arasında geçtiğidir. Havva'nın aracılığı ile yılan Âdem'e eziyet etmiştir.<sup>15</sup> Ve nitekim Havva'nın nesli ile yılanın soyu arasındaki ilişkide baş ve topuk ifadelerinin önemi zikredilmiştir. Kutsal Kitap'taki ifadeye göre, bundan sonra bu iki soy birbirine düşman olacak, kadın yılanın başını ezecek, yılan da onun topuğuna saldıracaktır.<sup>16</sup>

Kutsal Kitap'ta bazı peygamber eşleri başta olmak üzere örnek kişiliği ile ön plana çıkan -hatta peygamber olduğuna inanılan- Sarah, Rivka, Rachel, Purim gibi kadınlardan

<sup>10</sup> Hidayet Şefkatli Tuksal'ın *Kadın Karşıtı Söylemin İslam Geleneğindeki İzdüşümleri adlı kitabında* konuyla ilgili rivayetler ayrıntılı olarak ele alınıp değerlendirilme tabii tutulmuştur.

<sup>11</sup> Yaratılış, 1:26-28

<sup>12</sup> Yaratılış, 2:18-23

<sup>13</sup> Yaratılış, 2:23

<sup>14</sup> Maimonides, s.351

<sup>15</sup> Maimonides, s.352

<sup>16</sup> Yaratılış, 3:15

bahsedilir. Talmud'da da bilge kadınlardan ve hikayelerinden bahsedilir. Kur'an'da İsa Mesih'in annesi Meryem ve Firavun'un karısı övgüyle bahsedilen örnek kadınlardır. İlk dönemin önemli kadın isimlerinin -başta peygamber eşleri olmak üzere- toplumsal yaşamda örnek ve öncü rol aldıklarını konu alan yayınlar yapılmıştır.<sup>17</sup>

Kur'an'da insanın tek bir özden erkek ve kadın olarak yaratılmış olduğu belirtilmektedir. "Ey insanlar! Sizi bir tek nefisten yaratan, ondan eşini var eden, bu ikisinden de birçok erkekler ve kadınlar üretilen Rabbinize karşı gelmekten sakının."<sup>18</sup> "Allah, sizi başlangıçta tek bir nefisten yarattı ve kendisiyle ünsiyet edip gönül huzuru bulacağı eşini de aynı cins ve mâhiyetten var etti."<sup>19</sup>

Cennetten çıkarılmaya giden süreç ve sonrasında her iki cinsin birlikte muhatap alındığı, hatalarının farkına vardıklarında yine ikisinin ağzından "nefislerine zulmettiklerini itiraf ettikleri ve bağışlanma diledikleri" belirtilmiştir. Cennetten çıkarken "birbirinize düşman olarak oradan inin"<sup>20</sup> ifadesinde karşı karşıya getirilenin insan ve şeytan olduğu Kur'an'ın genel perspektifinden de açıkça anlaşılmaktadır. Ayrıca kadın olsun erkek olsun iyilik olarak ne yaparlarsa kendilerine kazanç olarak döneceği ve üstünlüğün de sadece Yaradan'a karşı "sorumluluk bilinci" olarak doğru ifadesini bulan takvaya bağlı olduğu açıkça ifade edilmiştir.

## Sonuç

Talmud ve Hadislerde yer alan, -bir kısmına bildiri metninde yer verdiğimiz- olumsuz ifadeler bu külliyatların derlendiği ve yazıya geçirildiği tarihsel ve sosyokültürel bağlamın yansımalarıdır. Gerek Yahudi gerek Müslüman toplumlarda kadınların statüsü bu metinlerde genellikle ataerkil bir düzen içinde konumlandırılmıştır. Feminist teolog olarak nitelendirilen bazı yazarlar bu ifadelerin o döneme ait normları güçlendirme amaçlı olduğunu ancak günümüzde kapsayıcı ve eşitlikçi bir bakış açısıyla yeniden yorumlanmaya ihtiyaç duyduğunu belirtmektedir. Aynı zamanda bu olumsuz ifadelerin her zaman sadece dinî bir öğreti değil dönemin sosyal kontrol mekanizmalarının da yansıması olduğunu belirtmişlerdir.

İnsanın bilgelikle ve onurlu bir amaca yönelik var edildiği, cinsiyet ve yaradılıştan getirilen herhangi bir özelliği dolayısıyla ayrımcılığa tabi tutulması, aşağılanması, şeytanın yanlış bir kıyasla kendini üstün görerek yaşadığı lanete ortak olmaya götürecek bir özelliktir.

Cinsiyet, Tanrı ayetlerindedir. Ve Tanrı, ayetleri üzerinde derin düşünmeye davet eder. Sürekli sevgi ve şefkatine atıfta bulunduğumuz Yaratıcı, kendisiyle bağ kurmaya ve yaratılmışlarla bu kutsal bağ üzerinden ilişki kurmaya çağırır.

Her iki inancın temel prensibi dünyanın ıslahıdır, iyileştirilmesidir. Bu amacı gerçekleştirmek kendi anlayışımızı ve iç dünyamızı iyileştirmekle başlayacak ve mümkün olacaktır. Kadın ve erkek, birey ve toplum olarak bu sorumluluk bilincini taşıyan bir örneklik sergilemek temennisiyle...

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# A Qualitative Evaluation on the Historical Development of Local Governments in Turkey

## *Türkiye'de Yerel Yönetimlerin Tarihsel Gelişimi Üzerine Nitel Bir Değerlendirme\**

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### ABSTRACT

Local governments are administrative units that operate within the framework of the principle of autonomy, emphasizing the participation of local populations in the planning and execution of public services at the local level. The historical development of local governments in Turkey has been shaped by political and social transformations, undergoing restructuring in response to changing needs and reforms from the Ottoman era to the Republic. This study examines the historical transformations experienced by local governments in Turkey from the Ottoman period to the present, based on institutional and legal frameworks. The research associates the formation process of local governments with the administrative reforms initiated during the reign of Mahmud II and focuses on the emergence of provincial special administrations (il özel idareleri) and municipal practices during the Tanzimat Era. The centralized administrative approach of the early Republican period is analyzed within the context of the 1930 Municipal Law, discussing the strict control of local government bodies and their decisions by the central administration. Furthermore, the 1982 Constitution, which created a hybrid structure combining central and local governance elements in Turkey, is evaluated in terms of its impact on the modernization of local government units. This study employs a qualitative methodology, drawing on historical documents, constitutional regulations, and local government legislation to analyze the institutional structures, functions, and relationships of local governments with the central administration. The findings reveal that local governments have demonstrated dynamic development throughout their historical evolution, directly influenced by the participation of local populations in governance and the level of autonomy of local units. Particularly, the roles of provincial special administrations and municipalities in this historical process are examined in detail as the fundamental building blocks of local governance.

**Keywords:** history of administration, central government, Türkiye, local governments, decentralization

### ÖZET

Yerel yönetimler, yerel düzeyde kamu hizmetlerinin planlanması ve yürütülmesinde yerel halkın katılımını esas alan, özerklik ilkesi çerçevesinde faaliyet gösteren yönetim birimleridir.

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Türkiye’de yerel yönetimlerin tarihsel gelişimi, siyasi ve toplumsal dönüşümlerle şekillenmiş; Osmanlı’dan Cumhuriyet’e uzanan süreçte, değişen ihtiyaçlar ve reformlar doğrultusunda yeniden yapılandırılmıştır. Bu çalışmada, Türkiye’de yerel yönetimlerin Osmanlı’dan günümüze kadar yaşadığı tarihsel dönüşümler, kurumsal ve hukuki çerçeveye dayalı olarak incelenmiştir. Araştırma, yerel yönetimlerin oluşum sürecini, II. Mahmud Dönemi’nde başlatılan idari reformlarla ilişkilendirmekte ve Tanzimat Dönemi’nde ortaya çıkan il özel idareleri ile belediyecilik uygulamalarını merkeze almaktadır. Cumhuriyet’in ilk yıllarındaki merkezîyetçi yönetim anlayışı, 1930 tarihli Belediye Yasası bağlamında ele alınarak, yerel yönetimlerin merkezi yönetim tarafından sıkı bir şekilde denetlenmesi tartışılmıştır. Ayrıca, 1982 Anayasası ile Türkiye’nin merkezi ve yerel yönetim unsurlarını birleştiren karma bir yapıya evrilmesi, yerel yönetim birimlerinin modernleşme süreci açısından değerlendirilmiştir. Bu çalışma, tarihsel belgeler, anayasal düzenlemeler ve yerel yönetim mevzuatına dayalı olarak, yerel yönetimlerin kurumsal yapılarını, işlevlerini ve merkezi yönetimle olan ilişkilerini nitel bir yöntemle analiz etmektedir. Araştırmanın bulguları, yerel yönetimlerin tarihsel süreç boyunca dinamik bir gelişim gösterdiğini ve bu gelişimlerin yerel halkın yönetime katılımı ile yerel birimlerin özerklik düzeyini doğrudan etkilediğini ortaya koymaktadır. Özellikle il özel idareleri ve belediyelerin tarihsel süreçteki rolleri, yerel yönetimlerin temel yapı taşları olarak detaylı bir şekilde ele alınmıştır.

**Anahtar Kelimeler:** İdare Tarihi, Merkezi Yönetim, Türkiye, Yerel Yönetimler, Yerinden Yönetim

## 1. Giriş

Yerel yönetimler, bir ülkede yaşayan bireylerin, müşterek ve yerel düzeydeki ihtiyaçlarını gidermek amacıyla oluşan anayasal kuruluşlardır. Başlıca görevleri merkezin ulaştırmakta zorlandığı hizmetlerin ayrı bir mal varlığı ve bütçeye sahip kurumlar tarafından yürütülmesidir. Yalnızca bir hizmet kuruluşu olmayıp ayrı bir tüzel kişiliği, idari ve mali özerkliği olan, demokratik ve siyasi birer kurum olarak da rollere sahiptirler. Organları, bir iradeyle karar alıp bunu hayata geçirmektedirler. Karar ve yürütme organı olmak üzere en az iki tane temel organları vardır. Ülkemizdeki temel yerel yönetim organları; il özel idaresi, belediye, büyükşehir belediyesi ve köylerdir. Türkiye’de yerel yönetimlerle ilgili ilk gelişmeler Tanzimat Dönemi’nden sonra gerçekleşmiştir. Bu anlamda o dönemden beri her geçen gün gelişmelerini devam ettirmektedirler. Yaşanan değişimler, denetimlerin de önemini koruyacağı göstermektedir.

Yerel yönetimler, milli sınırlar içinde farklı boyutlara sahip topluluklarda yaşayan bireylerin, müşterek ve yerel nitelikteki ihtiyaçların karşılanması için kurulan ve hukuki çerçevede oluşturulmuş anayasal kuruluşlar olarak tanımlanabilirler. Görevleri, merkezin üstlenmediği veya ulaştıramadığı bazı kamu hizmetlerinin özerk faaliyet gösteren, ayrı bir mal varlığı ve bütçesi olan kurumlar tarafından yürütülmesi ve kendi organlarıyla hizmetlerini devam ettirmeleridir (Güneş, 1996: 83; TMMOB Demokrasi Kurultayı, 1998; Varcan, Taraktaş & Hacıköylü, 2013: 3). Bir başka ifadeyle yerel yönetimler; bölge halkının ihtiyaçlarının yüksek düzeyde karşılanması için yerel topluma kamu hizmeti sağlamak ve bu alanda yaşamını sürdüren toplumun kendi seçtiği birimler tarafından yönetilen; toplumsal, siyasal ve yönetsel kurumlar olarak bilinmektedirler (Alhas, 2015: 11). Ülkelerin; tarihi, sosyal ve kültürel yapıları, ekonomik olanak ve araçları, siyasi kültürleri, yerel yönetimlerin yapısını ve çalışmalarını etkilemektedir. Adil bir yapıya sahip ülkelerde yerel yönetimler, diğerlerine oranla çok daha işlevsel niteliklere sahiptirler (Toprak, 2014: 21).

Yerel yönetimler; politik, sosyal ve ekonomik büyümede ve düzenin en önemli aktörleri arasında sayılmaktadırlar. Birçok ülke merkezi yönetimleri güçlü ve küreselleşen dünya ile rekabet edebilir hale getirerek yereldeki avantajlarını en iyi şekilde

kullanılmaktadır. Daha güçlü ve etkili bir şekilde bütün yerel faaliyetlerin bilgiye dayalı bir şekilde yürütülmesi, vatandaşların talep ve beklentilerini doğru saptamayı bunları daima göz önünde bulundurmaya gerektirmektedir (Özaslan & Banazılı, 2024: 862). Günümüzde bütün vatandaşların yerel karar alma süreçlerine katılıp, yerel sorunların çözümünde söz sahibi olan, yönetsel uygulamaları denetleyen, daha yaşanabilir ve sürdürülebilir bir kent için katkı sunan ve kentsel yaşam kalitesine ilişkin standartların yükseltilmesi için sorumluluk üstlenen bir role sahip olmaları beklenmektedir. Dolayısıyla günümüzde; şeffaf, katılımcı ve hesap verebilir kurumların oluşması gerektiği anlaşılmaktadır. Bunun yolu olarak da yerel yönetimlerin aktif, akılcı ve modern denetim ilkelerinin hayata geçirilmesidir (Kara & Karakılçık, 2016: 728). Böylece istenilen hedeflere ulaşılabilir. En büyük görev devlete ve devletin ilgili birimlerinde görevli memurlara düşse de ilgililerin birlikte hareket etmeleri, olumlu sonuçlar elde edilmesini sağlayabilir.

Bu çalışmada, Türkiye’de yerel yönetimlerin tarihsel gelişimi üzerine nitel bir değerlendirmede bulunmak amaçlanmaktadır. Bu nedenle Türkiye’deki yerel yönetimlerin tarihsel gelişimi, siyasi ve toplumsal dönüşümlerle birlikte verilmiştir. Ayrıca Osmanlı’dan Cumhuriyet’e, Cumhuriyet’ten günümüze uzanan süreçte, değişen ihtiyaçlar ve reformlar doğrultusunda yerinden yönetimlerin yeniden yapılanması, tarihsel dönüşümler, kurumsal ve hukuki çerçeveye dayalı olarak incelenmiştir.

## 2. Tanzimat Öncesinden Cumhuriyet’e Yerel Yönetimler

Tanzimat Dönemi, Batı’da yaşanan gelişmelerin Osmanlı Devleti’ne yansımalarıyla gelişen bir dönem olarak ifade edilebilir. Bu dönemde, bir modernleşme ve yenileşme hareketliliği yaşanmıştır. Sürecin 1839 tarihi ile sınırlandırılması da mümkün görünmemektedir. Çünkü sosyal olgularla ilgili net bir tarih vermek doğru bir bakış açısı olarak kabul görmemektedir. Gerek Lale Devri’nde gerekse daha önceki süreçte yaşananlar bu dönemin ortaya çıkmasında önemli bir alt yapı olarak kabul edilebilir. Dolayısıyla birçok konuda olduğu gibi yerel yönetimlerle ilgili olarak da Tanzimat öncesi dönemde yaşanan gelişmelerin sonraki süreçte yaşanan gelişmelere kaynaklık ettiği anlaşılmaktadır. Bu anlamda en fazla yenilik yapan padişahlardan biri olan II. Mahmud iktisadi, askeri, idari, hukuki, eğitim ve sosyal alanlarda birçok yenilik yapmıştır. Süme (2022: 94) tarafından yapılan çalışmada, Osmanlı’da muhtarlık teşkilatının II. Mahmut tarafından kurulduğu ve 1850’li yıllara kadar köy veya mahalle idaresinin imamlar tarafından yürütüldüğü tespit edilmiştir. Muhtarlık teşkilatı ilk kez 1829 yılında İstanbul’da kurulmuş ancak eyaletteki ilk uygulaması Kastamonu Sancağında Mutasarrıf Dede Mustafa Ağa tarafından İstanbul’daki örneklerinden yola çıkılarak 1833 yılında uygulamaya konulmuştur. Dede Mustafa Ağa yapılan çalışmaları ve elde edilen sonuçları belgelendirerek İstanbul’daki merkez ofise sunmuş, dönemin hükümdarı Sultan II. Mahmud ise yapılan çalışmalardan memnun kalarak muhtarlık teşkilatının vilayetlerde kurulmasını emretmiştir.

Tanzimat öncesi dönemde, dönemin ihtiyaçları gereği Osmanlı yönetim anlayışında bazı gelişmeler yaşanmıştır. Ancak bu gelişmeler, yerel yönetimlerin varlığıyla ilgili net bilgiler vermese de o dönemde yaşanan değişim ve gelişmeleri anlamak açısından önem arz etmektedir. Dolayısıyla yaşanan gelişmelerin yerel yönetimlerin oluşumunda önemli bir etkisinin olduğu söylenebilir. Tanzimat öncesi dönemde yerel hizmetler için gerekli olan kurum ve teşkilatlar; kadılık kurumu, vakıf kurumu, mahalle teşkilatı ve lonca teşkilatı olarak bilinmektedir. Kadılık kurumu, şehirdeki belediye hizmetlerini gerçekleştiren bir kurumken; vakıf kurumu eğitim, sağlık, dini, sosyal ve kültürel hayat ile bayındırlık ve şehircilik gibi hizmetlerin verildiği yerlerdir. Osmanlı’da mahalle teşkilatı çok fonksiyonlu bir oluşum olup her mahallenin yerleşimi ve fonksiyonu kendine özgü bir şekilde



düzenlenmiştir. Lonca teşkilatı ise, yerel kamu hizmeti veren ve halkın yönetimde söz sahibi olduğu bir kurum olarak öne çıkmaktadır (Akyol, 2012: 21-22).

Tanzimat öncesi dönem, Osmanlı yönetiminde dağılma ve yıkılışa neden olan olayların yaşandığı ve mevcut durumdan kurtulmak için yenilik çabalarının hız kazandığı bir dönem olarak ifade edilmektedir. Dolayısıyla Tanzimat Dönemi, modernleşme ve yeniliğin öncüsü olarak kabul edilmektedir. Tanzimatla birlikte, bütün alanlarda oluşan batılılaşma ve yenilik çabaları genelde devlet yönetimi ve yerel yönetim alanlarında kendini belli etmektedir. Batı ile olan ilişkilerde artış yaşanırken, Batılı kurum ve prensiplerin Osmanlı yönetim anlayışına alınmasına yönelik adımlarda da hızlı bir gelişme görülmektedir. Osmanlı'nın son dönemlerinde Batı anlayışına uygun yerel yönetim birimlerinin oluşmasına yönelik gelişmeler gözlemlenmektedir. Ülkenin siyasal durumu, azınlıklar ve Batı ile olan ilişkiler mevcut durumu açıkça ortaya koymaktadır (Karakılıç, 2020: 45).

Belediye adı; Fransa'da "*municipalite*", İngiltere'de "*municipality*" ve Osmanlı'da ise "*şehremaneti*" şeklinde karşılık bulmaktadır. 1876 tarihli Kanunu Esasi'nin ilan edilişi, Birinci Meşrutiyet'in başlarına denk gelmektedir. Kanunu Esasi'de yapılan düzenlemelerde yerel yönetimlerle alakalı hükümler bulunmaktadır. Bu yasanın 112. maddesinde "*yerel hizmetlerin Dersaadet ve taşrada belediye meclisleri tarafından yürütülmesinin esas olduğu*" ibaresi yer almıştır. Bununla birlikte Meclisi Mebusanın ilk çıkardığı kanunlardan biri de "Dersaadet Belediye Kanunu" olmuştur. O dönemlerde İstanbul başta olmak üzere taşra bölgelerinde ihtiyaçlara uygun olarak belediye kanunlarının oluşturulması kararlaştırılmıştır. İstanbul için "Dersaadet Belediye Kanunu" düzenlenirken taşra bölgelerinde "Vilayet Belediye Kanunu" düzenlemesi gerçekleştirilmiştir (Alhas, 2015: 22).

Osmanlı'da belediyelerin mali kaynakları, personel ve belediye organlarının yetkileri kısıtlı olmuştur. Bu şekilde kurulan belediyelerin, şehir yönetimlerinde beklenen başarıyı sağlayamadığı ifade edilebilir. 19. Yüzyıl Osmanlı taşra yönetiminde, belediye organları ve vilayet yönetimi organlarının birbirleriyle bağlantılı kurumlar olduğu görülmektedir. Bağlı bulunan üyelerin toplumsal kökeni, idari ve mali ilişkiler yönünden bir bütünlük arz etmektedir. Dönemin yöneticileri belediye kurumunu, genel idare organlarına bağlı bir kurum olarak kabul etmişlerdir (Ortaylı, 1985: 32).

İl Özel İdaresi, Osmanlı Devleti'nde 19. yüzyılda şekillenen bir kurum olarak öne çıkmaktadır. İl Özel İdaresi başlangıçta 1840'tan itibaren "muhassıllık meclisleri", "büyük meclis-küçük meclis", "memleket meclisleri", "eyalet meclisi-sancak meclisi" isimleri ile uygulamaya giren yerel meclis sistemine dayanmaktadır. Bu meclislerin; şekli, toplantı süresi, üye seçimi, yetki ve görevleri 1864-1871 tarihinde düzenlenen iki farklı nizamname ile belirlenmiştir. İl özel idaresinin, 1913 yılında oluşturduğu alt yapıyı 20. yüzyılda oluşturulacak yapı için kullandığı düşünülmektedir (Özel İhtisas Komisyonu Raporu, 2014: 5).

Kanun-i Esasi'nin kabul edilmesi ile merkezi idarede sistemsel bazı değişimler meydana gelmiştir. Padişahın buyruğu üzerine yönetimde padişahla birlikte bir meclisin de görev yapacağı kabul edilmiştir. Bu meclis, padişahın atadığı Heyet-i Ayan ve seçimle göreve getirilen Heyet-i Mebusan meclisinin üyelerinden oluşturulmuştur. (Kaya, 2019: 46). Merkezi yönetim ve yerel yönetimlerin ayrımından da bahsedilen bu anayasada yerel birimlerle ilgili genel düzenlemelerin, anayasanın 108 ile 112. maddeleri arasında "Vilayet" başlığı altında verildiği görülmektedir (Güven, 2023: 20). Taşra teşkilatlanmasında *eyalet* rejiminden vazgeçilerek *vilayet* düzenine geçilmiştir. Merkezi yönetimin en büyük birimleri olan vilayetler; liva (sancak), kaza, nahiye ve köy gibi alt birimlerden oluşturulmuştur. Yerinden yönetim birimleri ise vilayet idare meclisi, belediye, nahiye, mahalle ve köy (muhtarlık) yönetimlerinden oluşturulmuştur. İlk dönemlerde merkezi yönetim tarafından

atanan yöneticiler bu birimlerde görev alırken zamanla seçimlerle gelen yöneticiler ve üyeler çalışmaya başlamıştır (Uygun, 2015: 4).

1921 tarihli Teşkilat-ı Esasiye Kanunu, 1876 tarihli Kanun-i Esasi'den farklı bir şekilde illere ve bucaklara özerk bir statü ve tüzel kişilik vermektedir. İl tüzel kişiliğinin, il meclisi, il yönetim kurulu ve il başkanı olmak üzere üç organı bulunmaktaydı. İl başkanı ve il yönetim kurulu, yürütme organı olarak görev yapmaktaydı. Ayrıca ilde TBMM'nin temsilcisi ve vekili olmak üzere bir valinin bulunacağı, fakat devletin genel işleriyle yerel işler arasında bir sorun çıktığında valinin duruma müdahale edeceği belirtilmekteydi. Ayrıca 1921 Anayasası'nda bucaklara da özerklik ve tüzel kişilik tanınmıştır (Keleş, 2021: 165).

1921 Anayasası'nda devlet teşkilatı, merkezi ve yerinden yönetim ilkeleriyle dikkate alınmakta ve yerel yönetimlerin özerkliği anayasada güçlü bir şekilde savunulmaktadır. Bu anayasada yerinden yönetim ilkesine ağırlık verilmiş, yani ademi merkezîyetçilik esas alınmıştır. Fakat anayasanın öngördüğü il ve bucak meclislerinin (şuraları) toplanamaması, söz konusu anayasal hükümlerin de uygulanmasını zorlaştırmıştır. Dolayısıyla bu anayasanın yerel yönetimler için getirdiği önemli hükümler de uygulanamamıştır (Uygun, 2015: 7).

### 3. Cumhuriyet'ten Günümüze Yerel Yönetimler

29 Ekim 1923'te cumhuriyetin ilan edilmesiyle Türkiye devleti, birçok alanda yeni bir yapılanma içerisine girmiştir. Bu anlamda yerel yönetim anlayışında da önemli gelişmeler yaşanmıştır. Avrupa ülkeleri örnek alınarak kurulan belediye teşkilatları ve il özel idarelerine Cumhuriyet Dönemi'nde çeşitli hukuki ve idari düzenlemeler yapılmış ve bunlara işlerlik kazandırılmıştır. Anayasal düzenlemelerle kentlere ve köylere tüzel kişilik kazandırılmış, oluşturulan belediye, il ve köy meclisleriyle yerel mekanizmalar şekillendirilmiş, özellikle mahalli idareler aracılığıyla imar faaliyetleri gerçekleştirilerek ülke bayındır hale getirilmeye çalışılmıştır (Yedek, 2022: 1726). Bu doğrultuda, yapılan düzenlemelerin ülkenin idari yapılanmasında önemli birer basamak olduğu ifade edilebilir.

1921 Anayasası'nda devletin yapısı, hak ve özgürlüklerle ilişkili düzenlemelerin yetersizliği 1924'ten itibaren yeni bir anayasanın yürürlüğe girmesini sağlamıştır. Sert maddeleri olan 1924 Anayasası ile, "Anayasa'nın hiçbir maddesi hiçbir sebep ve bahane ile savsanamaz ve işlerlikten alıkonamaz. Hiçbir kanun Anayasa'ya aykırı olamaz" (m.103) buyruğunda anayasanın üstünlük ilkesi kabul görmüştür. Fakat bu anayasada, kanunların anayasaya uygunluğunun yargısal denetimi konusu yer almamıştır (Atar & Çelik, 2018: 8). 1924 Anayasası'nda ise, 1876 Anayasası'ndaki Görev Ayrımı ve Yetki Genişliği ilkeleri aynı şekilde kabul edilmiştir (Keleş, 2021: 166).

Cumhuriyetin ilk yıllarında derin bir merkezîyetçi yönetim yapısı oluşmuştur. 1944 yılına kadar ise tek partili yönetim yapısı hakim olmuştur. Bu dönemde yerel yönetimlerin merkezi yönetimden ayrılması çok güç bir hal almıştır. 1930'da yürürlüğe giren Belediye Yasası'nda belediye organlarının aldıkları kararlar, merkezi yönetim tarafından sıkı bir şekilde denetlenmiştir. II. Dünya Savaşı'ndan sonra gerçekleşen çok partili hayat, herhangi bir düzeltmeye neden olmamış, genel olarak önceki yıllardan kalan ve demokratik olmayan uygulamaları devam ettirmiştir. Böylece merkezi ve yerel yönetim arasındaki birliktelik neredeyse aynı kalmıştır. Yerel yönetimlerin, merkezi yönetimin bir taşra uzantısı şeklinde görüldüğü anlayış bu dönemde de devam ettirilmiştir (Tunç, 2016: 25).

Cumhuriyet Dönemi'nden sonra yapılan anayasa uygulamaların ve anayasalara bağlı oluşan yerel yasaların, günümüzdeki modern yerel yönetim birimlerinin oluşmasında önemli bir işlevi olduğu söylenebilir. Yapılan yasal düzenlemelerle, yerel yönetimlerin

varlıklarını kazanmaları ve hukuksal olarak bağımsız olmaları sağlanmıştır. Böylece merkezi yönetim karşısında yerel özerklik kazanmalarına bağlı olarak görev dağılımı konusunda kimseye danışmadan kendi kararlarını alabilmeleri sağlanmıştır. Ayrıca kendilerine ait kaynakları kullanabilme ve çalışanlarını belirleme gibi temel özerklik göstergelerine sahip olabilmeleri önem taşımaktadır. Bununla birlikte alınan kararlarda, seçimlerin yapılarak üyelerin belirlenmesinde ve modern bir dönüşümün yaşanmasında mevzuatın rolünün olduğu görülmektedir (Güven, 2023: 15).

1961 Anayasası ile beraber demokratik haklar ve hürriyetler geniş kapsamda oluşturulmuştur. Bu anayasa sonucu belediye başkanlığı seçimi tek kademeli çoğunluk sistemi şeklinde yapılmaya başlanmıştır. Bir diğer değişiklik ise belediye meclislerinin başkan karşısında sahip olduğu yetkiler arttırılmıştır. Merkezi yönetimin yerel yönetimler üzerindeki denetimi bu dönemde kısmen azalsa da bunun pek de bir önemi olmamıştır. Çünkü merkezi yönetimin yerel yönetimler üzerinde detaylı bir şekilde yaptığı mali ve idari denetim, bu dönemde de devam ettirilmiştir. Böylece merkezi yönetimin ağır denetimine tabi tutularak merkezi yönetimin alt yönetimi şeklinde çalışmalarını yürüttükleri görülmektedir (Tunç, 2016: 26).

1982 Anayasası'nın hükümlerine göre Türkiye'de yerel yönetim birimleri; il özel idaresi, belediyeler (büyükşehir, il, ilçe, belde belediyeleri) ve köylerden oluşturulmuştur. Türkiye'de halen yürürlükte olan 1982 Anayasası'nda, Türkiye'nin idari yapılanması ve işleyişi ile ilgili olarak organların görev ve yetkileri hakkındaki bilgiler ilgili maddelerde açıkça ifade edilmektedir. Buna göre 1982 Anayasası'nın 123. Maddesinde; idarenin kuruluş ve görevleriyle bir bütünlük teşkil ettiği, idarenin kuruluş ve görevlerinin merkezden ve yerinden yönetim esasına göre düzenlendiği belirtilmektedir (Güven, Karkacier & Şimşek, 2017: 191).

1982 Anayasasında Türkiye Cumhuriyeti'nin yönetim şeklinin merkezden ve yerinden yönetime dayalı karma yapıya sahip olduğu öngörülmüştür. Yerinden yönetim kuruluşlarının kendileri dışında bulunan, ayrı yönetsel kuruluşlarca, yasaların öngördüğü şekilde denetlenmesine "yönetsel vesayet denetimi" adı verilmektedir. Böylece yerel yönetimlerin yaptıkları denetim dışındaki kanunlar ile kısıtlı olmak şartıyla denetim uygulama yetkisine sahip olan kurumlar, merkezi yönetim kuruluşları olarak belirlenmiştir. Merkezi yönetim "İdari Vesayet" yetki, görev, denetim yetkisinden çok, yoğun bir kontrol ve müdahale yapısı olarak kullanılmaktadır (Aktalay, 2010: 3).

#### 4. Sonuç

Yerel yönetimler; yerelde yaşayan bireylerin ihtiyaçlarını karşılamak amacıyla ortaya çıkan, ayrı bir tüzel kişiliğe, idari ve mali özerliğe sahip kuruluşlardır. Merkezi yönetim bazı kamu hizmetlerini yürütmek için yerel yönetimlere başvurmaktadır. Alınan kararları ve toplum için gerekli olan hizmetleri yerine getiren, demokratik ve siyasi kurumlar olarak rol üstlenmektedirler. Türkiye'de Tanzimat öncesinde başlayan süreç günümüze kadar farklı siyasi, hukuki ve idari dönüşümlere maruz kalarak günün ihtiyaçları doğrultusunda değişimlere uğramıştır. Burada önemli olan, yerel yönetimlerin yakın birer gözlemci olarak toplumun sıkıntılarını çözüm üretmesi ve işlerin merkezi idareye ulaşmadan çözülmesidir.

Tanzimat Dönemi'nden önce yerel hizmetler; kadılar, vakıflar, mahalle ve lonca teşkilatları tarafından gerçekleştirilmekteydi. Ancak daha sonraki birçok gelişmeden sonra yerel hizmetler; il özel idareleri, belediyeler, büyükşehir belediyeleri ve köy muhtarları tarafından gerçekleştirilmeye başlanmıştır. Bu anlamda Sultan II. Mahmud'un yaptığı idari düzenleme, önemli gelişmelerin miladı olarak kabul edilebilir. Bu dönemden sonra çıkarılan yasal düzenlemelerle hem sorunlar çözülmüş hem de merkezi idarenin yükü hafifletilmeye

çalışılmıştır. Ancak ortaya çıkan büyük sorunlarda merkezi yönetimin denetimi, yerel hizmetlerin devamlılığını sağlamakta etkili olmuştur.

1961 Anayasası ile merkezi yönetimin yerel yönetimler üzerindeki denetimi kısmen azalsa da yapılan mali ve idari denetim bu dönemde de devam ettirilmiştir. Bu dönemde yerel yönetimler, merkezi yönetimin denetimlerine tabi tutularak merkezi yönetimin alt birimleri şeklinde çalışmalarını yürütmüşlerdir. Türkiye'de yerel yönetim birimleri 1982 Anayasası'nın hükümlerine göre; il özel idaresi, belediyeler (büyükşehir, il, ilçe, belde belediyeleri) ve köylerden oluşturularak son haline kavuşturulmuştur. Halen yürürlükte olan 1982 Anayasası'nda, Türkiye'nin idari yapılanması ve işleyişi ile ilgili olarak organların görev ve yetkileri hakkındaki bilgiler ilgili maddelerde açıkça ifade edilmiştir. Bu Anayasası'nın 123. Maddesinde; idarenin kuruluş ve görevleriyle bir bütünlük teşkil ettiği, idarenin kuruluş ve görevlerinin merkezden ve yerinden yönetim esasına göre düzenlendiği belirtilmiştir. Ayrıca 1982 Anayasasında Türkiye Cumhuriyeti'nin yönetim şeklinin merkezden ve yerinden yönetime dayalı karma yapıya sahip olduğu ifade edilmiştir. Yerinden yönetim kuruluşları halen kendileri dışında bulunan, ayrı yönetsel kuruluşlar tarafından, yasaların öngördüğü sınırlar çerçevesinde denetlenmeye devam etmektedir.

Kısaca söylemek gerekirse, Tanzimat öncesi dönemden günümüze kadar yerel yönetimlerin günümüzdeki yapısına kavuşması için yapılan bütün çalışmaların önemli olduğu ve bütün çalışmaların sürece katkı sağladığı ifade edilebilir. Ancak Kanuni Esasi (1876)'den 1982 Anayasası'nın ilanına kadar geçen süreçte yapılan anayasal uygulamaların ve yerel yönetimler üzerindeki yansımaların daha önemli olduğu ifade edilebilir.

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# Academic Motivation and Self-Efficacy: An Integrative Analysis Using MSLQ and SELF to Predict Learning Outcomes

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## ABSTRACT

Our research investigates the interplay between academic motivation and self-efficacy in predicting students' learning outcomes, utilizing two validated instruments: the Motivated Strategies for Learning Questionnaire (MSLQ) and Self-Efficacy for Learning Form (SELF). The study aims to provide an in-depth understanding of how motivation and self-efficacy influence academic performance in higher education contexts. By examining the relationship between these constructs, the study seeks to clarify the mechanism through which students' motivation orientation affect their engagement and efficacy in learning. The findings of the study will contribute to the development of evidence-based strategies designed to enhance academic achievement and promote self-directed learning among our students. Preliminary results indicate a significant correlation between evaluation anxiety and study effectiveness. Further analysis of other significant findings will be presented in subsequent sections. Through a comprehensive and methodologically rigorous approach, this study offers valuable insights into the psychological factors that underpin student success.

**Keywords:** strategies, self-efficacy, anxiety evaluation, MSLQ; SELF

## 1. Introduction

*Academic motivation and self-efficacy*

The growing complexity of educational environments has heightened the importance of understanding psychological factors that contribute to student success. Among these, *academic motivation* and *self-efficacy* emerge as critical determinants of student performance and engagement in higher education. Building from this understanding, Schunk(2011) emphasizes the strong association between academic motivation and self-efficacy, defined as individuals' beliefs in their ability to perform specific tasks. Self-efficacy differs from related

constructs, including perceived control, outcome expectation, value, and self-concept. Research consistently shows that self-efficacy significantly influences academic outcomes.

Both classical theories about motivation (see Bandura, 1986) and recently theories (Schunk, 2011) highlight that *self-efficacy* refers to individuals' confidence in organizing and implementing actions to achieve desired performance levels.

*Effectiveness* is another concept analysed by specialists; sometimes wrongly used instead of efficacy, it analyses the report between aims and resources used to achieve its. There are studies that have focused on the impact of effective human resources quality management on student academic performance. Those findings emphasize the critical role of efficient management practices and high-quality human resources in improving students' academic outcomes (Destari, 2023).

*Motivation*, often correlated with academic performance, refers to the drive to engage in a particular activity. Motivations are categorized into three types: controlled motivation (extrinsic), autonomous motivation (intrinsic), and a lack of motivation (Deci, 1999).

According to Dyskiv (2013), intrinsic motivation involves participating in activities for the inherent satisfaction and personal fulfilment they provide, while extrinsic motivation is determinate by external obligations or duties.

This understanding of intrinsic and extrinsic motivation is central to self-determination theory, which frames motivation along a continuum, reflecting different degrees of self-determined behaviour. For instance, a student intrinsically motivated might study for the joy of learning, whereas someone extrinsically motivated might do so to earn a good grade. Deci (2013) describes this continuum, noting that motivation reflects a complete absence of self-determination. As individuals progress through extrinsic motivation levels, they become increasingly self-determined, eventually reaching intrinsic motivation.

Overall, studies indicate motivation as a fundamental component of the learning process (Brewer & Burgess, 2005). Detloret al. (2010) identified several factors that are influencing learning outcomes, including student demographics, learning environment, and levels of academic motivation. Student demographics encompass personal characteristics such as gender, year of study, academic performance, and the relevance of the instruction to their career aspirations. Saracaloğlu & Dinçer (2009) found a moderate correlation between prospective teachers' self-efficacy and academic motivation, with minor yet positive association to overall motivation scores.

Xavier Oriol-Granado et al. (2017) get to the conclusion that positive support and autonomy support predict academic performance, self-efficacy and academic engagement, and self-efficacy predicts higher levels of academic engagement and improves academic performance.

Furthermore, a study by Chow & Wong (2020), involving 506 participants, revealed that nursing students scored lower on the Information Literacy Self-Efficacy compared to peers from other disciplines. These nursing students also exhibited lower overall information literacy self-efficacy. Considering the demands of nursing as a professional field, which requires continuous education and skill advancement, these findings underscore the importance of fostering effective lifelong learning strategies within nursing education.

Posada et al. (2018) conducted a study involving a sample of 695 Chinese high school students over two academic years to assess their academic stress and self-efficacy. The findings revealed a negative relationship between academic stress and self-efficacy, with

gender serving as a moderating factor. According with their findings, the impact of academic stress on self-efficacy is indicated as being more pronounced among female students compared to their male counterparts.

The pre-university educational system distinctly differs from the university system in several key aspects. In high school, students receive direct instruction from teachers, who provide assignments and conduct periodic evaluation through tests. In contrast, university educators often facilitate discussions and debates on various topics, fostering a more interactive learning environment. First-year university students frequently report challenges in assimilating the vast amount of information presented in their courses, primarily due to the absence of frequent assessments that characterize high school education.

Addressing to these challenges, Tikhomirova et al. (2016) investigated how well students assimilate educational information and develop problem-solving skills across cognitive levels (remembering, understanding, analysis, synthesis, and test) by evaluating terminological competence and structural organization of content in the didactics subject from Psychology and Pedagogy course. This transition necessitates that students develop self-regulation skills to effectively manage their time, engage with supplementary readings, and comprehensively grasp course materials.

However, many students approach their university courses with the mindset that mere attendance and passive listening are sufficient for success. As examination periods approach, stress levels increase, leading students to seek quick solutions, such as study aids, to enhance information retention. Consequently, they often find themselves inadequately prepared for assessments due to insufficient preparation time. A lack of effective study strategies or tendency to procrastinate can significantly hinder academic performance, underscoring the importance of proactive learning approaches in higher education.

### *Test Anxiety*

One of the most prevalent fears identified by the researchers in the modern society is the fear of others' evaluations. This anxiety often manifests as a reluctance to speak in public or in situations involving large groups of people. Our society places significant emphasis on tests and assessments; more, individuals' lives are modelled by the results of their test performance (Sarason, 1959).

Test anxiety is described as an intense concern about an evaluative task, often viewed as a threat to one's self-esteem or sense of competence (Khalaila, 2015), the worry, accompanying autonomous nervous system that can occur during examinations (Putwain, von der Embse, et. al, 2021).

*Public speaking* is a critical competency for teacher, particularly in the teaching profession. It has been observed that first-year students often struggle with interacting or articulating their opinions on a given topic. This difficulty appears to stem from negative experience during their pre-university education. In many cases, students report that they were not encouraged to express their thoughts freely; instead, they were often required to strictly follow classroom norms, such as raising their hands to speak. These practices may have inadvertently stifled their confidence and ability to communicate effectively.

Despite facing challenges such as low self-esteem and a lack of confidence in public speaking, many students still choose to pursue a career in teaching. This decision highlights



their determination to overcome these obstacles and develop the skills necessary for success in the profession.

An intriguing question arises: What motivates these students to pursue a teaching career despite their initial challenges? Based on feedback gathered from students over the years, the answer often lies in the influence of certain teachers. These are teachers who stand out, regardless of their subject - be it mathematics, history, religion, or psychology. They distinguish themselves by employing alternative teaching methods and prioritizing meaningful engagement over rigid adherence to the formal curriculum. Such teachers inspire their students and leave a lasting impact, demonstrating the profound role that educators play in shaping future generations. Katz (2000) highlights research results indicating that between 20% and 85% of individuals experience varying degrees of anxiety when faced with public speaking. This phenomenon is not limited to the general population, even professionals such as actors, politicians, and business leaders are affected by public speaking anxiety.

Many studies have shown that 20-85% of people experience more or less anxiety when they need to speak in public. Some professionals, including actors, politicians or business people, experience public speaking anxiety.

While speaking experiences can directly contribute to improved performance (Low & Sheets, 1951), this is not always the case, as individuals who experience the highest level of fear around public speaking (Jensen, 1976). According to Bodie (2010), general social anxiety may arise from unrelated events and later become linked to the act of speaking in public through a process of conditioning.

In the same line, other studies (Wei & Sun, 2024) have indicated the necessity for deeper study of test anxiety, getting to the conclusion that emotionality - not worry - during tests is correlated also with attentional control deficit; these results could be significant in the process of understanding the negative effect of test anxiety in academic performance.

Studies (Putwain, Stockinger, von der Embse, et.al., 2021) have been preoccupied about the effect of test anxiety on emotional evolution. So, they analysed if test anxiety could be a risk for emotion disorder development and get to the conclusion that test anxiety was distinct from general anxiety disorder and panic disorder, rather than a manifestation of these emotional disorders. The authors consider that their study's implications consist in a bidirectional relation between test anxiety as risk factor for general anxiety disorder and panic disorder, and, as consequence, intervention for test anxiety could reduce general anxiety disorder and panic disorder symptoms. In the same direction, another study (Putwain, von der Embse, Nicholson & Daumiller, 2024) get to the conclusion that high-test anxiety represents an elevated risk for emotion disorder development.

Facing test anxiety, the fear for failure, with implications in self-esteem and judgement of significant people from their lives (family members, friends etc.), students' career aspirations could be jeopardized (Banks & Smiths, 2015, Putwain, 2009 apud Putwain, von der Embse, Nicholson & Daumiller, 2024).

A significant challenge facing the education system today, particularly at the university level, is the increasing tendency of students to drop out. Observations from professors suggest that this issue often arises during the first evaluations of the semester or the initial exam period.

## 2. Methodology

The Motivated Strategies for Learning Questionnaire - MSLQ (proposed by Pintrich & De Groot since 1990) is a widely recognized instrument developed to assess students' motivational orientations and learning strategies. According to Pintrich (1991), the MSLQ is grounded in a general cognitive framework of motivation and learning strategies. The questionnaire comprises 31 items designed to evaluate students' goals and value beliefs related to a course, their self-perceived skills for achieving success, and their anxiety levels. Additionally, it examines the students' use of various cognitive and metacognitive strategies (Pintrich, 1991). Initially, the MSLQ was utilized by McKeachie et al. in 1985 to assess the effectiveness of the Learning to Learn course at the University of Michigan.

The Self-Efficacy for Learning Form (SELF) (proposed by Zimmerman & Kitsantas since 2005) is an instrument designed to assess three key variables: general study, test preparation, and note-taking. The SELF measures students' self-efficacy beliefs concerning their application of specific self-regulatory processes across different aspects of academic performance (Zimmerman & Kitsantas, 2015). In alignment with the primary objective of our research, we aim to explore whether there is a correlation between test anxiety and both general study and test preparation.

Data obtained have been completed with interviews meant to clarify our subjects' answers to the tests.

## 3. Participants

The study sample comprised 50 students from the Faculty of Letters and Sciences, representing a diverse range of academic disciplines. This sample was selected to provide a comprehensive understanding of the self-efficacy beliefs and study behaviours across various fields of study. The primary goal of this initial study is to gain a preliminary understanding of these relationships. In future research, we plan to expand the sample size and to include a larger, more diverse group of participants, which will allow for a more robust analysis and enhance the generalizability of the findings. The sample consisted of 50 participants, with 4 male students and 46 female students.

The research seeks to address and mitigate the phenomenon of university attrition.

## 4. Results

According to the data obtained by using the Motivated strategies for Learning Questionnaire (MSLQ), participants' level of anxiety in response to teacher evaluating their activities were distributed as follow: 36% reported low anxiety, 28% experienced moderate anxiety, and 36% demonstrate high level of test anxiety.

**Low test anxiety** refers to a mild level of nervousness or stress experienced before or during a test. This level of anxiety is often beneficial, as it enhances focus and performance, by keeping the individual within an optimal stress range. In the literature, this is referred to as eustress, a positive form of stress that motivates individuals to take action and achieve their objective.

**Moderate test anxiety** is characterized by a noticeable sense of worry or fear related to testing situations. Despite these emotions, the student is generally able to manage them effectively. Common sign of moderate test anxiety include difficulty for concentrating, and some of the mild physical symptoms, such as a sensation of butterflies in the stomach, sweaty palms, or facial flushing.

**High test anxiety** involves intense levels of anxiety that goes beyond typical nervousness. This condition is often linked with underlying conditions, such as generalized anxiety disorder, and can significantly impair performance.

Figure 1 presents the levels of test anxiety, highlighting an equal percentage for both low and high anxiety scores. Participants who exhibited a low level of anxiety reported during interview discussions that they experienced little to no emotional distress when being evaluated.

They attributed this to proactive behaviours, such as seeking clarification from teachers when they did not fully understand theoretical concepts, consulting with second-year students for guidance on challenging subjects, and addressing difficulties in specific disciplines early on.

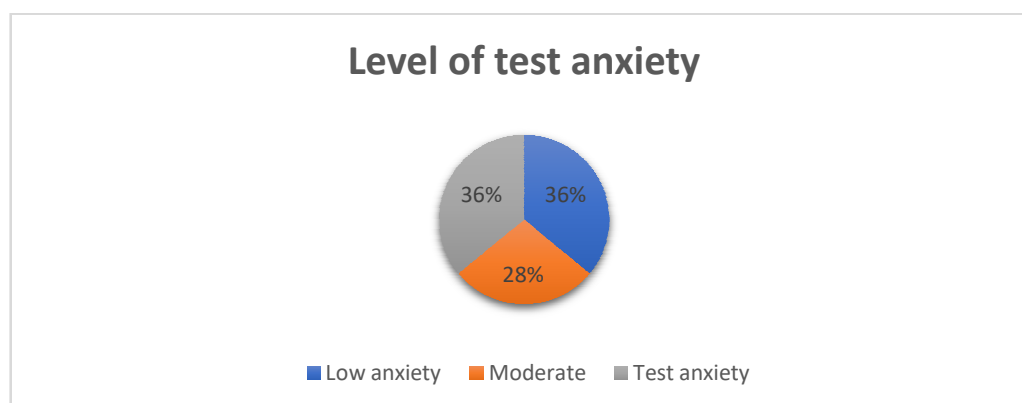


Fig. 1. Level of test anxiety

These strategies appeared to contribute to their confidence and reduced anxiety during evaluations. More than that, the equal distribution for both levels (low and high) could indicate that students coping mechanisms and external support systems play an important role in shaping test anxiety levels. Meanwhile, the last 28% reporting a moderate anxiety represent also a group that balances between these extremes, potentially managing stress effectively but still facing occasional difficulties (physical symptoms – like sweaty palms, or facial flushing).

According to their responses, participants with a moderate level of anxiety identified several factors contributing to their stress. They reported that certain subjects or disciplines were particularly challenging, with some topics being difficult to comprehend.

Additionally, they expressed concerns about not having sufficient time during class to write down definitions or key information, which further compounded their difficulties. An explanation for this situation is, as we have found during interviews, that they haven't achieved intellectual techniques that allow them to easily synthesize oral messages, to use codes of short-notes to facilitate note-taking, to find and use alternative sources to complete their notes etc.

These challenges may contribute to a sense of being underprepared, thereby increasing their anxiety levels during evaluations.

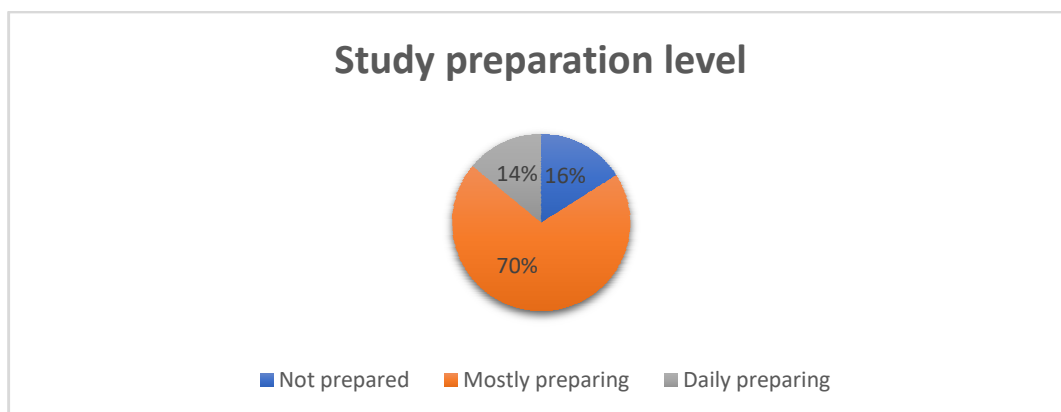


Fig.2. Study preparation level

Figure 2 illustrates the strategies reported by students for effective learning. The responses focus on whether they can recall complex definitions and rephrase them into simpler, more relatable terms to aid retention. Additionally, the items assess students' ability to manage their time effectively, particularly in reviewing lessons they initially struggled to grasp.

These strategies are analysed to determine whether students can plan and allocate sufficient time for study, avoiding last-minute preparation and ensuring readiness for evaluations. The findings provide insights into their ability to adopt efficient learning techniques and maintain consistent study habits.

According to figure 2, the distribution of students' preparation levels: 16% not prepared, 70% mostly prepared, and 14% daily prepared, highlights a clear trend in study habits. Data results reflect that 70% adopt a balanced approach, dedicating time to preparation but not on a daily routine. This group likely benefits from moderate time management strategies, although they might struggle with consistency.

A small percentage, 16%, reflects those students who may lack effective strategies or time management skills. If they do not have efficient strategies, this group could be at higher risk of poor academic performance due to an ineffective study practice. While, a minority of 14% demonstrate a strong discipline and a good budget of time management.

The contrast between the not prepared and daily prepared groups underscores the importance of time management and proactive study habits for success. The large proportion of mostly prepared students suggests that many recognize the need for preparation, particularly for 2 to 4 discipline they perceive as more challenging due to their complexity or the substantial amount of information required to understand and memorize. This indicates that these students tend to prioritize their efforts based on the perceived difficulty of the subject, focusing their preparation on areas that demand greater cognitive effort.

## 5. Discussion

*The absence of a structured or strategic learning style* maybe a significant factor contributing to the physical symptoms experienced by students with high level of test anxiety. This issue can often be traced back to the phenomenon of "leap learning/learning in bursts", which is a characteristic of higher educations.

In contrast to the pre-university education system, where students are guided systematically through a curriculum and are provided with more structured support, the university education system places greater emphasis on independent learning and self-

regulation. This transition often challenges students to manage their time and resources effectively.

University-level learning requires students to adopt efficient learning management strategies, including balancing the time allocated to studying with other academic and personal responsibilities. A critical factor in managing test anxiety lies in the timing of preparation for assessments. Students who begin their preparation late (few days before exams) or inconsistently may feel overwhelmed by the volume of material, leading to heightened anxiety levels. Conversely, those who adopt a proactive and sustained approach to their studies are better positioned to build confidence and reduce stress.

Another important consideration is that university education encourages students to develop *a broader perspective on their knowledge and skills*. This process involves *self-assessment*, where students compare their perceived level of understanding with the expectations of higher education. For those who struggle to adapt to this more self-directed learning model, the resulting gaps in knowledge and preparation can exacerbate test anxiety.

An additional potential factor is the disconnect between teaching strategies and learning methods adopted in high school and those implemented by university during higher education.

These differences are significant because, in pre-university education, students typically develop a comprehensive understanding of their learning preferences and effectiveness. They become aware of their individual learning styles, whether visual, auditory, or kinesthetics, and identify the times of day—morning, afternoon or evening when they learn best. Additionally, they gain insight into their organizational recognizing whether they are methodical and task-oriented or more spontaneous and prone to last-minute studying.

It is evident that students who achieve high scores on the MSLQ test often tend to rely on last-minute studying. Many of them report that initiating their study sessions is challenging due to an environment that is not conducive to learning. When asked to elaborate their answers, some students indicated that their study areas are cluttered, with numerous items on their desks requiring organization before they can begin. Others noted that they lack a dedicated study space and must share a room with a family member, further complicating their ability to focus effectively.

As teachers, it is essential to identify the primary causes behind students' test anxiety and their tendency to skip classes, seminars, or, ultimately, withdraw from university altogether. One significant factor contributing to these issues is *the lack of effective learning strategies*. Data indicates that many students struggle to study efficiently, which can lead to feelings of frustration, inadequacy, and a lack of motivation. Over time, these challenges can become critical barriers to academic persistence, causing students to disengage from their studies and consider abandoning their academic pursuits entirely.

## 6. Conclusions

Students face significant challenges during transitions in school, including adapting to new structures, different methods, meeting teachers' expectations, and navigating social relationships (Whitley, 2007). As our study results indicate, test anxiety could be a signal for our students need for improving their study preparation strategies.

According to Evans et al. (2018) this transition is a more stressful than other major developmental changes, such as puberty, often leading to declines in motivation and academic performance.

More, since 2017, Stăncescu considered that academic learning should foster collaboration both individually and in groups, emphasizing the importance of understanding the practical relevance of the material being studied. The ultimate goal is not merely to achieve grades, but to equip students with knowledge and skills that can be effectively applied in diverse contexts.

From this perspective it is crucial to prioritize over remediation, focusing on identifying the underlying causes to develop effective prevention programs and strategies for developing students' learning abilities, and also social abilities.

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# Interventions for Enhancing Motivation and Self-Efficacy in Educational Settings

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## **Abstract**

The article investigates evidence-based interventions aimed to enhance academic motivation and self-efficacy in educational settings, building on key concepts from the prior research – Academic Motivation and Self-Efficacy: An Integrative Analysis Using MSLQ and SELF to Predict Learning Outcomes. Drawing on established frameworks such as the MSLQ and the SELF scale, the analysis focuses on practical strategies that educators can employ to foster intrinsic motivation, and ultimately improve learning outcomes. These proposals for intervention discussed include goal-setting techniques, along with a synthesis of current literature, offering actionable recommendations for developing the competence **to learn how to learn**. The previous research involved 50 participants, recruited from the Faculty of Letters and Science (Petroleum – Gas University of Ploiești).

**Keywords:** motivation, education, self-efficacy, self-regulated learning

## **1. Introduction**

Academic motivation and self-efficacy, as we have presented in our previous study, are two critical determinants of academic success, influencing how students engage with learning activities and overcome challenges. Building on prior research that evidence the predictive value of these elements for learning outcomes, this article explores targeted interventions designed to enhance both motivation and self-efficacy in educational settings.

Certainly, motivated students are better equipped to confront academic challenges, as they are driven by the need to achieve their educational goals. According to Zimmerman (2000), self-efficacy beliefs are particularly responsive to changes in students' performance contexts, interact with self-regulated learning processes, and play a mediating role in academic achievement. Schunk (2008) examined the relation between self-efficacy, motivation, and performance in both cognitive and sport domains.



Since 2016, Dörrenbächer & Perel, analysing through an experimental program the effect of self-regulated learning training, get to the conclusion that the effect of this training is motivational in nature.

## 2. Need for interventions

Despite extensive research on these concepts, there is a gap in implementing structured, practical interventions to develop motivation and self-efficacy in classrooms. As demonstrated in our previous research, which utilized the Self-Efficacy for Learning Form in conjunction with the Motivated Strategies for Learning Questionnaire, a significant correlation was identified between test anxiety and the level of study preparation. In that study, the authors highlighted the primary factors contributing to test anxiety.

Previous research (Eftimie, 2022) on students from our university indicated a high score both for *intrinsic motivation* (for knowledge, accomplishments and stimulation) and *extrinsic motivation* (for identification, introjection, external regulation). An interesting result was the lack of satisfaction about relations, indicated by master students. Other studies indicated the relation between academic motivation and “social reinforcement, defined as the positive way one person pays attention to another through acknowledgments or praise (Losada, 2018, apud Latorre-Coscolluela, 2022). We intend to extend the analyse of intrinsic motivation and extrinsic motivation and also their relation with satisfaction (autonomy, relation and competence) concerning academic activities.

Not only motivation is the key for academic success but also the *autonomy* and *self-regulated learning*. Unfortunately, we consider that some educational services that parents use for their children, like after-schools or private meditations support, are not always beneficial for developing learning autonomy. From our students’ testimony, during after school of private meditation activities there is always an adult that show / guide them what to learn and how to solve tasks. So, finding independently (re)sources and algorithms for solving learning tasks is not a usual practice for them. That’s why, in the absence of a guide, academic learning environment / relationship is perceived as challenging, difficult to overcome.

Building on this foundation, the present paper adopts a preventative rather than reactive approach, offering a practical guide aimed at individuals seeking to mitigate test-related stress during examination periods.

Studies, continuing researches of Dweck on mindset, have identified a correlation between *growth mindset and self-regulated learning (SRL)*. People with growth mindset, consider Dweck (2017) is a trait of people that appreciate that abilities could be developed through a lot of effort and involvement, learn from mistakes, persevere, take risks, accept challenges, learn from other successes. Vosniadou et al. (2020) (apud Karlen et al., 2023) demonstrated that a growth mindset is consistent with self-regulated learning and fixed mindset is inconsistent with it. They consider that people with growth mindsets assume that self-regulated learning skills can be acquired and improved over time and thus focus on developing their abilities; in contrast, people with fixed mindsets believe that self-regulated skills are unchangeable and relate to a given talent, thus focusing on validating their abilities (Hertel & Karlen, 2021, apud Karlen et al., 2023).

As specialists in the field of education, teachers must prioritize the free development and formation of future independent adults capable of adapting to the challenges of an ever-changing world.

Since 2011, Romanian Education Law, in accord with European directives, indicate *learning to learn* as a key - competence for Romanian graduates' education system. In 2008, The Centre for research on Education and Lifelong Learning published a comprehensive guide for measuring the competence to learn to learn (Hoskins & Fredriksson, 2008). This guide introduced a critical new dimension to the concept metacognition (Stăncescu, 2017). Metacognition equips students with essential skills to take responsibility for their own learning process. It enables them to work independently, effectively manage the time allocated to individual study, and maintain a steady pace of learning throughout the academic year, thus avoiding last-minute cramming. Moreover, metacognition supports students in continuously evaluating their knowledge, skills, and competencies, while applying their achievements in various contexts, all aligned with their established goals (Stăncescu, 2017).

And, because it is accepted that it is easier to prevent than to correct, we propose some directions for intervention concerning academic learning self-efficacy.

### **Learning to learn**

In the learning process, one of the most critical questions is: *how to learn?* From pre-university education to higher education, teachers focus primarily on equipping students with extensive knowledge in specific domains. Occasionally, alternative methods are adopted to facilitate better understanding in particular situations. However, few, if any, educators place emphasis on teaching students how to learn. In some schools from our city, there is a practice to apply a diagnostic test; this is administered at the beginning of the academic year to identify the learning styles of students (from the 5th and 9th grades).

Based on the results of this test, teachers can identify students who exhibit one of the three main *learning styles*. This approach enables both teachers and students to tailor their teaching and learning strategies to better address the specific needs of the class, ultimately bridging the gap between educational content and the actual learning requirements of students.

Due to these practices we could suppose that our students become able to identify their best strategies that make them cope with academic demands. Students exhibit diverse approaches to learning, making distinct choices, preferring specific times for learning, and adhering to unique rituals or routines, they respond differently to tasks and display a wide range of emotion in the learning process.

According to the literature in the field, learning styles reflect individual preferences in the learning process. These include the time of day when students are most productive, whether in the morning, evening or late at night, and their approach to tasks, such as focusing intensely on a single task within a set time frame or alternating between multiple tasks with breaks in between. Learning preferences also encompass environmental choices, such as studying at a desk, on the floor, on the couch, or in bed, as well as organizational habits, ranging from maintaining an orderly workspace to embracing a more chaotic setup. Furthermore, students may prefer working individually or in groups, and their sensory preferences vary, they may rely on visual aids, auditory input, or kinesthetic activities, such as hand writing in order to learn, to absorb and retain information effectively.

In 1982, Anthony Grasha & Sheryl Hruska-Reichmann have developed a comprehensive scale to identify students' learning style, categorizing them into six distinct types: the competitive, collaborative, avoidant, participatory, dependent, and independent

style. This framework provides valuable insights into how students engage with learning environments, interact with peers, and respond to educational challenges. By understanding these styles, educators can tailor their teaching approaches to better meet the diverse needs of their students, fostering more effective and inclusive learning experiences.

### 3. Proposed interventions

The *self-regulation of motivation* intensity and a solid sense of self-efficacy among learners represent the ultimate goal of our discussion. In the volume *Academic Adaptation: Theories, Research, and Interventions* (edited by Cazan, Truța, Stan, and Maican, 2024), a series of interventions are listed that could prove to be successful practices in supporting these objectives and the academic adaptation of first-year students. Such interventions include student counselling to support academic success, activities for emotional regulation, the professor's understanding of their role, the support provided by electronic learning platforms, the optimization of self-regulated learning among students, mentoring in the academic environment, and student-centred curricula. Below, we elaborate on these proposals, assessing them as relevant interventions that can enhance motivation and self-efficacy in educational settings:

*Educational Counselling for Students.* The role of counsellors in the Career Counselling and Guidance Centres (CCOCs) within universities is vital for managing learning and supporting students' motivation for study. Stoica and Truța (2024) evaluate educational counselling as “an essential intervention” with a “fundamental role” in this direction, clearly outlining and exemplifying counselling types based on targeted objectives. According to the authors, individual counselling is more suitable for supporting students' social and emotional adaptation, identifying the necessary balance between extrinsic and intrinsic motivation, achieving optimal motivation, or setting goals that could enhance learning efficiency.

In contrast, group counselling activities are aimed at developing skills and competencies to support academic success. These latter activities are proposed to be conducted through optional courses designed to develop critical thinking and problem-solving skills, positive attitudes toward lifelong learning, and effective management of academic tasks and learning.

*Emotional Regulation Activities for Students.* Starting from the premise that young people are “active builders of their own emotions” and based on an exploratory study conducted in 2023 on the effects of an experiential intervention on emotional intelligence, Năstasă (2024) proposes a series of activities to facilitate emotional regulation among students. The proposal includes specific activities to enhance resilience and develop students' emotional regulation skills, with particular emphasis on how they can use emotional experiences to optimize cognitive processes. Our intervention should also be focused on emotion control and test anxiety self-control before and during examination.

*The Role of Professors in Enhancing Motivation and Self-Efficacy.* According to Necșoi (2024), the professor's role in fostering motivation and self-efficacy in educational settings is evident in three key areas of intervention: instructional orientation, the organization and implementation of teaching, and student relations/academic ethos. Strategies such as maintaining high expectations for student learning, employing active-participatory teaching

methods, offering individualized feedback, and cultivating a “managerial attitude” in students toward their own learning are highlighted as critical interventions.

Professors also should reflect on their evaluative practices and not use evaluations / examinations as a purpose but for a mean to improve learning and teaching. Also it will be useful to reflect on their mindset and help students to develop their growth mindset.

*Teaching Students How to Learn.* A valuable proposal is to involve students in a course such as Learning How to Learn, where they are taught self-regulated learning strategies that strengthen their capacity to regulate and guide their learning behaviour while reinforcing their sense of self-efficacy. Henter (2004) emphasizes that “Self-regulation is a proactive process that fully engages the individual throughout their activities. Furthermore, it is a process that can and should be taught to students by instructors competent in their own self-regulation” (p. 367). Training metacognitive skills such as performance self-observation, productive self-reflection, self-monitoring, and self-assessment will lead to the development of students’ self-regulation abilities and, consequently, deeper learning.

*Mentoring in the Academic Environment.* Mentoring is another approach worth considering. In academic contexts, Voinea (2024) recommends mixed mentoring (combining synchronous and asynchronous mentoring sessions) and group mentoring (e.g., a mentor working with a group), with the mentor tasked with fostering more effective behaviour in the mentee by reflecting on their experiences. Peer mentoring can also support students in identifying the most suitable learning strategies and developing effective learning practices, provided that volunteer students are identified to carry out these activities.

Also, a good practice demonstrated in previous studies (Dörrenbächer & Perels, 2016) is to train students to complete an everyday diary with their reflection on learning activities.

*Student-Centred Curricula.* Student-centred curricular structures also offer significant benefits aligned with our discussion. Tudor (2024) highlights key features such as setting realistic instructional objectives, efficient management of teaching time, emphasizing the professor's role as an organizer, counsellor, and motivator, gaining a deep understanding of students, promoting learning at their own pace, and engaging students in both formal and informal educational activities. Flexibility in teaching, learning, and assessment is particularly important. A distinct dimension of this student-centred curriculum, we believe, should aim at improving the experiences of students with specific learning disorders in higher education (Langa and Lazăr, 2022). The teaching and learning practices and tools that are utilized must facilitate inclusion and engagement in their own learning for these categories of students. Moreover, electronic learning platforms play a crucial role in personalizing learning experiences by providing real-time feedback, significantly enhancing learning efficiency and effectiveness (Maican, 2024).

In omania there is a decentralized process for admission in universities that allows universities to admit students no matter of their previous education path (as long as they have graduated with bachelor degree). In our (and also in other universities) there are situations when students change their educational path - for example, they have graduated philological profile and choose to continue to a career as engineer. That’s why for them, often the adaptation process to academic exigences is more difficult. In order to meet their needs, faculties could propose a “filter - curricula” (a module) that help them build in the first year / semester the fundamentals that allow to cope with specialty curricula in the new field.

*Digital interventions.* The incorporation of gamification strategies across diverse sectors of society has gained significant momentum. Data research highlights education and

training as the leading fields where gamification is not widely applied but also extensively studied and explored (Koivisto, 2019) incorporate elements of game design, such as levelling up to enhance engagement and persistence in learning tasks. *Adaptive learning* system by using AI-driven tools to personalize learning pathways, ensuring students receive appropriately challenging tasks to experience consistent progress.

#### 4. Conclusions

Academic adaptation is sometimes a difficult process to deal with. Students need all the support and understanding from their teachers because new generations are less orientated for effort, and long-term results and more orientated for immediate results.

Perceiving their adaptation process for the first two years of university studies as a successful one is crucial for their graduation. Addressing to this issue requires a proactive and multifaceted approach. First, educators must foster a supportive learning environment that encourages open dialogue about academic challenges, helping students feel understood and less isolated. Second, incorporating workshops or courses on study skills, time management, and stress management can equip students with the tools they need to approach their studies more effectively. Additionally, personalized interventions, such as mentoring programs, can provide tailored guidance and emotional support to students at risk of academic disengagement. And students should be encouraged to apply all new acquired strategies in their everyday learning.

Preventing student attrition is not only about addressing immediate academic concerns but also about instilling a sense of confidence and competence in students. By helping them develop efficient learning strategies and providing the necessary resources to overcome anxiety, educators can play a pivotal role in ensuring students remain engaged and committed to their profession.

Learning results are not only grades that student obtain to the tests, as many of investigated students have answered. Students also learn how to learn, learn techniques that help them in the process of permanent education, develop competences that help them solve problems, develop attitudes and social values, learn to make self-evaluation, self-regulation of learning / metacognition etc.

If testing anxiety is a problem for our students, they could be taught how to cope with examination situations being prepared both informational, methodological and psychologic.

Also, they have to be more effective during classes activities – to be guided towards exercises in synthesizing oral messages, the use of a code of short-notes to facilitate note-taking, to find and use alternative sources to complete their notes etc.

The key for all these strategies is their systematic application and cooperation between specialists in education sciences and all other professors, so, an important step for the success of our program is to sensibiliser our colleagues to involve in applying our measures meant to improve the efficacy of our students learning.

A meta-analysis considering self-regulated learning for programs in universities (Theobald, 2021) indicated a “larger training effects for metacognitive and resource management strategies as well as motivation. Cooperative learning arrangements predicted larger training effects for cognitive and metacognitive strategies. The provision of learning protocols predicted larger training effects for resource management strategies. Moreover,

training programs based on a metacognitive theoretical background reported higher effects sizes for academic achievement compared to training programs based on cognitive theories. Further, training programs that targeted older students and students with lower prior academic achievement showed larger effect sizes for resource management strategies. To conclude, self-regulated learning training programs enhanced academic performance, self-regulated learning strategies, and motivation of university students."

As studies demonstrated before (see Dörrenbächer & Perels, 2016) it is important that students learn to assume that their success is up to them through a reflection practice, learn to focus attention during classes, and learn to plan activities so that to reserve the amount of time everyone need for study.

So, academic learning is a complex process with a multitude of factors that influence and beyond all this all human factors should cooperate and reflect about it in order to transform it in a successful experience for all partners involved.

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# Ghana's Debt Restructuring Debacle: Securing Debt Sustainability to Deepen Economic Woes

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## **ABSTRACT**

The huge government expenditure and debt servicing processes in recent years have worsened Ghana's economic woes. With respect to the high fiscal risks of the country, reliable fiscal consolidation measures were required to offset the excessive public debt to minimize the domestic financing risks in the immediate post COVID-19 era. This study aimed to investigate Ghana's domestic debt restructuring program sanctioned by the IMF in the post COVID-19 era and its implications on the economic outlook of the country. It deployed the qualitative research approach by interviewing fifty respondents purposively selected. The study reveals that the fiscal management strategy adopted by the government aimed at restoring fiscal discipline, controlling external borrowing, and putting the public debt on a downward trajectory to secure debt stability has plunged the country into perilous economic situations. Additionally, the study found out that although restructuring the country's debt sourced the much-needed IMF funds for stabilizing the economy, the conditions attached to the loan have adversely affected living standards of Ghanaians. The study recommends strengthening domestic policies, value addition to primary commodities and active involvement of civil society and other non-state actors in policy decision making to avoid continual resort to the IMF for economic bailouts.

**Keywords:** debt sustainability, domestic debt restructuring, IMF, economic hardship, standard of living



## 1. Introduction

The COVID-19 pandemic remains one of the dangerous killer diseases in most recent times. In many ways, the pandemic stunted economic growth and national development reflecting in massive devastations in health and education systems, and fiscal and monetary policies (Braithair & Bofo-Arthur, 2020). There was virtual cessation in trade, manufacturing, aviation, hospitality, and productivity globally (Aduhene & Osei-Assibey). Emerging economies faced worse economic challenges. The industrialized nations such as the US, UK, Italy, France, Russia, and Germany were neither spared the intense wave of the pandemic. Surprisingly, in Emerging Markets and Developing Economies (EMDEs), the impact of the pandemic was profound than earlier projected. Inflationary figures remained largely subdued and echoed sharp drops in real GDP. Also, there were labour market slack that caused global rise in indices on hunger, poverty, and inequality (World Bank, 2022). The various measures taken by governments around the world, namely, lockdowns, reduced numbers at public gatherings, travel bans, and a halt in the import-export trade to reduce the impact of the pandemic even though had immediate positive results, created economic challenges to various countries (Onyeaka et al., 2021). The COVID-19 policy measures therefore subverted economic growth and developmental trajectory of many African countries.

Ghana grappled with the irresistible elements of COVID-19 from 2020 to 2022. Statistically, job losses reached over 42,000 in just two months of the pandemic. Relative to the tourism industry, Ghana lost approximately US\$171 million dollars in three months because of lockdowns and closure of the tourism and hospitality centres in the country (Aduhene & Osei-Assibey, 2021). Unfortunately, the Government of Ghana's relief packages that were provided to businesses and individuals during the pandemic contributed very little in salvaging the situation. The education, health, and transport sectors, for instance, suffered major setbacks due to closure of schools, restrictions on the number of passengers and the number of COVID-19 cases reported and dealt with respectively. In terms of international trade, Ghana's major trading partners such as the USA, UK, France, China, The Netherlands, Belgium, and Switzerland experienced worse economic conditions under the pandemic (Amponsah & Frimpong, 2020). Consequently, the adverse effects of the pandemic on development partners had adverse repercussions on Ghana's economy.

In response to the negative impacts of the pandemic and other global shocks on the Ghanaian economy, the government implemented several policies to cushion the citizenry on the virtual economic sloth in the country (Botchway & Hlovor, 2021). A plethora of discretionary health, economic and social policies were therefore enacted during and immediately after the pandemic. Prominent among these policies were personal income tax waivers for frontline and medical practitioners, reduction in utility tariffs, food ration for the most vulnerable, and provision of financial assistance to businesses to deal with the harsh conditions (Donkor, 2023). Additionally, in April 2020, the government began a nationwide disinfection and fumigation exercise of schools, colleges, and universities to facilitate the reopening of schools. For the private sector to remain a viable entity in national development, the financial expenditure of the government on COVID-19 included series of bailouts for businesses and private individuals. The Coronavirus Alleviation Programme Business Support Scheme (CAPBuSS), which was launched by the government in May 2022 supported more than 110,000 businesses. The Ghanaian parliament also granted tax waivers of Gh¢174 million cedis on income taxes of frontline health workers that lasted for a period of three months (Arhinful & Opoku, 2020). The tax waiver was extended to the end of 2020. In the mid-year budget review presented to

Parliament in July 2020, it was reported that the government spent an amount of about Gh¢54.3 million cedis to provide hot cooked meals to 1,827,581 and 917,142 vulnerable people in Accra and Kumasi respectively, and further distributed dry food packages to about 470,000 vulnerable households during the lockdown (Dapaah, 2020). Sufficient reasons were advanced for these social intervention policies and programs. These interventions notwithstanding, the war in Ukraine, bottlenecks in the global supply chain and pre-existing fiscal and debt vulnerabilities, pushed Ghana's public and external debt up (IMF, 2023). The fiscal strategy of the government and the economy in general were severely hampered.

The economic indices of the country in the immediate post COVID-19 era showed anemic growth, high rate of unemployment, elevated inflation, uncontrollable currency depreciation, and lack of access to the external capital market because of the looming unsustainable public debt. Specifically on the public debt, Ghana's debt experienced a substantial upswing in 2020. Although the government had projected the Present Value (PV) of Public and Publicly Guaranteed (PPG) debt to GDP ratio of 55% by the close of 2028 towards its *Ghana Beyond Aid* vision, by November 2022, it stood at a record high of 100.34% (Agblovor & Nsafoah, 2023). Ghana's public debts increased astronomically from 2013 but took a rather harrowing spike by December 2020. Consequently, the country not only infringed on the IMF recommended debt-to-GDP ratio of 70% but also recorded a hefty debt service-to-revenue ratio of 127% contrary to its 55% threshold (Bickersteth, 2023). Continuing its borrowing spree, the government issued a US\$3 billion Eurobond in the early part of 2021. By the end of 2022, Ghana owed bilateral creditors about US\$5.4 billion. China was owed US\$1.9 billion while US\$13.1 billion of debt was owed to Eurobond holders. Significantly, the country owed the Bank of Ghana and commercial banks an amount of US\$34.5 billion (IMF, 2023). These were amounts businesses and private individuals had invested in debt securities like bonds, treasury bills, and pension funds. The Ghana cedi declined by 28% against the US dollar between January and mid-December 2022, relegating it to the status of one of the worst performing currencies in the world. Paradoxically, when it became apparent that the economy was struggling, the government refused to seek support from the IMF (Hlovor, 2023), but rather sought to introduce a 1.75% on electronic levy, popularly called E-Levy. The introduction of E-levy further eroded investor confidence in the Ghanaian economy (Ntim & Botchway, 2023). With the passage of the Electronic Transfer Levy Act, 2022 (Act 1075), the E-Levy which constituted 1.5% tax on electronic payments became operational in May 2022. A year on, the rate was reduced to 1%.

To restore debt sustainability, macroeconomic stability and build the foundation for higher and more inclusive growth, the government approached the IMF for support in July 2022 (IMF, 2024). As a precondition for securing the loan facility, the Government of Ghana began structural reforms in support of fiscal adjustments and the economy's resilience to external shocks. Among others, these policies were to increase domestic revenue mobilization, improve efficiency in public expenditure, and control inflation. Other conditions required for obtaining the economic bailout of US\$3 billion from the IMF included restructuring both domestic and external public debts. A comprehensive debt restructuring strategy comprising both domestic debt exchange and external debt restructuring programme was launched in December 2022 amid considerable resistance from civil society, the media, and citizens. Bondholders and external creditors were stunned by the government's unilateral suspension of interest payments on Ghana's public debt ahead of the restructuring scheme targeted at the IMF loan (Dontoh, 2022). A "staff level agreement" on a 3 billion loan facility between Ghana and the IMF was signed, with debt restructuring as one prominent condition (Savage, 2024). The then Finance

Minister stated that the domestic debt exchanged closed in February 2023 with about 85% of eligible bondholders on board after the deadline for the DDEP had been extended the fifth time. External creditors had to also agree to terms prescribed by the IMF to agree a restructuring of Ghana's debts. Subsequently, in May 2023, Ghana's official external creditors including China and France agreed to restructure their loans to the country. With the financing assurance from these external creditors, the IMF US\$3 billion extended-credit facility was finally approved. The bailout included payment of US\$600 million immediately to Ghana, however, the rest of the facility was to be paid depending on the government's adherence to some austerity measures. Besides the domestic debt exchange, other austerity measures the IMF expected Ghana to adopt were increase in taxes and apparent imposition of losses on domestic investors. This way, the increase in taxes encompassed raising income taxes, the Value Added Tax, and other taxes on commodities and utilities in the country. Further, it also meant that about two-thirds of domestic bond holders had to agree voluntarily to exchange their existing securities for others with less interest payments or rescheduled payment terms.

Ghana's return to the IMF the 17<sup>th</sup> time for credit facility and the debt restructuring program generated considerable research interest after the COVID-19 pandemic. In contrast, the real impacts of the austerity measures earmarked for economic stability and improved standard of living of Ghanaians have not received sufficient scholarly attention. Recent studies in this area have been skewed generally towards the impacts of the COVID-19 on Ghana's economy, and the reasons Ghana sought an IMF bailout. For instance, while Ntim and Botchway (2023) recounted some draconian policies of the government in the immediate post COVID-19 period, Hlovor (2023) reported on domestic politics as the prime reason the Government of Ghana earlier on refused to approach the IMF for credit facility to salvage the economy. Laary (2023) also investigated Ghana's return to the IMF for the 17<sup>th</sup> time and projected that the IMF credit facility with aid conditions would adversely affect the poor and vulnerable in society. This is because of government's reckless borrowing and expenditure prior to the IMF loan. In respect of the scanty scholarly works on the IMF credit facility to Ghana aimed at restructuring the economy in the post COVID-19 period, the study examines the effects of the debt restructuring for the economic bailout and the IMF conditionality on the living standards of Ghanaians.

The study contributes to the extant literature on Ghana's economic diplomacy with the Bretton Woods Institutions and its repercussions on living standards of the people by outlining the negative impacts of conditionalities of IMF loans on the economy. Again, it contributes to knowledge by highlighting the dire consequences of some elite decisions which ostensibly disregard public opinion. The paper is structured as follows. The theoretical framework that anchors the study is presented in the next section and is followed by the methodology. Presentation of results and discussion of findings are captured in the subsequent sections while the conclusions drawn from the findings constitute the final section of the paper.

## **2. The Elitist Perspective on Management of Ghana's Economy in the Post COVID-19 Era**

Elite theory of public policy making, assumes the position that society consists of two groups of people - the mass of people and the ruling minority (Otieno, 2024). The theory was developed by Italian scholars to underscore the class of individual who govern an organization beyond the formal structures and democratic practices (Mariotti, 2020). After the Second World War, the theory became crucial in assessing public policy decisions, tackling important

questions such as how decisions emanating from top class individuals in a country impact the lives of the public.

The fact that the ruling class, who are composed of the minority makes decisions or policies that bind and affect the activities of the populace is incontrovertible (Salawu, 2023). Applied to governance structures, the theory holds that a class of people who occupy topmost positions form a tapestry of power and influence. In the case of Ghana, the elite wield and control considerable political power and influence in the society and dictate the pace of governance and economic policies with little or no inputs from the masses who gave them the legitimate power. An instance is the enactment of a development plan, the *Ghana Beyond Aid* vision with least inputs from the civil society, academia and the citizenry which continue to occupy pages of the *Ghana Beyond Aid* Charter and Strategy Document without practical initiatives and policies to herald its implementation in 2028. The resources of the state are concentrated in the hands of just a few powerful individuals who allocate them based on their preferences. According to the elite theory, all the various forms of governance are essentially oligarchies. Whether in democracies or authoritarian regimes, the elite employ various tactics and strategies to justify the power struggle and manipulate the consent of the masses. Today, it is obvious that the determining factors of policy initiation and execution in Ghana is skewed towards fulfilling an elitist agenda, raising questions about the country's democratic consolidation that was achieved decades ago. Despite Ghana's touted democratic credentials, in recent years, political leaders have substantial latitude of pushing through draconian and unpopular economic policies (Ntim & Botchway, 2023). It is rather unfortunate that the several years of democratic practices have yielded widespread official impunity and loss of most cherished ideological bulwarks particularly in the post COVID-19 period of stringent economic policies (Simons, 2023). Of course, it is this perceived sense of entitlement of the elite in public policy decision making that caused the subversion of the *General Will* of bondholders including retirees and persons with disability during the domestic debt restructuring exercise. Perhaps, that is the reason for which when some bondholders requested to be excluded from the exercise, the government decided not to heed their concerns.

Although political power and decision making are a preserve of the elite, sometimes the actions of the political elite bereft of public opinion create many problems for the State. For instance, it could be observed that the 2016 election promises in the form of tax cuts, subsidies, and abolishment of so-called nuance taxes such as VAT/NHIL on real estates, financial services and import duties landed the country in the ambit of the IMF for the 17<sup>th</sup> time (Abeyrathne, 2023). Indeed, the apparent level of misappropriation of funds during the COVID-19 pandemic, corruption among public officials and its concomitant effect on livelihoods today show the extent elitism can endanger economic growth and national development.

### 3. Methodology

The rationale of the study is to examine the cumulative effect of Ghana's debt restructuring programme and the IMF loan aimed at achieving debt sustainability and macroeconomic stability. An accessible population of fifty respondents including bankers, bondholders, teachers, the media, directors of state institutions (education and health) and unemployed graduates from Ghana's universities and colleges were used.

### **3.1 Sampling and Data Collection**

The study employed the case study design within the qualitative research approach and the interpretative paradigm. This research design was adopted because the study aimed at examining closely the effects of the domestic debt restructuring exercise on the living standards of the people. In the opinion of Schoch (2020), a case study provides the opportunity for a thorough analysis of a situation or a specific experience. Most researchers adopt this design in respect of its ability to offer a detailed explanation and understanding of the manner a phenomenon occurred and reasons behind same (Abubakari, Agyemang & Tei, 2023). The study used interview, focus group discussion and observation as the research instruments. Primary data were collected using a semi-structured interview guide. The main questions bothered on how the restructuring affected the informants and the effects of the IMF loan on livelihoods. Same set of questions were asked throughout the interviews. With a clearly defined scope of research questions and objectives prior to the interviews, the researchers focused on collecting relevant and unbiased data to address research goals, rather than searching for evidence to prove preconceived ideas right.

The participants were purposely sampled based on their expertise and experiences with the phenomenon under study. Selecting a suitable sample size in qualitative research is still an area of conceptual debate and practical uncertainty (Vasileiou et al., 2018). Regarding this assertion, Marshall et al. (2013) indicates that in qualitative research, the researcher should ensure there is enough data to make the study credible. On the contrary, other scholars have found that an appropriate sample size for a qualitative study should range between 12 and 30 participants (Boddy, 2016). Following these findings and the application of the principle of data saturation, the present study used a sample size of 50 to underscore the pervasiveness of the subject matter. The study area was the Greater Accra Region of Ghana. The region harbours most state institutions and contains a mixed population of the elite and the masses. While there are more public sector workers in the urban Centres of Accra, many slum dwellers can also be found in the region. This offers a wide-ranging perspective on the subject matter.

The data were collected between February and June 2024. Data were collected from bankers, bondholders, teachers, media personalities, directors of state institutions and graduates from Ghana's universities and colleges in the study area. The interviews lasted for an average of 30 minutes while the focus group discussions spanned a period of one hour each. Data were prepared through verbatim transcription of interviews and typing field notes. After the transcription, more than two-thirds of the interviewees were involved in member checking to validate their data's accuracy. The researchers studied the data judiciously by sorting and coding the different data into common identifiable themes. As a result, a blend of the emerging and programmed codes was used.

To further enhance credibility, transferability, dependency and confirmation of data and outcome as scholars including Ntim (2022) and Campbell et al. (2020) assert under qualitative study, the study employed other forms of triangulation. By adhering to ethical standards such as informed consent of interviewees, confidentiality, and avoidance of conflict of interest, validity, objectivity, and credibility of the research were enhanced. Apart from the primary data, other documentary analysis from secondary sources were carried out. Thus, the study used more than one method of data collection and analysis technique and multiple sources of evaluating the data such as member checking and peer debriefing. To achieve transferability of findings to other emerging economies that seek IMF loans, a variety of descriptions of situations

and analysis were done. Dependability of the findings was also realized because other researchers read and shaped field notes and examined the research report as well. Finally, confirmability was achieved as secondary data were used to either confirm or refute the stream of primary data. In brief, using inductive and deductive interpretations, the report was written in the context of relevant extant literature.

### 3.2 Demographic Characteristics of Participants

Collection of data commenced in the month of February 2024 and ended in June 2024. Fifty participants were sampled for the interviews. The participants included 30 males and 20 females with varied experiences in their establishments. Table 1 provides a summary of the characteristics of the participants.

**Table 1: Classification of Participants**

S/N	Class of Respondents	Number of Respondents	Age Distribution
1	Bankers	8	40 - 54
2	Bondholders	10	45 - 75
3	Teachers	10	25 - 55
4	Media Personalities	6	36 - 52
5	Directors (Health and Education)	6	53 - 57
6	Unemployed Graduates	10	25 - 38
<b>TOTAL</b>		<b>50</b>	

Source: Field Survey (2024)

## 4. Results

Two key issues were investigated. These are the effects of the domestic debt exchange programme and the IMF loan conditionality on the standard of living of Ghanaians. While admitting that the period before the DDEP and the IMF loan facility to Ghana was not a time of complete state of relief and luxury for Ghanaians, the domestic debt restructuring, and the IMF conditionality have had enormous impact on the standard of living of Ghanaians. Findings of the study point to this direction and are analyzed in the subsequent sections.

### 4.1 Predicaments of Bondholders

Domestic bondholders in Ghana had to sacrifice their investments in support of the Domestic Debt Exchange Programme for the IMF loan. The study found that after the bondholders had hesitantly signed a Memorandum of Understanding (MoU) with the government and participated in the DDEP, the expected coupons on their investments were either delayed or not paid. Some of these bondholders were persons who had retired from active service and had invested their pensions in various government bonds. A couple of these retirees

also survived on these coupons as they had to use the money to purchase drugs and health support systems because of their old age and ill-health. According to one of the bondholders:

*A large portion of my pension funds was invested in bonds. So, my entire life virtually depends on the coupons I receive occasionally from the bonds I purchased. However, for the past months, I have not received anything on my investment to be able to buy drugs and visit the hospital for medical review (Bondholder 3, June 8, 2024).*

One of the key findings of the study was that the maturity periods of domestic bonds were extended but at reduced coupon rates. This led to several protests and demonstrations by the Coalition of Individual Bondholders Group (CIBG) which consisted of the Ghana Individual Bondholders Association Forum and the Individual Bondholders Association of Ghana against the government. It was observed that the non-payment of outstanding principals and coupons on bonds affected not only breadwinners of families but also persons whose education, healthcare and welfare depended on many of these bondholders. On this, a bondholder submitted that:

*The government has extended the maturity date of my bond. Meanwhile, I am told I will earn less than what I expected. In fact, this whole saga is affecting my entire family because I must pay fees of my wards in tertiary educational institutions, care for my sick mother among others. It is a bizarre situation. These are the main reasons I decided to join the protests the finance minister (Bondholder 7, June 8, 2024).*

It is clear from the quotation above that most bondholders face plethora of challenges due to the unanticipated extension in the maturity dates of their bonds. Not only are bondholders affected by the DDEP but also the livelihoods of their relatives in terms of healthcare, education and social welfare are all ostensibly in limbo.

#### **4.2 A Fragile Banking System**

Generally, domestic debt restructuring entails decision of a government to streamline its outstanding domestic debt obligations to reduce the burden of debt service while improving the fiscal health of the country. On the consequences of the domestic debt exchange programme on banks, the study revealed that the exercise involved conversion of short-term debt into long-term debt thereby increasing the interest rate risk exposure of banks. The domestic debt exchange programme had significant spillover effects on the financial sector of the country. Most commercial banks in Ghana are now experiencing declines in liquidity, profitability, and capital adequacy ratio (CAR). It also emerged from the study that the DDEP has not only led to a reduction in the value of the government bonds held by domestic banks but has further caused a sharp decline in the capital of commercial banks and contraction of credit. In this sense, businesses found it difficult to access credit facilities and invest in new projects. Divulging information on this subject, a banker with the Ghana Commercial Bank claimed that:

*Yes, some banks are already feeling the pressure of the domestic debt exchange programme that was carried out in 2022 and 2023. Local banks are facing numerous challenges around their balance sheet and capitalization plans. Besides, customers are no more investing in bonds and other securities. Some Ghanaians who prior to the DDEP used the banking system now make life savings in their homes instead (Banker 1, March 5, 2024).*

Corroborating the data, another staff of Bank of Africa also submitted that:

*Due to the low profit margins of the Bank of Africa, some workers of this branch have lost their jobs. Again, there is always pressure from customers to either cancel their existing investments or close their savings accounts. The banking sector in Ghana is indeed suffering the consequences of the domestic debt restructuring (Banker 6, April 11, 2024).*

Largely, as the data reveal, some Ghanaians have lost confidence in the banking sector. This situation sharply contradicts the hitherto public interest in transacting business with banks which saw the flourishing of the banking sector. In recent times, a cross-section of customers is withdrawing their savings from banks. Neither are others interested in investing in treasury bills and bonds after the DDEP. Every monetary policy seems to be working against banks in the country which is a major concern for the citizenry.

### **4.3 Increased Utility Tariffs**

Utility tariffs have increased steadily after the IMF granted the loan facility to Ghana. It emerged from the findings of the study that the hikes in commodity prices stem from some of the preconditions of the IMF loan. Compounding this, administrative charges ranging from processing of passports to payment for services in tertiary institutions have all occasioned upward reviews. In a discussion, a group of four teachers in Accra retorted that:

*The IMF conditionality is very biting on teachers. The hikes in fuel prices, electricity and water tariffs have consequences on our standard of living. It appears fuel prices are increased monthly at the pumps. This has affected transport fares and so those of us who commute between the workplace and home through vehicles do not find it easy. As a result, you can hardly budget to meet the exigencies of these hard times as costs of food items, other goods and services keep increasing on daily basis. Where you have a family and dependants to cater for, it becomes so difficult to manage with meagre salaries (Focus Group Discussion 1, April 27, 2024).*

In support of the foregoing, a media personality shared her views as follows:

*All administrative charges have increased. Cost of obtaining passport has gone up by more than 50%. For the prices of petroleum products like LPG and petrol, the least said about it, the better. Now, the cost of production in Ghana is very high (Media Personality 3, May 5, 2024).*

Ghana's 17<sup>th</sup> programme with the IMF was associated with some harsh economic policies for achieving macroeconomic stability. Specifically, the IMF demanded reforms in tax policy, revenue administration, governance, and public finance administration. Specific initiatives included removal of VAT exemptions for companies (to save approximately 2% of GDP) and corporate income tax holidays (Acheampong, 2023). The IMF further sanctioned an automatic adjustment of fuel prices, electricity and water tariffs and the adoption of a new fiscal regime for the extractive industries. In respect of this, costs of obtaining Ghanaian passport went up over 100%. Electricity and water tariffs also experienced upward adjustments in July 2024.



#### 4.4 Worsening Poverty Levels

The rise in inflation in the country has negative effect on livelihood. The study revealed that income levels of people do not commensurate with the high cost of goods and services in the market. Prices of most basic life requirements such as food, water and shelter have been affected by high inflation. In a focus group discussion, some teachers in the Ga South Municipality claimed that:

*We are unable to feed our families as expected. The prices of food, rent and utilities have increased and so we cannot afford three square meals a day. In fact, we are living witnesses to the financial challenges of many homes after the IMF loan. Rent charges are high because the price of a bag of cement has been increased recently. We live in real difficult situations and other family members who can help are also unable because of the widespread hardship in the system (Focus Group Discussion 3, June 19, 2024).*

Similarly, three medical directors of health facilities in the Greater Accra Region contended that some patients who visited their facilities were unable to foot the hospital bills when they were discharged because the cost of drugs and other medical apparatus had increased in the country. They had to spend on average two months in the facilities until a philanthropist came to their aid. Regarding education, two directors of education also recounted that parents found it difficult to address the educational needs of their wards under the pretext that cost of school items were expensive. It is important to note that the strain on household budgets is widespread with those in the informal sector equally affected. The worsening poverty levels among these teachers and some parents only reflect a significant portion of the population that grapples with economic challenges due to the preconditions on the IMF loan. Findings of the study also show that while the private sector has little capacity to offer employment to the teeming unemployed youth because of the devastations of the COVID-19, unemployment rates are soaring in the country. According to a graduate from one of Ghana's universities:

*I hold a master's degree in banking and finance but currently unemployed. I have written several application letters to various state institutions and departments to no avail. The usual refrain has been there is an embargo on employment due to the IMF loan to Ghana. In some cases, I was told that only those who embarked on further studies with pay are being employed. It is frustrating that at age 28 and despite the huge cost I incurred in pursuing university education, I still must depend on my parents and other benevolent friends to make a living (Unemployed Graduate 8, May 13, 2024).*

In 2019, the government was able to recruit new graduates from the universities and colleges of education. Ghana had then completed an IMF programme. Nevertheless, the study found that in subsequent years, especially in July 2023 after the country had reached a staff level agreement with the IMF for the loan facility, most employable youth are now trolling the streets of urban centres in search of non-existing jobs. In a focus group discussion, some unemployed graduates in the Accra asserted that:

*... the high rates of unemployment in Ghana now have made some of us miserable. We are married but unemployed. We only try to engage in menial jobs like selling dog chains, plantain chips, loaves of bread and assorted drinks near traffic lights here in the central business district of Accra. But we hardly make profit on our products. All amounts of money we make from these sales are spent on feeding and rent. The most dangerous part of this business is that we usually must chase speeding vehicles to collect our money when the traffic lights turn green. We must do this because since last year June, no state institution or*

agency has called us for any interviews or even discussions about our applications for employment. (Focus Group Discussion 2, May 18, 2024).

As the data show, unemployment figures have risen in the country. Graduates from tertiary institutions are unable to secure meaningful jobs to able to cater for their families. The situation in Ghana is gradually pushing many to the depression stage and causing great disaffection for a lot of people in the society.

## 5. Discussion

This research offers both a qualitative and quantitative (mixed method) insights into the IMF economic bailout contracted by the Akufo-Addo Administration in July 2023 and its impacts on living standards in the country. This section of the paper discusses the findings of the study and is organized under three thematic areas –unilateral domestic debt restructuring system, struggling banking sector and implications of IMF loans on poverty reduction.

### 5.1 Unilateral Domestic Debt Restructuring System

Every debt restructuring exercise throughout the world begins with broad informal consultations with stakeholders before the actual programme commences. In the Caribbean, for example, where countries such as Antigua, Belize and Jamaica are notable for engaging in debt restructuring more often, it takes an average of 13 months of consultations, negotiations, and settlements to be carried out. However, in the case of Ghana, when the government proposed a 30 - 40% haircut to bonds and other securities, all processes related to the debt restructuring exercise were carried out by policy makers within one month. The net effect was felt when prices of such investments sunk in sharp response to the exercise, affecting the huge investments of bondholders and the general economic outlook of the country. Even after the first failed attempt to seek the consent of bondholders, the whole DDEP took less than 3 months to complete. This sharply contradicts best practices in the world.

In another instance, in 2003, Uruguay's debt restructuring began with detailed deliberations between creditors and the sovereign debtor for two months, hence the actual exercise took only seven weeks (Simons, 2023). For Sri Lanka, there were rounds of formal discussions on the domestic debt restructuring exercise with bondholders. When the IMF and official creditors objected to a previous draft deal, the Sri Lankan government held further consultations with bondholders in September 2024 to be able to clinch \$12.5 billion bond rework deal (Libby et al., 2024). While Uruguay, Sri Lanka and other countries received a lot of commendations for their approach, the style adopted by Ghana in this whole debt restructuring exercise was deemed unilateral, shambolic, and demeaning. Perhaps, this is the reason some domestic bondholders refused to participate initially unlike what pertained in Argentina and Barbados. Invariably, Ghanaian policy makers' reluctance to heed early warnings on mismanagement of the economy, the rushed attempts at restructuring individual bonds, and the country's flawed debt servicing record have combined to impact adversely on bondholders and their dependent relatives.

### **5.2 Struggling Banking Sector**

There is no doubt that the IMF loan facility curtailed the external debt servicing challenges in the short-term. Nonetheless, the DDEP posed threats to the banking sector of the country. The findings of the study show that most commercial banks in Ghana appear to have liquidity challenges. The data is consistent with the 2022 audited accounts of Ghana's banks which show that 15 out of 22 banks recorded losses. For instance, the audited accounts showed that the Ghana Commercial Bank incurred a loss of ₵593.4m (\$52m), Standard Chartered Bank, Ghana posted a net loss of ₵297.8m (26m) while Consolidated Bank made a loss of ₵1.5bn (\$131m) in 2022. Even though the government injected 15 billion cedis from the financial stability fund into the economy to provide liquidity for affected banks commencing in September 2022, the fund was inadequate to resolve the insolvency threat of these financial institutions. It appears that the commercial banks in Ghana will need additional capital from both domestic and foreign shareholders to be able to absorb the capital losses and the associated loss of interest revenue because of the DDEP.

Earlier, Reuters had reported that an amount of Gh₵15bn (\$1.36bn) in cocoa bills and locally issued dollar denominated bonds, all constituting 5% of Ghana's total domestic debt was targeted for the domestic debt exchange programme (Adombila, 2023). Accordingly, about \$809m in dollar bonds were replaced by four and five-year bonds with interest rates of 2.75% and 3.25% respectively (Kanika & Nyabor, 2023). Certainly, this has huge ramifications not only on the banking sector but the standard of living of Ghanaians as investors' life savings are still locked in bank securities awaiting prolonged years while among them, the aged and pensioners suffer societal ridicule for their extreme poverty, ailments and other socio-economic challenges that need huge financing to deal with.

As part of the IMF conditionalities, laws that governed the Bank of Ghana have been amended to strengthen the central bank's independence. The global fund also directed the Bank of Ghana to stop lending to the government and eliminate financing of budget deficits which increased inflation. Considering the income levels in the country in the post COVID-19 epoch, the austerity measures geared towards economic recovery are making life quite unbearable for the ordinary people. The situation where inflation soars, utility and petroleum prices skyrocket and prices of general goods and services increase steadily in a murky economic meltdown is apparently responsible for the surge in social deviancies such as prostitution, teenage pregnancy, drug addiction and armed robbery, among the youth.

### **5.3 Implications of IMF Loans on Poverty Reduction**

The implications of IMF loans and conditions on living standards particularly poverty reduction in emerging economies have drawn considerable scholarly attention. Some studies have found that IMF programmes that contain structural conditions increase poverty while loans with stabilization conditions are less likely to adversely impact poverty (Reinsberg et al., 2019). According to Biglaiser and McGauvran (2022), the structural arrangement encompasses structural benchmarks such as trade, tax policies, capital account, labour reforms, privatization of state-owned enterprises and institutional restructuring. Among others, the structural conditions aim to transform political economies using neoliberal mechanisms like deregulation, liberalization, and privatization. Given its comprehensive nature and the fact that the reforms consist intrusive conditions, they restrain the borrower state from adjusting them to mitigate the

adverse consequences on poverty. In that sense, as Easterly (2005) notes, structural reforms encroach on the sovereignty of the borrower state.

In contrast, the IMF (2018) classifies stabilization reforms under macroeconomic variables such as monetary and credit aggregates, fiscal balance, international reserves, and external borrowing that are usually placed under the control of the borrower state. Some modification could be done to the conditions to reduce poverty. Undoubtedly, the primary data is consistent with findings of several studies that claim that whatever conditions are attached, countries that seek IMF loans experience worsening cases of poverty. For instance, Biglaiser and McGauvran (2022) observed that developing countries that accessed IMF loans between 1986 and 2016 had to undertake stabilization reforms but that impacted negatively on poverty reduction. The prevailing living standards in Ghana confirm the assertion that IMF loans have little impact on the poor in borrower states despite the IMF's claim that its poverty reduction programmes are to bridge the gap between the rich and the poor (Lang, 2021).

Ghana has a long-standing history at the IMF in terms of requests for economic assistance. All regimes since independence have sought IMF interventions. For instance, when socialist countries including Russia were unable to support Ghana to overcome its economic challenges in 1983, the Provisional National Defence Council led by Jerry Rawlings returned to the IMF which it had lambasted earlier for assistance (Boafo-Arthur, 1999). In the shorter-term, the economy regained strength. Inflation reduced significantly from 120% in 1983 to 10.4% in 1985 while GDP growth stood at 5% (Debrah, 2009). However, the Economic Recovery Program (ERP) also known as the Structural Adjustment Programme (SAP) embarked upon to overturn the fortunes of the economy ended in adoption of neoliberal policies such as privatization of state-owned enterprises, trade liberalization, retrenchment of workers, cut in subsidies among others. Unfortunately, the SAP and the neoliberal policies which emerged from the Washington Consensus increased unemployment rates and utility tariffs, widened the income inequality gap, and further worsened living standards in Ghana. Although the country was commended by the IMF for being a model to the rest of Sub-Sahara Africa due to its ability to implement the austerity policies (Boafo-Arthur, 1999), the citizenry faced difficult times later. Not even the introduction of the Programme of Action to Mitigate the Social Costs of Adjustment (PAMSCAD) in 1988 could salvage the situation.

The case of the fourth republic is not different from the foregoing narrative. All the administrations in the fourth republic resorted to IMF loans to address key economic issues. However, the conditions attached to these loans included freeze on employment in the public sector, hikes in utility tariffs and stringent control on government spending. An instance is that in a speech delivered at the 69<sup>th</sup> session of the UN General Assembly in September 2014, former President John Mahama noted that Ghana was partnering with the IMF to assess the Ghanaian economy to implement "change in pursuit of true progress" as part of the processes to attain a low middle income country status (Mahama, 2014, p. 5). Based on this, the IMF lent Ghana \$918 million loan facility in 2015 (Appiah-Konadu, et al., 2016). Undesirably, after only three years of implementing an IMF programme of reestablishing debt sustainability, strengthening monetary policy, and cleaning up the banking sector through limited public sector employment, removal of subsidies on petroleum products, among others (Ntim, 2022), the economy experienced high inflation and interest rates, sharp depreciation of the cedi and a host of others. This supports the argument that while Ghana had always sought IMF assistance as a last resort to resolve economic crisis, some of the conditionalities, structural and stabilization reforms prescribed usually exacerbate inequalities and vulnerabilities.

Similar experience exists in Egypt. The IMF recognizes the significant impacts of its support to the Egyptian economy which is complex to manage given the conflict in Gaza and Israel and the disruptions in the Red Sea. The global fund has therefore been consistent in resolving immediate economic crisis in Egypt. As Salma et al. (2024) note, Egypt has borrowed more than \$20 billion in three loans since 2017 and an additional \$8 billion just recently. The IMF approved a support package in December 2022 for the country to achieve macroeconomic stability and private sector-led growth. Despite the interventions by the IMF, the poverty rate in the country which was projected at 29.2% in 2019 increased to 32% in 2020 (Saifaddin, 2024). Although in 2022, the poverty level reduced to 27.9% in anticipation of further declines in 2023 and 2024, living standards among the vulnerable, unemployed graduates and other identifiable groups in Egypt, just like the Ghanaian, Angolan and Kenyan experiences, have not improved after the IMF economic bailouts. In all these countries, reports show that poverty rates keep soaring among households with more individuals and are most prevalent in rural communities than urban centres.

## **6. Institutional Reforms to Boost the Ghanaian Economy**

Diversification of the economy is key to achieving economic growth. Presently, management of the economy through local revenue mobilization or taxation; import and export duties, income tax, property tax among others is not enough to supplement other sources of revenue. The informal sector comprising market women, artisans and smallholder businesses should be roped in the economy. There are sound reasons why everybody should be incorporated in the revenue mobilization of the country. A case in point is that most activities of persons in the informal sector involve import-export trade, use of hard currencies, high electricity voltage and water consumption and deterioration of the environment which are integral to weakening the economy. However, if there are systems to ensure people pay for their ineptitude and activities that derail the stability of the economy, government will, for instance, save money in employing other people to manage waste, reclaim lands at mining sites and engage in green evolution.

Fundamentally, experience has shown that whenever the Ghanaian economy is faced with difficulties, policy makers rush to the IMF for assistance which in turn intensifies the economic hardship in the country in the long run. This demonstrates that while external interventions in the economy may solve problems temporarily, domestic solutions to economic challenges last. Again, studies have shown that policies that support agribusiness and local industries such as value addition to natural resources before they are exported reposed the Asian Tigers, namely, Singapore, Hong Kong, Taiwan, and South Korea to industrialized status (Agba & Ozor, 2018). It is therefore recommended that a carefully thought-out system of value addition to primary products like cocoa, timber, gold, and bauxite through the establishment of agro-processing industries and other refineries will improve Ghana's growth in the export trade and international credit worthiness. Against this backdrop, the government should improve its industrialization drive by granting more local industries and firms start-up capitals and tax holidays to be able to process cocoa, timber, and other natural resources into finished products for export. It is obvious that exporting processed goods would earn the country more foreign exchange, prevent depreciation of the cedi against major currencies, improve GDP growth, reduce over-dependence on foreign aid and enhance equity in international trade. This would boost the economy and make it resilient to exogenous infractions.

Six years after Ghana drew up a development plan, *Ghana Beyond Aid*, to reduce the country's dependence on aid for economic growth and national development, the shift in the development paradigm remains aspirational rather than a meaningful goal to be attained by 2028. The *Ghana Beyond Aid* agenda was unveiled in 2018. The agenda aimed at economic self-sufficiency and minimal reliance on foreign aid given the notable repercussions of aid on the Ghanaian economy such as huge debt burdens and the negative effects on national sovereignty since 1992. On June 13, 2018, the *Ghana Beyond Aid* Committee was inaugurated while the *Ghana Beyond Aid* Charter and Strategy Document was subsequently formulated in April 2019. The Document captures *Ghana Beyond Aid* as a vision which aims to unleash the prospects in all Ghanaians; traditions, norms and values and its resources so that collectively, the citizenry can build a "prosperous and self-confident Ghana that is in charge of her economic destiny; a transformed Ghana that is prosperous enough to be beyond needing aid, and that engages competitively with the rest of the world through trade and investment" (Osafa-Maafa, 2019, p. 8). As Kumi (2021) has underscored, the *Ghana Beyond Aid* vision is validated by the argument that Ghana has achieved limited economic transformation that has rather culminated in over-reliance on foreign aid amidst political and socio-economic challenges. The prospects of the agenda lie greatly in transforming the economy by embarking on rigorous industrialization and infrastructural development, modernizing agriculture, among others with robust domestic resources and minimal foreign assistance (Cudjoe, 2024). Essentially, the agenda is inclined to a gradualist approach to disintegrate the Ghanaian economy from over-dependence on donor partners for economic growth and national development.

Prior to the outbreak of the COVID-19, the agenda appeared to be given urgent attention in major economic policy decisions. On the contrary, in recent years, policy makers have reduced the *Ghana Beyond Aid* vision to the status of a mere bargaining chip for seemingly harsh economic policies in Ghana (Owusu & Botchway, 2024). No serious attention is now paid to the vision. Specifically, the *Ghana Beyond Aid* Committee remains largely defunct while policies towards a *Wealthy, Inclusive, Sustainable, Empowered and Resilient* Ghana as stipulated in major policy documents are hardly pursued. This situation may perhaps be due to policy makers' ardent belief that economic support from the IMF and other bilateral and multilateral donors is always accessible to resuscitate the fragile economy. Obviously, this situation is an affront to any quest for economic self-sufficiency in the current century. Regardless of the challenges that hinder the success of the *Ghana Beyond Aid* initiative, it has the potential of securing in the future, the much-anticipated economic self-reliance that the country needs. The case of Botswana and Mauritius, where aid was utilized alongside prudent domestic policies to transform their economies should be emulated by Ghana. Thus, to extricate the economy from the snare of the foreign aid regime especially the so-called bailouts of the Bretton Woods Institutions, there should therefore be a shift in focus on heavy dependence on aid. Policy makers should use resources judiciously by following financial management procedures while supporting the private sector to lead the way. Further, more emphasis should be placed on sensitizing the populace on the *Ghana Beyond Aid* agenda for them to better appreciate the keystones and at what level their contributions would matter in the full actualization of the vision. Using this mechanism, the citizenry would be ready to make sacrifices towards attaining economic stability which could further be leveraged for sustained and increased local revenue mobilization schemes than IMF interventions that impugne heftily on living standards.

Substantially, policies that support fiscal prudence in the country are blatantly defied while institutions responsible for ensuring compliance remain adamant. An instance is that,

even though the Fiscal Responsibility Act, 2018 (Act 982) has been passed by Parliament to ensure fiscal discipline, prudent public financial management and sustainable national debt, state officials continue to flout the law (Pimpong & Tei, 2022). On this score, this paper recommends that institutions of State such as the Fiscal Responsibility Council, the National Development Planning Commission and Parliament's Public Accounts Committee should be well-resourced to be able to protect the public purse. Moreover, it is about time civil society, constitutional bodies like the judiciary, leaders of faith-based organisations and influential persons of the State spoke on incessant corrupt practices that derail the economy of its robustness.

## 7. Conclusion

Ghana's economy has been severely battered. On the surface, the economy appears to be responding to the measures earmarked by the Bretton Woods Institution to attain debt sustainability. The excruciating economic situation after the restructuring of domestic public debts as precondition for the IMF loan facility is however impacting negatively on the living standards of the people. Poverty and inequality levels, and general economic hardships in the country still linger. This situation seems to worsen daily with fluctuations in food prices, persistent increases in utility prices and a virtual slough in economic projections of the country. It is obvious that IMF structural or stabilization programmes are rife with ambiguities and uncertainties as far as addressing living standards in developing countries are concerned. Clearly, this situation indicates that in most cases, IMF programmes have short-term good impacts on economies but long-term adverse consequences on livelihoods. While prudent fiscal policies are a check on financial management, they are not enough to cure the perennial economic challenges of the Ghanaian economy.

The paper has argued that the austerity measures imposed on Ghana by the IMF to resuscitate the ailing economy add an extra layer of complexity to the pre-existing low standard of living among Ghanaians. This assertion is in line with the elite theory of public policy that suggests that the political elite sometimes make decisions with little or no inputs from the people and indifferent about the repercussions it would have on the public. The findings also show that the State's actions in terms of providing urgent welfare services to the vulnerable in society are inadequate, hence worsening the poverty levels in Ghana. To mitigate the potential of Ghana's economy succumbing to external vulnerabilities and shocks that call for inescapable resort to IMF loans with unbearable conditions, there is the need to disentangle the economy from over-reliance on development partners. This paper invites further investigations into Ghana's debt restructuring exercise with China, the Paris Club, and other creditors in 2023 as a precondition for the IMF loan and its consequences on domestic policies in the post COVID-19 period. Future research could also explore how other loan facilities from Asian countries deepen Ghana's socioeconomic woes, a reason the *Ghana Beyond Aid* initiative must be prioritized by the State.

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# The Noun Phrase in Dosoftei's Writings: The Quantifier

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## ABSTRACT

In the present paper, we aim to analyze the noun phrase in Dosoftei's writings, focusing on the syntactic function of quantifier. The paper will be divided into two parts, the first one dealing with the theoretical framework and the second one being dedicated to the analysis of the investigative corpus. After providing a definition of the noun phrase, quantification and quantifiers, we will focus on means of expressing quantification in Romanian. Then, we will observe the peculiarities of the quantifier as a syntactic function introduced in the *Basic Grammar of Romanian Language*, describing both internal and external quantifiers. As far as the investigative corpus is concerned, we will first discuss the class of substitution of the quantifier. We will then proceed to the description of complex noun phrases, in which quantifiers co-occur with other syntactic positions, namely determiners, modifiers and possessors. We will first discuss the internal structure of each noun phrase and then we will provide examples to support our demonstration. All in all, the examination of the investigative corpus will reflect the complex possibilities of structuring the noun phrase, illustrating the diversity of syntactic constructions in Old Romanian, as far as the quantifier is concerned.

**Keywords:** noun phrase, quantifier, quantification, internal quantifier, external quantifier

## Introduction

In the present paper, we aim to analyze the noun phrases in Dosoftei's writings, paying particular attention to those which have quantifiers as adjuncts. We will first provide a theoretical overview of quantifiers and then we will proceed to the analysis of the investigative corpus.

The corpus is represented by Dosoftei's main writings, namely, *Psaltirea în versuri* (DPV.1673), *Cartea de rugăciuni* (DCR.1673), *Dumnezeiasca liturghie* (DDL.1679), *Psaltirea de-nţales* (DP.1680), *Parimiile preste an* (DPar.1683) and *Viaţa şi petrecerea svinţilor* (DVS.1682-6). We chose this corpus because of the great variety of syntactic patterns found in Dosoftei's writings. We will adopt the perspective exposed in the *Basic Grammar of the Romanian Language* (GBLR).

## 1. The theoretical framework

### 1.1. The noun phrase

The noun phrase can be defined as that part of the sentence which has a noun, a pronoun or a number as its head, along all the constituents subordinated to it, known as adjuncts (e.g., *acel băiat inteligent pe care l-am întâlnit ieri / that intelligent boy I met yesterday*).

### 1.2. Quantification and quantifiers

**1.2.1. Quantification** can be defined as a semantic function specific to the noun phrase and fulfilled by quantifiers, whose function is to specify the extension of the predicate, i.e. to indicate the quantity of individuals for which the propositional function is true or false. Quantification can be numerical, if it is expressed by cardinal numbers (e.g., *There are three notebooks on the desk.*), or nonnumerical, if it is expressed by indefinite pronouns or adjectives (e.g., *There are a few notebooks on the desk.*) (DTG 2023: 187).

**1.2.2.** The term **quantifier** was first introduced in logics in order to specify the number of individuals for which the propositional function is true or false. There are two main types of quantifiers in logics: *universal quantifiers*, if the proposition is true for all individuals pertaining to a particular domain, and *existential quantifiers*, if the proposition is true for some of the individuals pertaining to a particular domain. Logical quantifiers (universal and existential) should be distinguished from numerical quantifiers, represented by cardinal numbers. Both types of quantifiers belong to the larger class of quantitatives. As far as the semantic-syntactic function within the noun phrase is concerned, quantifiers should be distinguished from, on the one hand, determiners, represented by articles and by possessive and demonstrative adjectives, and, on the other hand, modifiers, represented by adjectives, prepositional phrases and relative clauses. (DTG 2023:187-188).

### 1.3. Quantification in Romanian

In Romanian, quantification is expressed by quantifiers, including quantitative determiners and other types of adjuncts: cardinal numbers (e.g. *trei copii/three children*), certain indefinite adjectives (e.g., *în fiecare zi/each day*), interrogative adjectives (e.g., *câte cărți?/how many books?*), relative adjectives (e.g., *Nu știu câte cărți ai acasă./I don't know how many books you have at home.*), negative adjectives (e.g., *nicio remușcare/no remorse*) and the definite and indefinite article (e.g., *cartea/the book, o carte/a book*) (GALR I 2008: 101).

Cardinal numbers express a definite quantity, while indefinite adjectives express an indefinite quantity (GALR II 2008: 81).

### 1.4. The syntactic function of quantifier as described in the *Basic Grammar of the Romanian Language*

The quantifier is a syntactic function specific to the noun phrase with a noun as its adjunct which can occur only in the presence of the determiner, and is expressed by quantitatives. A distinction should be made between, on the one hand, quantitatives, a semantic class of words belonging to different parts of speech (numbers, indefinite pronouns and adjectives, negative adjectives, adverbs), and, on the other hand, the syntactic position of

quantifier, which is unique within the noun phrase and occurs only in the presence of the determiner<sup>1</sup>. (GBLR 2016: 374-375). The syntactic function of quantifier is realised through the semantic role of the subordinate term (Băilă 2018a: 20).

Another important distinction should be made between **prototypical quantifiers**, internal to the noun phrase (e.g., *aceste două cărți/these two books*, *aceste multe cărți/these many books*) and **external quantifiers**, which cannot be interpolated among the other internal constituents of the noun phrase (e.g., *toate cărțile/all the books*)<sup>2</sup> (GBLR 2016: 376-377).

Alexandru Nicolae observes that external quantifiers can co-occur with internal quantifiers<sup>3</sup> (Nicolae 2011: 643).

## 2. Analysis of the investigative corpus

### 2.1. Class of substitution

The quantifier can be expressed by an indefinite pronominal adjective: *grija cea multă/the great care* (DPV.1673, p. 145, p. 154) or by an adjective cardinal number: *mucenicii doi/the two martyrs* (DPV.1673, p. 348).

### 2.2. Syntactic patterns containing quantifiers

The quantifier can co-occur with other syntactic positions, illustrating a diversity of syntactic patterns, as follows:

#### 2.2.1. Noun phrases with quantifiers expressed by indefinite pronominal adjectives

- (1) determiner (definite article) + emphatic determiner (demonstrative article) + quantifier: *grija cea multă/the great care* (DPV.1673, p. 145, p. 154);
- (2) external quantifier + determiner (definite article): *toată vita/all cattle* (DPV.1673, p. 3);
- (3) determiner (definite article) + external quantifier: *poruncile toate/all commandments* (DPV.1673, p. 11);
- (4) determiner (definite article) + external quantifier + modifier (relative clause): *păsările toate, ce sânt zburătoare/all birds, who fly* (DPV.1673, p. 23);
- (5) external quantifier + determiner (definite article) + modifier (relative clause): *cu toți credincioșii ce-are Izrailul/with all the faithful people Israel has* (DPV.1673, p. 32);
- (6) external quantifier + modifier (relative clause) + modifier (relative clause): *toți ceia ce să închină ciopliților, carii să laudă de idoli săi/all those who worship the heathens, who praise their idols* (DP.1680, p. 528);
- (7) external quantifier + determiner (definite article) + modifier (relative clause) + modifier (relative clause): *toată gânșaniia ce să trage pre pământ, ce are în sân*

<sup>1</sup> There are some words in Romanian that semantically express quantification (*niște, fiecare, niciun, orice* etc./some, each, no, any etc.) but function as determiners within the noun phrase because of their position. For a detailed analysis of their status, see Lavinia Dălălu-Nasta (2018). *Observații privind funcțiile sintactice din grupul nominal*. „Dacoromania”, XXIII, no. 1, p. 43-44.

<sup>2</sup> For a detailed analysis of internal and external quantifiers, see Adela Drăguțoiu (2018). *Problema principiului unicității funcțiilor sintactice în gramatica românească*. „Dacoromania”, XXIII, no. 1, p. 57-58.

<sup>3</sup> For a critique regarding the uniqueness of the position of quantifier within the noun phrase, see Adelina Patricia Băilă (2018b). *Uniqueness in the Romanian Syntax*. „Journal of Romanian Literary Studies”, XXI, no. 1, p. 705.

- suflare de viață/all bug which crawls on the ground, which has in itself the breath of life* (DPar.1683, p. 111);
- (8) external quantifier + determiner (definite article) + modifier (common noun preceded by a preposition): *ca tot omul de supt soare/like all people living under the sun* (DPV.1673, p. 108);
- (9) determiner (definite article) + external quantifier + modifier (common noun preceded by a preposition): *binele tot de pre lume/all the good on earth* (DPV.1673, p. 155);
- (10) external quantifier + determiner (definite article) + emphatic determiner (demonstrative article) + modifier (adjective) + modifier (relative clause): *Tot puternicii cei tare./Ce-i sântet supt ascultare./All the mighty and strong people,/Who are under his rule.* (DPV.1673, p. 234);
- (11) external quantifier + determiner (definite article) + possessor (possessive adjective) + modifier (relative clause): *tot lucrul său ce-au fapt de-atunce/all that he has done ever since* (DPV.1673, p. 323);
- (12) external quantifier + determiner (definite article) + modifier (adjective) + modifier (relative clause): *tot sufletul viu ce-i cu voi/ all living souls that are with you* (DPar.1683, p. 141);
- (13) determiner (demonstrative adjective) + external quantifier + modifier (relative clause): *aceale slove toate ce să tâlcuiesc/all those translated letters*(DPar.1683, p. 258);
- (14) determiner (definite article) + possessor (common noun in the genitive case) + emphatic determiner (demonstrative article) + quantifier: *hiara codrilor cea multă/the many beasts living in the forests* (DPV.1673, p. 112);
- (15) external quantifier + determiner (definite article) + possessor (proper noun in the genitive case): *toată țara lui Hamos/all the land of Hamos* (DPV.1673, p. 241);
- (16) determiner (definite article) + possessor (proper noun in the genitive case) + external quantifier: *răgulele Dommului toate/all the rules of God* (DPV.1673, p. 285);
- (17) external quantifier + determiner (definite article) + possessor (common noun in the genitive case): *toată prada pizmașilor/all the prey of those who envy us* (DCR.1673, p. 151);
- (18) determiner (definite article) + possessor (personal pronoun in the genitive case) + external quantifier: *căile lui toate/all his ways* (DPV.1673, p. 57);
- (19) external quantifier + determiner (definite article) + possessor (personal pronoun in the genitive case): *toată polata și curtea lui/all his storeroom and yard* (DDL.1679, p. 38);
- (20) determiner (demonstrative adjective) + quantifier + modifier (relative clause): *acea puțână sârbie, ce o învăța/the little bit of Slavonic he was learning* (DP.1680, p. 277);
- (21) external quantifier + determiner (definite article) + possessor (possessive adjective) + modifier (common noun preceded by a preposition): *cu tot fiii săi din casă/with all his sons who were living in the house* (DPV.1673, p. 222);
- (22) determiner (definite article) + external quantifier + emphatic determiner (demonstrative article) + modifier (proper noun preceded by a preposition): *stihirile toate ceale din Paraclisul Preacistii/all those hymns from the Virgin's chapel* (DCR.1673, p. 267);
- (23) external quantifier + determiner (demonstrative adjective) + modifier (common noun preceded by a preposition): *toate acele de spăsenie cerșeturi/all those beggings of the humble* (DDL.1679, p. 187);

- (24) external quantifier + determiner (definite article) + modifier (adjective) + modifier (common noun preceded by a preposition): *tot copaciul valan de Vasan/all the oak trees growing in Vasan* (DPar.1683, p. 112);
- (25) determiner + quantifier (indefinite pronominal adjective) + modifier (common noun preceded by a preposition): *alte multe basne de dumnădzăi/the many other stories about gods* (DPar.1683, p. 279);
- (26) determiner (demonstrative adjective) + external quantifier + modifier (common noun preceded by a preposition): *această toată frățâme de surori/this whole brotherhood of sisters* (DVS.1682-6, p. 241);
- (27) external quantifier + determiner (definite article) + possessor (personal pronoun in the genitive case) + modifier (adjective): *toate greșele lui scârnave/all his trivial mistakes* (DDL.1679, p. 195);
- (28) external quantifier + modifier (adjective) + determiner (definite article) + determiner (definite article) + possessor (personal pronoun in the genitive case): *toată bărbăteasca partea lor/all their manly part* (DP.1680, p. 678);
- (29) determiner (definite article) + external quantifier + modifier (common noun preceded by a preposition): *ceatele toate de svinț/all the groups of saints* (DCR.1673, p. 265);
- (30) external quantifier + determiner (definite article) + possessor (proper noun in the genitive case) + modifier (common noun preceded by a preposition): *toate sărbătorile lui Dumnădzău de pre pământ/all of God's celebrations on earth* (DP.1680, p. 463);
- (31) external quantifier + determiner (definite article) + modifier (common noun preceded by a preposition): *toț svinții din țară/all saints in the land* (DPV.1673, p. 200);
- (32) determiner (definite article) + external quantifier + modifier (common noun preceded by a preposition): *limbile toate din lume/all the languages on earth* (DPV.1673, p. 230);
- (33) external quantifier + determiner (definite article) + possessor (possessive adjective) + modifier (common noun preceded by a preposition) + modifier (relative clause): *toț șerbii tăi din țară/Care-am sprejinit în poală/all your serfs/That I supported* (DPV.1673, pp. 204-205);
- (34) external quantifier + determiner (definite article) + possessor (personal pronoun in the genitive case) + modifier (relative clause): *toț boiarii lor, carii dzăsără/all their boyars, who said* (DP.1680, p. 492);
- (35) determiner (definite article) + possessor (proper noun in the genitive case) + external quantifier + modifier (common noun preceded by a preposition): *șerbii lui Dumnezeu toț din lume/all of God's serfs* (DPV.1673, p. 301);
- (36) external quantifier + determiner (definite article) + modifier (adjective) + possessor (proper noun in the genitive case) + modifier (relative clause): *Și toate crăiile bătrâne/A lui Hanaan, ce-s limbi păgâne./And all the old reigns/ Of Hanaan./That are pagan languages.* (DPV.1673, p. 302);
- (37) external quantifier + determiner (definite article) + denominative modifier (proper noun): *toată țara Evilât/all Evilat country* (DPar.1683, p. 113);
- (38) external quantifier + determiner (definite article) + possessor (proper noun in the genitive case) + modifier (adjective): *toate mireasele lui Hristos preacurate/all the most pure brides of Jesus* (DCR.1673, p. 257);

- (39) emphatic determiner + external quantifier + determiner (definite article) + possessor (proper noun in the genitive case): *alalt toț uciniciei lui Hristos/all the other apprentices of Christ* (DCR.1673, p. 261);
- (40) external quantifier + determiner (definite article) + possessor (common noun preceded by a preposition) + modifier (adjective): *toate jigăniile pământului trăgătoare/all the working beasts on earth* (DPar.1683, p. 110);
- (41) external quantifier + determiner (definite article) + possessor (personal pronoun in the genitive case): *toți îngerii lui/all his angels* (DP.1680, p. 528);
- (42) external quantifier + determiner (definite article) + possessor (proper noun in the genitive case) + modifier (relative clause): *toț șerbii Domnului, carii staț în casa Domnului, în curțile casii Dumnădzăului nostru/all of God's serfs, who live in God's house, in the yards of our Lord's house* (DP.1680, p. 622);
- (43) external quantifier + possessor (common noun in the genitive case) + modifier (relative clause): *toate alalte a firii carile n-au nice o prihană, nice pâără/all the other parts of human nature that know neither moral guilts nor denunciation* (DVS.1682-6, p. 217);
- (44) external quantifier + determiner (definite article) + modifier (common noun preceded by a preposition) + modifier (relative clause): *toate fierile de pre pământ ce feace Domnul Dumnădzău/all the beasts on earth which were created by God* (DPar.1683, p. 115);
- (45) determiner (indefinite pronominal adjective) + quantifier + modifier (adjective) + modifier (relative clause): *alte multe bătrâne [mănăstiri] ce-ș da cuvînța/many other old [monasteries] which were built accordingly* (DPV.1673, p. 4);
- (46) external quantifier + determiner (definite article) + possessor (possessive adjective) + emphatic determiner (demonstrative adjective) + modifier (relative clause): *toate lucrurile sale ceale ce feace/all the things He does* (DPar.1683, p. 111);
- (47) determiner (indefinite article) + quantifier + modifier (relative clause) + modifier (adjectival phrase) + modifier (adjective): *un eparh orecare, ce-l chema Hurasadem, ascuțat la mânie și la muncit măiestru/a certain eparch, known by the name Hurasadem, who was hot-tempered and hard-working* (DVS.1682-6, p. 152);
- (48) external quantifier + determiner (definite article) + modifier (adjective) + modifier (verb): *toată iarba vearde de mâncat/all the green grass to be eaten* (DPar.1683, p. 111);
- (49) external quantifier + determiner (definite article) + possessor (proper noun in the genitive case) + emphatic determiner (demonstrative article) + modifier (adjective) + modifier (adjective): *tot chedrul Livanului cel înalt și preînălțat/all the tall and very tall cedars of Livan* (DPar.1683, p. 112);
- (50) external quantifier + determiner (definite article) + modifier (relative clause) + possessor (common noun in the genitive case) + possessor (common noun in the genitive case) + possessor (common noun in the genitive case): *toată carnea ce să mișcă pre pământ, a păsări și a dobitoace și a hiară și a toată gângania/all the living things on earth, birds and animals and beasts and bugs* (DPar.1683, p. 135);
- (51) external quantifier + determiner (definite article) + modifier (common noun preceded by a preposition) + modifier (relative clause) + modifier (relative clause): *toată mulțamea de musică carile au turburat ș-au îngrozât acel nărod din toată lumea strâns/all the music which unsettled and terrified that people gathered from all over the world* (DPar.1683, p. 244);

- (52) external quantifier + possessor (proper noun in the genitive case): *alalte toate a Văhodului/ all the others belonging to Văhod* (DDL.1679, p. 112);
- (53) determiner (definite article) + possessor (possessive adjective) + emphatic determiner (demonstrative article) + quantifier: *mila sa cea multă/His great mercy* (DPV.1673, p. 20, p. 177);
- (54) determiner (definite article) + possessor (possessive adjective) + external quantifier: *ocina ta toată/all your property* (DPV.1673, p. 64);
- (55) determiner (possessive adjective) + quantifier: *a tale cămări multe/your many pantries* (DPV.1673, p. 236);
- (56) determiner (demonstrative adjective) + external quantifier + modifier (adjective): *aceste vase toate de moarte gătate/all these vessels prepared for death* (DPV.1673, p. 22);
- (57) determiner (indefinite pronominal adjective) + quantifier: *alte dări multe/many other lendings* (DPV.1673, p. 8);
- (58) external quantifier + determiner (definite article) + modifier (adjective): *tot soborul creștinesc/all the Christian assembly* (DPV.1673, p. 136);
- (59) external quantifier + determiner (definite article) + emphatic determiner (demonstrative article) + modifier (adjective): *toată viața cea izrailească/all the people of Israel* (DPV.1673, p. 150);
- (60) determiner (definite article) + modifier (adjective) + external quantifier: *fiii omenеști toți/all the human sons* (DPV.1673, p. 324);
- (61) external quantifier + modifier (adjective) + determiner (definite article): *toți dumnezăieștii dascal/all the godly teachers* (DCR.1673, p. 243);
- (62) modifier (adjective) + determiner (definite article) + external quantifier: *ascunsele fapte toate/all the hidden deeds* (DPV.1673, p. 373);
- (63) external quantifier + determiner (definite article) + emphatic determiner (demonstrative adjective): *toți munții aceștia/all these mountains* (DPV.1673, p. 148);
- (64) external quantifier + determiner (definite article) + modifier (adjectival phrase): *tot peștele de frunte/all the best fish* (DPV.1673, p. 241);
- (65) external quantifier + modifier (adjective) + determiner (definite article) + modifier (adjective) + determiner (definite article): *toată preuțeasca și călugăreasca/all the assembly of priests and monks* (DDL.1679, p. 29-30);
- (66) external quantifier + determiner (definite article) + modifier (adjective) + modifier (adjective): *toată greșala volnică și nevolnică/all the mistakes that I did on purpose or were unintentional* (DDL.1679, p. 31);
- (67) determiner (definite article) + external quantifier + modifier (adjective) + modifier (adjective) + modifier (adjective) + modifier (adjectival phrase): *zua toată întreagă, svântă, păciuită și fără păcate/during a whole holy, calm day without sins* (DDL.1679, p. 102, p. 115, p. 149, p. 183);
- (68) determiner (demonstrative adjective) + external quantifier + modifier (adjective) + modifier (adjective): *acestea toate munci cumplite și groznice/all these horrible and terrible labors* (DVS.1682-6, p. 238).

### 2.2.2. Noun phrases with quantifiers expressed by adjective cardinal numbers

- (1) determiner (demonstrative adjective) + quantifier + modifier (relative clause): *acei 2 părinți carii spusăra și viața și sfârșeniia lor/those 2 parents who talked about their life as well as their death* (DVS.1682-6, p. 226);



- (2) determiner (personal pronoun in the genitive case) + quantifier: *cu a ei trei fete/with her three daughters* (DPV.1673, p. 368);
- (3) determiner (indefinite pronominal adjective) + quantifier + modifier (relative clause): *alți cinci ai în carii nu va hi arătură, nice săcerătură/other five years in which there will be neither ploughing nor reaping* (DPar.1683, p. 166);
- (4) determiner (demonstrative adjective) + quantifier + modifier (common noun preceded by a preposition): *aceale doauă vârouri de copaci/those two tree tops* (DVS.1682-6, p. 27);
- (5) quantifier + determiner (definite article) + emphatic determiner (demonstrative article) + modifier (adjective): *doi luminătorii cei mari/the two big skylighters* (DPar.1683, p. 108);
- (6) determiner (demonstrative adjective) + quantifier: *acei trei cuconi/those three children* (DPar.1683, p. 276).

### 3. Conclusions

In Dosoftei's writings, the quantifier can be expressed by cardinal numbers (if it specifies a definite quantity) or by indefinite pronominal adjectives (if it specifies an indefinite quantity). As demonstrated by the 74 syntactic patterns we have taken into account, the quantifier occurs only in the presence of a determiner. Additionally, within the noun phrase, it often co-occurs with other internal constituents, namely modifiers and possessors. Quantifiers can be both internal and external. All in all, the syntactic patterns we have identified reflect the complex possibilities of structuring the noun phrase in Dosoftei's writings, illustrating the diversity of syntactic constructions in Old Romanian in the corpus to be analyzed, as far as the quantifier is concerned.

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# Towards a Deeper Understanding of Global Economic Processes

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## **ABSTRACT**

The economic turmoil that is shaking the world or the poverty from which some countries are unable to extricate themselves calls for new scientific research in the field of economics. One way is a deeper understanding of economics and money. It is essential to understand that the economy can be of two kinds, that is, it can be a closed and an open economy. In closed economies there is no money. Open economies, on the other hand, involve the use of money. The power of money in two countries is theoretically the same (parity) when, say, no one in one country buys anything from the other country and, at the same time, no one in that country buys anything from the other country. Therefore, the power of money is measured by the money of each country divided by the balance between buying and selling. Naturally, all selling implies buying and the opposite.

**Keywords:** economy, many, economic crises, scientific research.

## **Introduction**

Economic crises have always shaken the countries of the world, but they have also shaken some of the free societies. It is a sign that we need new knowledge about economics. We tried to look at the economy in a different way than we are used to. We'll try to show briefly where we've gotten with our research.

## **Economy**

*The economy* is meant to acquire and transform the things of the world into means of livelihood.

It is very important to know that all economies can be divided into two: a) *closed economies* and b) *open economies*.

The economy is open when a community has significant economic links with other communities or with another community. The opening of an economy can (a) bring a richer life, (b) a poorer life, or (c) a life similar to the one before the opening.

At its core, an open economy brings all the more wealth, the more that which is in demand is sold to as many countries and as many people in those countries as possible for as much profit, i.e., with low expenses and high incomes. The state of things is different in closed economies. Here the decisive thing is to make all the necessities of life and to save as much as is needed for a rainy day. In other words, the economy tends, in an open economy, to limit itself to a few things, while in a closed economy it seeks to do all that is necessary for a self-sufficient living. The strong side of an open economy is that it can bring great enrichment when there are enough buyers ready to pay well, and the weak side is that it can bring economic collapse or great poverty if the buyers have changed their tendencies, i.e. they no longer have money to give, they no longer think they need such things, they are better off buying from someone else, they do not want to buy from a particular seller... An economy that has opened up can make life worse for most people, even when people did not realize from the very beginning that they would not succeed in the new economic circumstances, that is, they did a bad reckoning, they did not foresee their economic future well. The strong side of a closed economy is that it cannot lead to a collapse or to great poverty for the majority of the people, and the weak side is that it cannot bring any great enrichment.

The opening of an economy brings countless changes to a community. One of them is the movement of people out of the flock. Like things, those of buying and selling, people begin to move out of the society.

### **Money**

One of the general economic laws is the economic law of the power of money.

The power of money in two countries is theoretically the same (parity) when, say, no one in one country buys anything from the other country and, at the same time, no one in that country buys anything from the other country.

Who can buy something? Who in one country could buy something from another country and, on the other hand, who in another country could buy something from the other country? Travelers, state envoys (envoys, diplomats or other dignitaries), those who go to study abroad, business people, and maybe someone else.

A traveler, an envoy, or someone going to school needs to pay for food, lodging and other things. They must pay with foreign money when they are in a foreign country. But where do they get foreign money from? From those who have such money. Who has foreign money? Foreigners, for it is their country and they use this money in their everyday life. Foreign money can also be sold by businessmen who have sold something abroad, or by other foreigners who, like them, have sold something in that country and have been given money instead of the goods sold. Foreigners can sell foreign money only if they need money from another country (to make a trip, to do a business, etc.). If none of them need money from a country, then the people of that country cannot acquire foreign money other than by selling goods. If the foreigners do not want to buy any goods, then the people of this country have no way to acquire foreign money, other than by dishonest means (theft, cheating...).

Business people are in the same circumstances. If businessmen sell things abroad, then they get foreign money only if foreigners want to buy these things. But if businessmen want to buy things from abroad, then they have to find people who need their money, or find

businessmen who have sold things abroad and found themselves with foreign money in their pockets. Only people who want to come to a country (travelers, state envoys, teachers...) or want to buy something from that country need money from a country. The easiest in this respect are the businessmen who buy things from abroad with the money they received abroad for the things from their own country that they sold there.

As we have said, the power of money is the same as long as there are no links between countries. When a country buys nothing from abroad, but sells nothing abroad, the country's money power is 1 to 1 with all the money of other countries. However, sellers can do otherwise. A seller of money may not realize that the power of money is the same, for which reason he may put a different price. Rather, he will put a price which seems to him to be better both for the sale and for the profit. The price he sets, however, has no meaning until there is a buyer. Then the true price is seen. This price is determined by circumstances. It does not, therefore, remain fixed, but changes with circumstances. One circumstance is the need of the buyer or seller. If the buyer has a great need, then he will give a higher price, and if his need is small, then the seller will either have to lower the price or wait his luck, if his need does not squeeze him. The rulers of one country may, of course, decide on another balance between the money of that country and the money of other countries, but the black market will quickly upset this balance.

Looked at in general, the power of money is seen by the power of money in another country. For example, if 10 lei can be sold for just one dollar, then the leu is ten times weaker than the dollar.

So, traders buy things abroad and sell them in their own country. They buy these things, let's say, with dollars abroad and sell them with lei in the country. Then they have to exchange the leu into dollars to buy other things abroad to sell in the country. But who needs lei? Only those who want to buy things in this country and then sell them in other countries, at home or abroad, need lei. The fewer there are, the cheaper the leu will sell. In other words, the leu will be weaker than the dollar. We say it again, the strength of the country's money is measured by its size relative to foreign money.

Even if there was something good to buy in a country, but if foreigners don't want to buy it, whatever the reason (political, military, spiritual...), then the leu would remain weak. Therefore, the leu gets stronger as traders buy more things from the leu's country to sell abroad, or as people from the leu's country buy fewer things made abroad. As we see, if a country made many things but nobody bought them, its money would still remain weak. So, there is not a neat and measured connection between things and money, i.e. money does not always and at once mirror things. It's about sales at home and abroad, it's about bargaining.

Back to travelers. A traveler from one country can buy money from the country he is going to, to buy the things he needs to travel and live. If no one from abroad is willing to come to this traveler's country, then the money in his country will immediately weaken. Everything happens as described above. Why is this parable significant? To show, once again, the rupture between money and things. Let us say that only ten men from one country, some sent to the rulers of foreign countries, neighboring and powerful ones nearby, went abroad and bought money from those ten countries. The money-power in the country of these ten travelers suddenly fell sharply, although ten men can buy only very-very few of the things that are made in the country in question. We say that the power of money has fallen sharply, because the seller knows that no one asks for such money, and therefore will not be able to sell it. The money in the land of the ten travelers is not worth as much as a dead onion in these circumstances. Though they have bought little of the country in which they have arrived, the purchase of money is natural. As you would not, the strangers have sold something, but bought nothing. So little is more than nothing. The seller of money

might buy their money, only if he wished to have such money in his treasury for the eyes of the world, or if he wished to boast of it to relatives, friends, or acquaintances. There may, of course, be other thoughts in the seller's mind, but there is no use in naming them all. The strength of his desire to buy money from the land of the ten travelers will determine the size of the price. Rather, the ten travelers will have to take some things with them and try to sell them abroad in order to get money. The state of things changes when the traveler takes enough goods with him, sleeps in places where he does not have to pay for staying (e.g. under a tree) and so on. This is why we largely reject today's scientific theories about the balance between money and things and the power of money. We have provided other evidence in this scientific paper and in the scientific papers we have printed before.

Foreigners can usually not touch a country's money at all. They have come and exchanged their things for some things of this country. They can put their hands in, but not keep the money here. They came, they sold their things, with the money they got they bought other things instead, and they went with them to their own country or even to other countries.

Therefore, the power of money is measured by the money of each country divided by the balance between buying and selling. Naturally, all selling implies buying and the opposite.

It's different with money, which many countries use, such as the dollar or the euro. What is it about? The country's tycoons or businessmen one day think that they want to keep their wealth earned in foreign money. By doing so, they give increased power to this money. The power of this money, say the dollar or the euro, increases to the extent that traders and businessmen in other countries think the same way, and even want to sell in this money. People tend to use more often (a) money that is used by more people and (b) money that weakens more slowly. The more a penny weakens, the more the person who has it loses some of his wealth, because he can buy fewer things with it. It's amazing, but a penny gets weaker by the very fact that it gets weaker. People tend to get rid of this money and buy other money instead, i.e. money that loses weight more slowly. The money that loses weight quickly loses even more power. That is why it is in the interests of the rulers of countries to slow down the rate at which the country's money weakens. Let's put it this way: if money (objectively) weakens (objectively) by 1% per month, it will (subjectively) weaken (subjectively) by, say, another 0.5% per month. This coefficient by which a penny weakens is, in fact, a measure of how fast it weakens.

Let's follow a telling example of the added power of money sought in many countries. Let's say we buy with our own money 10 units of money from a foreign country, with the money we receive we buy money wanted in many countries (dollar or euro). Then with this money we buy our own money. We will have enough money in our hand to buy 10 units of the money from the foreign country we started with. We do the same with money from other countries. We can even go on buying and selling money from other countries. We will end up there. It is an unnatural state of affairs, because the economies and economic links between countries are different, so the buying and buying of money should also be different. These facts make us wonder: does not the money sought in many countries acquire an added power over and above its economic power? Rather, this power is derived from the intermediation they make between the money of different countries. The economy of the countries whose money is sought in other countries thus adds to their gain. The added power does not, of course, save all the money sought in many countries from great shocks.

There are many ways of strengthening the country's money. For example, the country that sells something endeavors to sell these goods in the countries from which it can buy what it needs, and thus it uses not a money that is widely circulated among the countries of

the world (dollar or euro), but the money of that country. The dollar or euro is so powerful because it is used by many people in many countries. This power gives it even more power, as it slowly weakens because of the power it has. What is more, money that is used by many people in many countries is safer from economic crashes in the various countries where it is used. Thus, the economy of the United States of America is also safer from some economic crashes. It is not shielded from all of the factors that trouble an economy, but it is shielded from some of them. It is, therefore, healthier, stronger... Countries that have money used in many other countries can afford not to shop abroad. Let's say someone sold some things abroad. He sold them for foreign money. Now what to do with this money? If no one in his own country is looking for such money, i.e. he doesn't want to buy anything abroad (when traveling, to sell at home, some wealth abroad...), then he can only (a) put it in his stock, (b) lend it, (c) buy things that are wanted in his own country and sell them at home or (d) exchange it for money that is wanted in your country (if it is such money). All this may not work and then the seller complains that he has no profit from selling things abroad. In other words, selling abroad forces you to also buy from abroad, still from the country in whose money you were paid for the things or works you sold abroad. Here is another reason why money that is used in more than one country is so sought after. The seller goes to country A and sells there his things or works for which he gets dollars or euros, then he goes to country B and buys those things which are better priced and more sought after in his own country or sells this money to the dealers in the country who buy from country B. Lack of money which is used in many countries makes the sellers to sell their goods in the countries from which the goods which are wanted or sold in his country are bought. There is a narrowing of the selling-powers. Let us consider an example. A seller can sell his goods in countries A, B and C. Except that nobody in his country buys anything, or buys little, less than this seller has to sell, in countries A and B. This seller is forced to sell his things in country C, even if the profit is lower. Countries whose money is used in many other countries, such as the dollar or the euro, gain, as we have said, by not having to buy anything abroad. Selling abroad brings gains in that the seller increases his sales volume, i.e. he gets more buyers, and therefore more profits. If the money in which he sells his goods is also used in his own country, he can spend it freely at home without having to convert his earnings from foreign money into his own. The emptying of the country of foreign goods or works, that is, goods or works bought from abroad, enables businesses to win the buyers at home, which brings new gains.

Labor must be included among the goods sold. Some countries have started selling labor to foreigners. These foreign workers earn money abroad and bring it back home. As a result, the country's money is getting stronger. At the same time, countries gain some capital that can be used in business. This money was one of the most powerful sources of capital for the country's business community in the early years of the transition from communist to capitalist rule. It helps the money brought in by those who have gone abroad to work and to develop certain branches of the economy, particularly masonry, since the main target of those who have left is housing. All these gains are of course accompanied by losses.

The economic and monetary situation in the country is not changing. In other words, on the one hand, the country's economy is neither better nor worse than before, and on the other hand, the country's government does not print more money or take any other monetary measure. But the price of a good which the country buys from abroad increases. Under these circumstances, we see that the price in the money of the country increases for this good, but the difference between the money of the country and the money with which this good is bought abroad remains unchanged. There is therefore inflation. The higher the prices of more goods bought abroad, or the greater the importance of these goods in the country's economy, or the greater the number of goods bought abroad, the higher the

inflation will be, and the more inflation will affect other branches of the economy. However, the balance between national and foreign money will not remain unchanged for long, for any increase in the price of goods bought abroad weakens the economy of the country and impoverishes the people in an open economy.

In general, the rulers of a country that is in economic loss, i.e., that has a bad balance of sales and purchases in and from abroad, can keep the country's money from weakening by using some public levers. They can, for example, demand that the country's money be used for sales or deposits in the bank, or demand that all sales of expensive things, such as houses or motor vehicles, be made through bank accounts. We shall not go through the whole series of little examples on this point, for our parables reflect their generality. Money can also be strengthened by unnatural economic levers, strengthening the economy. One way is to place large duties on things brought into the country from abroad, which helps to support domestic enterprises and thus to develop the country's economy. The most that can be burdened with duties are the things sought after by the rich, for they have the means to pay and cannot tie up their desires. Non-economic levers can also be used. They can, for example, persuade the citizens that they should try to use the country's money wisely in order to improve the economic state of the country and, therefore, of each one of them. It is not easy, but it is not impossible either.

It is clear that the country which sells more than it buys from another is in profit, and this profit is shown, roughly speaking, by the difference in the power of money in each country, one from the other, in the frontiers of sales, as the economy is more comprehensive. Undoubtedly, if a country sells much at a large profit to ten countries, and sells a little at a small loss to one country, it will usually be in profit, and will not feel the loss it has. The profit at which things are sold abroad is a necessary factor in strengthening money. How much is sold is the quantitative side, and how much is sold is the qualitative side. They are two sides of the same thing, and can by no means be separated, except in our minds, for the sake of an easier knowledge of the world. Both have a decided bearing on the power of money. It is useless to sell much abroad if you sell at a bad price. We're talking about the country. An enterprise or two may make a good profit even under these circumstances, and their owners may even be great rich men. The country will remain poor, that is, most of its inhabitants. It is worthwhile for the country to sell abroad at such a profit that the country's treasury is filled with money, so that the needs of the whole population (defence, diplomacy, culture, science, etc.) as well as those of each individual citizen (home, health, school, work, kindergarten, etc.) are met. The extent to which people's needs are met is decisive in determining the profit of selling things abroad and of buying things abroad. The balance between quantity and quality may be such that sales abroad may fall, but the country's revenue may rise, because the price of the goods sold also rises, and the goods sold increase more than the number of things sold abroad. Moreover, an increase in the selling price and a decrease in the goods sold, to such an extent that the revenue is still on the rise, is to the advantage of the seller. If the businessman will be in profit, then the workers may not know the same good. Some of them might end up with higher wages, but others will lose their jobs. Under these circumstances, the country's rulers could easily increase the debts to the businessmen in this or those branches of the economy and easily fill the country's treasury even more.

A measure of a country's economic strength is also the share of things done in the country. It is not enough to look at relative magnitudes to measure the well-being of people or the country. We must also look at the absolute ones, that is, count the things done in the country. These measures are all the more telling, the more people live in cities, particularly in large cities with many buildings.



Every country must, therefore, in the circumstances of an open economy, sell abroad and buy from abroad as much as it can make a profit, or at least not make a loss, by seeking prices which are to its advantage, that is, it must sell more expensively what it has to sell and buy more cheaply what it has a necessity to buy. Otherwise she weakens economically. It is just that it is impossible for all countries to be in profit, which is why we have rich countries and poor countries. It's easy to do that in a communist society (communism, socialism...), but it's different in a capitalist society or a society where there is oppression of man by man. The sellers are not the state (state enterprises), but the common man (private enterprise). On the one hand, everyone works on his own and has no comprehensive view of the country's economy, and on the other hand, everyone is a slave to himself. The businessman doesn't care if the country loses as long as he's winning. The open economy is therefore much worse than the closed one. The statistical analysis of the two (weighting by quality of life) proves it. Money power is only one measure of a country's economic health, which is not always enough. We also have to look at how much is bought and sold and at what price it is bought and sold, i.e. at a profit or at a loss. If little is sold and bought outside, the power of money tells us nothing. Therefore, the best measure is always hours of labor.

It's true that some countries sell a lot abroad at a very good price, but they have a very weak currency. One factor may be the over-printing of money, i.e. crowded money. The country's rulers choose to print a lot of money, more than is needed. As a result, the country's money is weaker than money in other countries. If printing money is done all the time, then we will have a continuous weakening, linear or in steps, depending on how the money is printed. Foreigners will not, under these circumstances, want to keep this country's money. Neither will the business men of this country wish to do so, unless they are compelled by the various levers, of which I have spoken a little above, by the landlords of the country.

Who benefits from strong money and who benefits from weak money? Thanks to a strong bank, at least: (a) the common people, i.e. most of the commoners (every weakening of money, which comes with price increases, is a loss of wealth), especially those with very low incomes; (b) the country's treasury, because the dignitaries do not complain that they do not have enough money at the end of the year as a result of price increases; (c) economic projects or projects involving long-term economic expenditure, i.e. strategic development; (d) banks, since more people keep their money there, unless other factors (e.g. corruption, which leads to large bank thefts, or frequent economic upheavals) are opposed; (e) everyone, because the fickleness of money power makes businessmen expensive and they look for a big profit in a short time; (f) the country's money, because more people use it both at home and abroad.

What does an incessant weakening of money tell us, when it is not the printers who are to blame, who print or beat on their own head more ba-ni? This incessant weakening tells us that the country's economy is constantly crumbling, which means that the people are also sinking into poverty. Only a handful of well-to-do are doing well in all circumstances. No matter how poor a people may be, there will always be a handful of rich and very rich people in countries where there is economic oppression. At the very least, the weakening of money urges us to make economic analyses that reassure us that it is not due to other monetary or, more broadly, economic factors.

The strengthening of the country's money should not be a cause for rejoicing under all circumstances. If we sell well abroad, but do not bring goods from abroad and do not have them in the country, then people will lack the necessities of life and will suffer, they will be poor. There's no point having good money in your pocket if you have nothing to buy with it. In times of hardship, people would give a bag of money for a loaf of bread.

The economic knowledge that we have presented in this scientific paper can be used to build an economic prediction model of the strengthening and weakening of money. The core of the model is to be made up of three parts, namely: a) the balance of sales in and purchases from outside the country, b) the money policy of the country, c) loans from outside the country to the state treasury, and d) the use of money by the people of the country and of other countries for the preservation of.

A rich country and a strong economy does not mean rich people and a rich society. The money that remains in the pockets of businessmen, always few in number, does not bring wealth either to the people or to the society. Likewise, the money of the rich may end up in the country's treasury, but not in the people's pockets. Thus we see countries that have beautiful houses and buildings, well-made roads and bridges, mown and watered grass, and so on, but the people are still poor, being reduced to the bare necessities and forced to count every penny very carefully. The good and even clean houses and roads, as well as the mown and cut grass, make you think that people are doing very well in these countries, which is not the case. What is more, you can see in these countries how the smartest, most honest and hardworking people are sitting without a job. Each individual man and the people as a whole have as much as they can get from businessmen.

This economic law can be called, as I said at the outset, the economic law of the power of money. We are talking, as can be seen, both about the power of money in relation to other money, and about the power of money (domestic and foreign) over the economy of the country and the world.

It must be said that the measures expensive and cheap are relative to the average purchasing power of a population. Nothing is cheap or expensive. Each seller sets the price that brings him the life he wants. Who would say it is wrong to want to live well? The other is that not everyone can buy everything. In other words, it's more appropriate to say that a good sold is or is not in someone's pocket.

It must be realized, however, that money and sales to and from abroad are not the only factor that has a powerful bearing on the state of an economy and, as a consequence, on the lives of the people or the economic power of the people as a whole, though it may become powerful enough to plunge and hold a country in poverty and subjection not only economically but also politically or otherwise.

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# Cultural Heritage, Sustainable Development Goals, and Digital Citizenship through an Interdisciplinary Learning Scenario

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## **ABSTRACT**

This paper explores an innovative interdisciplinary learning scenario that interweaves cultural heritage, sustainable development goals (SDGs), and digital citizenship for English language teaching within a primary school setting. This scenario engages students in researching European monuments using digital tools, crafting digital brochures, and participating in online collaborative interactions. The scenario's activities aim to enhance intercultural awareness, fostering a deeper understanding and appreciation of Europe's rich cultural diversity.

By incorporating themes of cultural heritage, the current scenario promotes values of shared responsibility and mutual respect, aligning with the principles of active citizenship. Simultaneously, it strengthens students' digital literacy and equips them with essential skills for navigating an increasingly interconnected and digitalized world. Through the integration of SDGs, students are also introduced to global challenges, encouraging them to reflect on sustainable practices and their roles as global citizens.

The scenario underscores the significance of connecting language learning with broader educational goals, demonstrating how students can simultaneously develop linguistic proficiency, intercultural competence, and digital citizenship skills. This innovative scenario is implemented as an interdisciplinary one involving the combination of multiple school subjects as it is a vehicle for cultivating active and responsible future citizens capable of addressing the complexities of a globalized society.

**Keywords:** cultural legacy, UN development goals, digital citizenship, cross-disciplinary learning project, education

## 1. Introduction

Nowadays, there are more and more challenges as the world is getting globalized and digitized. Education can deal with these challenges by the integration of interdisciplinary learning scenarios. Themes/topics that can be part of such scenarios may be cultural heritage, the United Nations' SDGs and digital citizenship. On the one hand, cultural heritage plays a crucial role in forming identities, cultivating global understanding, and contributing to sustainable development. On the other hand, the SDGs put emphasis on the importance of inclusive, quality and equitable education, which supports cultural preservation and the ethical use of technology. Similarly, digital citizenship underlines the responsible and informed use of digital tools to engage in societal and cultural development. Based on the above, this paper presents an educational proposal where cultural heritage, sustainability, and digital engagement intersect into an interdisciplinary learning scenario for primary school students.

## 2. Literature Review

As our world becomes increasingly diverse, and diversity is reflected at the core of each culture, education can play a significant role in preserving cultural heritage by implementing educational programs that promote the value of different cultures and aim to shape future citizens who respect and strive to maintain them. This can be achieved through the use of technological and digital tools available in educational contexts. At this point, it is necessary to clarify the key terms of the present paper. First of all, the term Cultural Heritage «includes artefacts, monuments, and groups of buildings and sites that have a diversity of values including symbolic, historic, artistic, aesthetic, ethnological or anthropological, scientific and social significance» (Unesco, 2009:25). Cultural heritage encompasses the physical artifacts and intangible attributes of a community or society, reflecting its history, values, and identity. Unesco (2013) highlights the significance of incorporating cultural heritage into education as a means to promote intercultural understanding and appreciation for diversity. By engaging students in exploring monuments, traditions, and histories, educators can instill a sense of shared responsibility for preserving cultural legacies. Educational approaches to integrating cultural heritage often involve experiential learning, field visits, digital recreations of artifacts, or collaborative storytelling which have been shown according to Smith (2016) that deepen students' emotional and cognitive connections to heritage. The Council of Europe<sup>1</sup> (n.d) supports that «heritage should be part of official school curriculum or an extracurricular activity and provide relevant skills based on a multidisciplinary and cross-sectoral approach. Heritage education helps to develop a better understanding and respect of our living environment, ourselves and others». For this reason, it recommends 11 key pillars (ibid).

- K1 incorporate heritage education more effectively in school curricula
- K2 implement measures to encourage young people to practice heritage
- K3 encourage creativity to capture the attention of the heritage audience
- K4 provide optimum training for non-professional players and for professionals from other sectors with a connection to heritage
- K5 diversify training systems for heritage professionals
- K6 develop knowledge banks on local and traditional materials, techniques and know-how

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<sup>1</sup> <https://www.coe.int/en/web/culture-and-heritage/strategy-21-k1>

- K7 ensure that the knowledge and skills involved in heritage trades are passed on
- K8 guarantee the competences of professionals working on the listed heritage
- K9 develop study and research programs that reflect the needs of the heritage sector and share the findings
- K10 encourage and support the development of networks
- K11 explore heritage as a source of knowledge, inspiration and creativity

All in all, cultural heritage education constitutes an essential component of the initiatives executed in accordance with the obligations of sovereign states and ought to engage a diverse array of stakeholders, fostering networks and operating in synergy with other initiatives or campaigns that are grounded in various international conventions Jagielska-Burduk et al., (2021). It is worth mentioning that culture, which as outlined by Unesco Courier<sup>2</sup> (2023) is «who we are, and what shapes our identity...is the only way to ensure a human-centred, inclusive and equitable development» is at the heart of 17 SDGs<sup>3</sup> that were established by the United Nations in 2015. As stated by the United Nations (n.d<sup>4</sup>):

*«The Sustainable Development Goals are the blueprint to achieve a better and more sustainable future for all. They address the global challenges we face, including those related to poverty, inequality, climate change, environmental degradation, peace and justice. The 17 Goals are all interconnected, and in order to leave no one behind, it is important that we achieve them all by 2030».*

Education plays a significant role in realizing these goals by empowering learners to understand and address global issues (UNESCO, 2015). Global issues related to cultural heritage and the 17 SDGs can be addressed to the benefit of students through technology, with a focus on digital citizenship. Digital citizenship encompasses the responsible and ethical use of technology and internet, encouraging individuals to adhere to moral standards and practices while engaging online and contributing constructively to the digital community (Mossberger et al., 2007) consequently, digital citizens are individuals who utilize technology and internet regularly and effectively. In this context, a digital citizen is someone who leverages information technology to participate in societal, political, and governmental activities (ibid). Ribble and Park (2019) introduced three guiding principles to help digital users responsibly engage with technology and develop as digital citizens: respect- focuses on etiquette, access, and law, emphasizing the importance of valuing and respecting other digital users-, educate- highlights literacy, communication, and commerce, encouraging users to learn how to navigate the digital world appropriately and effectively-, and protect- addresses rights and responsibilities, security, and health and wellness, ensuring users remain safe and maintain well-being in both digital and physical environments. Last but not least, interdisciplinary learning and interdisciplinary learning scenarios in primary education. What is interdisciplinary learning? It is the process by which students come to understand bodies of knowledge and modes of thinking from two or more disciplines and then integrate them to create a new understanding (Kanmaz, 2022). In accordance with Deneme and Ada (2012:886) «Interdisciplinary teaching requires the application of methods and language from more than one academic discipline to deal with a theme, issue, question, problem or experience». Interdisciplinary learning in primary education offers significant advantages, developing students' cognitive, social, and creative skills by integrating knowledge across multiple disciplines and addressing complex, real-world situations (Drake & Burns, 2004). According to the above, an innovative

<sup>2</sup> <https://courier.unesco.org/en/articles/culture-heart-sustainable-development-goals>

<sup>4</sup> <https://www.un.org/sustainabledevelopment/sustainable-development-goals/>

interdisciplinary learning scenario follows that is consistent with the pillars of cultural heritage, the SDGs and digital citizenship.

### 3. From theory to praxis: an interdisciplinary learning scenario

The learning scenario was implemented within the framework of the collaborative eTwinning project "Monumental Europe", involving 15 educators from various disciplines and 219 students from Greece, Spain, Italy, France, and Poland, in 2018, the European Year of Cultural Heritage. Monumental Europe won the eTwinning Award in the category of Primary Schools, for Cultural Heritage, which was awarded by the European Commission. The project was also awarded the European Language Label in Greece. The learning scenario "European Explorers" was developed and implemented as part of the "Teacher Training Program on the Utilization and Application of Digital Technologies in Teaching Practice (Level B ICT Training)". The subject areas involved are English as a Foreign Language, Greek Language/any students' native language, Geography, History, Art, and ICT. As far as curricular Integration is concerned the scenario aligns with the school curriculum and syllabus, specifically, in Greece, with the 5th Grade English Unit 1: "Internet Friends around Europe." It can be carried out in the ICT lab, fostering interdisciplinary learning and collaboration while enhancing students' digital literacy and cultural awareness.

The learning scenario adopts an interdisciplinary approach, fostering a comprehensive understanding by integrating knowledge and methodologies from multiple disciplines. The key pedagogical strategies include guided discovery, encouraging students to explore and uncover knowledge through structured guidance, fostering curiosity and critical thinking (Fisher, 2005). Also, it includes experiential learning, engaging students in hands-on, real-world activities that make learning meaningful and memorable and group collaboration promoting teamwork and peer learning, allowing students to exchange ideas and build collective understanding (Wetzel & Brophy, 2014). This interdisciplinary approach enables students to come to understand bodies of knowledge and modes of thinking from two or more disciplines and then integrate them to create a new understanding. It combines language learning with learning from a variety of disciplines, creating a rich learning experience (Wood & Wood, 1996). It links language acquisition with broader educational goals, enhancing its relevance and application. It also encourages active, engaged, and responsible learning, empowering students to take ownership of their educational journey. It cultivates the skills and values necessary for responsible global citizenship, preparing students to contribute meaningfully to their communities and the world and providing a transformative educational experience that aligns with the principles of lifelong learning and sustainable development.

The learning scenario has been designed to develop a wide range of competencies, equipping students with essential skills for the 21st century:

- Language Skills: Strengthening proficiency in understanding and producing reading, writing, speaking, and listening through interactive and meaningful language activities.
- Digital Literacy: Enhancing abilities in research, collaboration, and creative digital production by utilizing various ICT tools and platforms.
- Intercultural Awareness: Fostering an appreciation of European cultural diversity, encouraging students to explore, respect, and celebrate cultural differences.

The learning scenario integrates diverse thematic elements to provide a comprehensive and engaging educational experience. It focuses on cultural heritage,

exploring what cultural heritage is, including tangible and intangible heritage and discussing why cultural heritage is vital in education. It introduces the concept of researching European monuments, which results in their appreciation of cultural diversity and promotes intercultural awareness. It integrates SDGs, which are part of the New Curriculum -2022- in Greece (Eurydice, 2022)<sup>5</sup>, and encourages students to reflect on sustainable practices and develop a sense of global citizenship. It, thus, aligns with the principles of active citizenship and empowers educators to facilitate global awareness and foster a deeper understanding of the interconnectedness of social, environmental, and economic issues. Furthermore, it emphasizes the development of digital citizenship, equipping students with the ability to navigate the various digital environments safely and responsibly while actively and respectfully engaging in these spaces. This includes strengthening students' digital skills, engaging in online collaborative interactions, using digital tools for research and creation, and, ultimately, preparing students for a digitalized and interconnected world.

It addresses primary school students, aged 10-12 years old, with a language proficiency level of A1+ to A2 on the CEFR (Council of Europe, 2020) scale<sup>6</sup>. The learning activities take place over six teaching hours in the school lab, assuming students are familiar with digital tools such as Google Forms, Padlet, and ProProfs, basic English structures, including the Present Simple tense, adjectives, and nationalities, and basic online navigation skills with Google Maps.

Connecting language learning to broader goals is a dynamic approach that integrates language skills, critical life skills and global awareness. Initially, students enhance their linguistic proficiency through immersive language experiences that align with international educational objectives, bridging the gap between language acquisition and practical application (Dendrinou, 2006). Then, by fostering digital citizenship skills, students become adept at navigating the digital landscape responsibly. They learn essential online etiquette, digital safety, and critical evaluation of information, equipping them for the challenges of the world. It also emphasizes intercultural awareness, helping students understand and appreciate the rich cultural diversity of Europe. By engaging with the values and history represented by European monuments, students develop critical thinking skills and gain a deeper understanding of identity and heritage. This, in turn, builds a global perspective, encouraging them to recognize the importance of cultural preservation and sustainability. Furthermore, the integration of language learning with active citizenship prepares students to address global challenges with confidence and empathy and helps them develop a sense of responsibility and empowerment. In this learning scenario students work together in national and/or transnational groups, a process that requires communication and teamwork. This collaborative learning environment not only improves their language skills but also builds essential life skills such as problem-solving and negotiation. Finally, it nurtures a lifelong learning mindset, inspiring students to continue exploring languages and cultures and preparing them for success in a globalized society.

### ***Activity 1: A European Poster***

Students begin by observing an online map, accessed in Photodentro (n.d)<sup>7</sup> which is the Greek National Learning Object Repository for primary and secondary education, featuring various European monuments. Through guided brainstorming and discussion, they respond to questions such as "What can you see?" and "What countries are

<sup>5</sup> <https://eurydice.eacea.ec.europa.eu/news/greece-national-curriculum-revision>

<sup>6</sup> <https://rm.coe.int/common-european-framework-of-reference-for-languages-learning-teaching/16809ea0d4>

<sup>7</sup> <http://photodentro.edu.gr/>

represented?" This activity aims to activate prior knowledge about European geography and cultural landmarks, encouraging curiosity and engagement.

#### ***Activity 2: What Nationality Are You?***

In this matching exercise, students pair countries with their corresponding nationalities. This reinforces vocabulary related to countries and nationalities, providing a foundation for further discussions about European identity. The activity promotes vocabulary retention and strengthens connections between geographic and linguistic knowledge in a fun and interactive way.

#### ***Activity 3: European Monuments***

Students work in groups to research specific European monuments. Using digital tools, they create written descriptions of the monuments, incorporating historical and cultural details. This activity emphasizes digital literacy, collaboration, and mediation skills, as students synthesize information and present their findings in a structured and engaging format.

#### ***Activity 4: European Monuments Quiz***

Students collaborate in groups to solve an interactive quiz hosted on ProProfs. This activity consolidates their knowledge of European monuments through a gamified approach. By working together, students reinforce their understanding while fostering teamwork and problem-solving skills.

#### ***Activity 5: Cultural Heritage Discussion***

Through a guided class discussion, students explore the concept of cultural heritage and its significance. They reflect on questions such as "Why is it important to preserve cultural heritage?" This activity connects their learning to global themes, encouraging critical thinking and the recognition of cultural diversity as a shared human value.

#### ***Activity 6: Digital Brochure Creation***

Students, working in groups, use the online tool "BigHugeLabs" to design a digital brochure about a chosen monument. They, then, present their creation on the online tool "Padlet", a process that can enhance communication and collaborative learning.

#### ***Assessment***

Students participate in a final questionnaire via Google Forms for reflection. This activity enables students to evaluate their own learning experiences and gauge the effectiveness of collaborative efforts throughout the course. The teacher employs a structured rubric to evaluate student participation and performance in group activities. This assessment focuses on key aspects such as teamwork, creativity, and effective communication. The final stage ends with students sharing their experiences and insights from the project. This collective reflection deepens their understanding of the interconnectedness of the activities, their learning outcomes, and their broader implications for active citizenship and global awareness.

## **4. Conclusion**

This paper highlights the significance of incorporating cultural heritage and SDGs into education through digital tools, using an interdisciplinary approach within the framework of a language subject. The integration of language learning with broader educational goals yields a transformative impact on students, empowering them to



communicate and collaborate in an interconnected world, to work for sustainable development. By cultivating their critical thinking and problem-solving abilities, students develop a foundation for responding to multifaceted global challenges. The development of intercultural competence fosters greater awareness, respect and appreciation for cultural diversity, predisposing learners to engage constructively in international collaboration and dialogue. Furthermore, strengthening digital citizenship practices can ensure responsible participation in digital communities, safeguarding against the pitfalls of the online world. Finally, by reflecting on sustainability and global challenges, learners can be equipped to tackle pressing issues such as quality education (SDG 4), sustainable cities and communities (SDG 11) and peace, justice, and strong Institutions (SDG 16). This paper sheds light on the potential of connecting language learning with broader educational goals, preparing students for a globalized, digitalized world. Future research could explore how interdisciplinary approaches can further enhance global citizenship education and the role digital literacy can play in fostering intercultural understanding.

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# Sustainable Development Goals as a Catalyst for Forming Global Citizens in Democratic Educational Contexts

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## **ABSTRACT**

This paper presents an educational project that has been inspired by the principles of democratic education. It was designed for primary school students and integrates selected Sustainable Development Goals (SDGs) through the implementation of collaborative activities. It aims to equip students with the knowledge and skills that will allow them to be global citizens, who will actively engage in their communities and collaborate with others to create a more peaceful, sustainable, and equitable world. Through diverse activities, it aims to raise students' awareness of vital global issues and foster key soft skills. Students are engaged in exploring human rights topics, such as war, refugees, and child labor, aligning with SDG 16: Peace, Justice, and Strong Institutions. They collaborate on activities addressing climate change under SDG 13: Climate Action and work together to protect and preserve the world's cultural and natural heritage, addressing SDG 11: Sustainable Cities and Communities. All activities are designed within the context of providing quality education that supports lifelong learning opportunities for all according to SDG 4. This paper emphasizes student-centered learning, participatory decision-making, equality and inclusion in education, critical thinking, creativity, and empathy, aiming at urging learners to act towards a sustainable future. By linking global challenges with local contexts, this paper aspires to foster future global citizens to contribute to a more equitable and sustainable world.

**Keywords:** United Nations Sustainability Agenda; Global Citizens; Education within Democratic Frameworks; Educational Project

## **1. Introduction**

Mankind faces numerous problems and challenges, including wars, poverty, hunger, inequality, and environmental degradation. These real-world challenges should be addressed in educational contexts that promote and prioritize equity, inclusivity, participatory decision-making, solution-oriented approaches, critical thinking, and shared responsibility for the planet. Such contexts are democratic ones, grounded in principles like fairness, equality, participation, respect for others, and human rights. Their primary goal is to shape future global citizens who

value diversity, practice empathy, and engage in actions aimed at collective well-being by highlighting the interconnectedness of local and global issues and actions. But how can local issues and actions be effectively integrated into education? One way is through the SDGs. According to the above, this paper presents an educational project that its basic pillars are adhering to democratic educational contexts, SDGs and formation of future global citizens.

## 2. Literature Review

Education systems have a significant role to play in building societies that are more sustainable, cohesive, and inclusive for the future. Education and democracy are inextricably linked to one another (Barber, 1984). Democracy is primarily associated with politics, in the sense that it constitutes a form of governance, a type of political system. Democracy, for Dewey, is more than a government. It is “an associated way of living,” promoted and sustained by a shared, community experience (Dewey, 1916).

The concept of democracy, in addition to its political dimension, also has a value-based essence. Some of the values that are prerequisites for a society to be characterized as democratic include justice, equality, freedom, the rule of law, respect for human rights, diversity, and differing opinions, as well as intolerance towards violence, whether verbal or physical. Certainly, the term democracy in today's multifaceted and diverse world cannot but encompass multiple interpretations: «as a concept, as an idea, as an institution, as a utopia, as a process, as a way of life, as an everyday reality» (Schmidt, 2004: 31).

The ethical principles of democracy can be summarised in three concepts or values: freedom, equality, and justice (Greene, 1988; Kelly, 1994). These principles are the basis for most of the democratic education programmes described by Novak (1994). Democratic values must be at the core of educational frameworks so that their members can strengthen democratic societies (Zajda & Daun, 2009). Education must include activities aimed at fostering political competence and a sense of community (Council of Europe, 2011). Davis (2010) highlights the importance of teaching democracy through practice in schools. Therefore, democracy should be encouraged everywhere, and the best way to raise awareness about democratic values is to integrate democratic education into schools and universities (Lappé, 2006). Dewey (1899, 1916, 1938) promoted the idea of democratic education as a path to engaging in an associated way of living – being in a community and becoming a citizen.

Sleeter (2008) described a series of key characteristics of teaching for democracy in schools. These key characteristics include creating conditions for students to become aware of social issues in order to achieve the common good, enabling them to make democratic decisions related to issues concerning their class, their community, their country, their continent, and the world at large. At this point, it is worth mentioning the following excerpt by Amy Gutmann (Sardoc, 2018:249):

*«...that a well-constituted democracy requires citizens to understand and respect – without necessarily accepting – opposing perspectives. We need to exercise critical judgment in taking up unpopular ideas. We need to respect reasonable points if we robustly – yes, even vehemently – disagree with them, and we need to be law-abiding in the face of legitimately enacted public policies from which we dissent. We should carefully examine the many factors that have contributed to the retreats we have witnessed from toleration and mutual respect across divides, but we must not overlook the central role that a keen focus on civic education can play in helping to turn the tide».*

Such citizens that Gutmann refers to above should be active. According to Reisinger (2017: 24):

«...citizens are active when they are interested in everyday life beyond their families and friendship, e.g. in other people, communities, social and economic processes, and when they act for a better society whether through lot of kind of activities or just through few of them but regularly» and can take part in a wide range of activities (ibid: 25-26):

**Table 1: A wide range of activities of citizens who are active Reisinger (2017: 25-26)**

<p><b>A) activities related to civil/nonprofit organisations or good cases</b>  donating to civil or nonprofit organisations  donating to local/national issues  being a member in civil or nonprofit organisations  being a leader in civil or nonprofit organisations  working at civil or nonprofit organisations  volunteer activity in civil organisations  volunteer activity in non-civil organisations  collecting litters  1% donation  giving blood</p> <p><b>B) activity concerned with local governments</b>  participation on consultation hours of local representatives  participating in public hearings  giving own ideas in public hearings  participating in local forums  giving own ideas in local forums</p> <p><b>C) activities from home</b>  writing blogs  joining to internet groups (e.g. Facebook, etc.)  writing letters to local representatives  writing comments on on-line contents</p> <p><b>D) personal responsibility</b>  health-conscious eating  participation on self-development training</p> <p><b>E) monitoring and/or intervention in local/national issues</b>  monitoring the local issues  monitoring the national issues  monitoring the international issues  getting information from local media  getting information from national media  signing up petition  protesting  establishing firms</p> <p><b>F) political participation</b>  organising petition  voting in referendum  voting in EU election  voting in local/national election</p>
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An educational proposal that combines the principles of democratic educational contexts with an emphasis on forming active citizens through the teaching of the SDGs is the Curriculum "Active Citizen Actions"<sup>1</sup> for Kindergarten, Primary, Middle, and High School, developed by the Greek Ministry of Education, Religious Affairs, and Sports (Law 130372/ΓΔ4/01-11-2024- B' 6048: 61521-61522).

*«...This curriculum promotes a holistic approach, incorporating the 17 SDGs and cultivating students' ability to address complex social, economic, and environmental issues. Its aim is to prepare citizens with critical thinking, collaboration, and social responsibility skills who actively contribute to the creation of a sustainable society based on sustainability, social justice, and environmental protection... emphasizes the principle of individual and collective responsibility, promoting the active involvement of the school community and broader social groups in actions that prepare and shape creative, active, and critically thinking citizens. These citizens can make a substantial contribution to achieving the 17 SDGs, as well as to significant aspects of civic competence...its methodological approach focuses on the holistic, interdisciplinary, and transdisciplinary analysis of topics to highlight the complexity and diversity of global challenges. Through their participation in active citizen actions characterized by experiential, exploratory, and authentic learning: a) Students become aware of the problems of the community (school, local, and broader), b) They design organized interventions to address these problems, and c) They undertake organized action to solve or mitigate the related issues».*

The project presented below, although predating it, aligns with the rationale of the aforementioned curriculum.

### 3. Project Overview

The project "Global Schools" was generated during the meetings of the Transatlantic Educators Dialogue (TED) Program (University of Illinois Urbana-Champaign, n.d.) , which is an opportunity, offered by the University of Illinois (USA), a program of the European Union Center of the University of Illinois at Urbana-Champaign, for educators in the United States and Europe to come together online for shared exploration and examination of a variety of educational topics, such as global collaboration, supporting diverse learning needs, parental involvement, and technology in the classroom. By integrating diverse perspectives, participants explore innovative strategies to support diverse learning needs, parental involvement, and the effective use of digital tools in education (Akkari & Maleq, 2019). Additionally, it encourages the co-creation of resources and lesson plans, which can be implemented across different educational settings to promote inclusivity and transnational collaboration. This initiative not only enhances professional development for educators but also empowers them to inspire their students to think globally and act locally, reinforcing the principles of global citizenship education (Global Education Monitoring Report, 2020). In the program, European participants are mainly invited through the eTwinning platform, which offers educators the opportunity to create collaborative projects and to work in groups on specific issues, on the European School Education Platform.

The project integrates pedagogical approaches (Bourn, 2016) that promote active citizenship and digital literacy, equipping students with essential 21st-century skills. It targets

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<sup>1</sup> <https://iep.edu.gr/el/component/k2/content/199-draseis-energoy-politi>

primary school students aged 11–12 and emphasizes on various subjects, focusing on English, Art, ICT, and Citizenship. Byram (2008) advocates that foreign language teachers engage in how language is offering a new perspective, a challenge to the primary language of identity and a different vision of the culture they live in. This results in to a shift of focus on what can be accomplished through the foreign language. Through their collaboration, students can develop key skills such as critical thinking, creativity, digital literacy, active citizenship and cultural awareness while exploring global issues (Andreotti, 2015). The project involves the pedagogical use of web tools like Canva, Padlet, and Google Drive so that students can engage in meaningful activities that connect them with peers worldwide. These interactions foster a sense of shared responsibility and deepen their understanding of global challenges, such as climate change, human rights, and cultural heritage. The program encourages students to reflect on their roles within a global community, inspiring them to propose solutions and take actionable steps toward a sustainable future.

It is designed to achieve a set of clearly defined learning outcomes aimed at fostering globally competent and engaged citizens. Participants will gain a comprehensive understanding of pressing global issues, encompassing human rights violations and protections, the multifaceted impacts of climate change, and the significance of preserving cultural heritage in a globalized world. Furthermore, the project will actively cultivate essential soft skills; participants will develop their skills in critical thinking to analyze complex information, collaborate effectively within diverse teams, and develop creative approaches to problem-solving. Ultimately, through this integrated approach, the project seeks to foster active citizenship, empowering participants to translate their knowledge and skills into meaningful engagement and responsible action within their local and global communities. By bridging classroom learning with real-world applications, the Global Schools Initiative cultivates informed, empathetic, and proactive global citizens. Building upon these foundational outcomes, the project further aims to equip participants with a deeper understanding of key concepts involving human rights, the complexities of environmental issues and sustainability, the diversity of cultural heritage and its preservation, and quality education. Furthermore, the project will actively develop essential 21st-century skills; learners will develop their communication skills across various mediums, strengthen their collaboration skills in diverse team settings, enhance their critical thinking to evaluate information and perspectives, and build proficiency in relevant digital skills for research and engagement. Creativity can also be fostered through the innovative application of art and web tools, encouraging participants to express their understanding and solutions in innovative ways. Finally, the project aims at engaging learners in citizenship, providing participants the opportunity to explore real-world global challenges in depth and collaboratively propose sustainable solutions, turning the theory into action.

### Topic 1: Human Rights

Participants will reflect on contemporary issues, investigating war and peace, the plight of refugees and their rights, and the challenges of child labour. To facilitate understanding and engagement, students will answer a questionnaire to assess prior knowledge and identify areas for deeper exploration. Building upon this, participants will collaboratively create digital posters designed to advocate for human rights. Canva will also be used to enable learners to make informative posters, while Padlet will serve as a collaborative platform for brainstorming,

sharing ideas, and providing peer feedback. Furthermore, ChatGPT will be used as a research tool to gather information, explore different perspectives, and assist in crafting messages for the posters. This combination of theoretical exploration and practical application will strengthen understanding and empower participants to communicate effectively on these vital human rights issues.

#### Topic 2: Climate Change

The 2<sup>nd</sup> topic addresses climate change, and it will result in the production of a 1-minute video and/or radio spot. During the introductory phase students engage in research about climate change, exploring scientific data, global implications, and the urgent need for action. This will be followed by a brainstorming session where students generate ideas for simple, everyday actions that individuals can adopt to mitigate climate change, such as minimizing carbon footprints, promoting renewable energy, and advocating for policy changes. After that, students working in transnational and/or national groups will collaboratively write, record, and produce their own video and/or radio spots. The final products can be disseminated through European School Radio and the schools' websites, maximizing their reach and impact.

#### Topic 3: Virtual museum tour and Cultural Heritage e-book

The 3<sup>rd</sup> phase involves students working in an immersive exploration of cultural heritage through virtual museum tours and the creation of a digital cultural heritage eBook. Firstly, students will discuss the concept of cultural heritage -both tangible and intangible heritage, traditions, monuments, arts, and languages- and then share examples from their own culture (festivals, famous landmarks, and traditional crafts), emphasizing its importance in preserving the identity and history of society. Then students will engage in virtual tours, such as the Louvre, the Acropolis Museum, or UNESCO World Heritage sites. Each group of students will select a site or artifact that resonates with them, fostering personal connections to global cultural narratives. The culmination of this exploration will be the creation of a collaborative digital eBook, where students will contribute pages featuring an image of their chosen site or artifact, accompanied by a concise description detailing its origin, significance, and an intriguing fun fact. Additionally, students will reflect on their choice, articulating why the site or artifact holds personal or cultural importance. This project not only enhances students' understanding of cultural heritage but also encourages them to appreciate and share the diverse tapestry of human history through a modern, accessible medium.

#### Topic 4: Education and Global Peers

In Topic 4, the project focuses on education and global peers through the activity of creating a Photo Journal. The introduction will emphasize the importance of education globally and highlight the challenges faced, such as the lack of resources, which can significantly impact learning opportunities. Students will research school life in different countries, collaborating with global partners through eTwinning to gain insights into diverse educational contexts and experiences. Then, students will take photos of their daily school routines and write descriptive captions. Using Google Slides, they will create a collaborative photo journal titled "A Day in Our School," showcasing their images and experiences. The photo journal will be shared on the

school's website, allowing the broader community to appreciate the rich tapestry of school life around the world.

#### Final Assessment: Exit Tickets

As a final activity for the project, students will complete exit tickets to reflect on their learning across various topics. The exit ticket prompts are designed to encourage thoughtful consideration of the project's key themes. For the "Human Rights" topic, students will respond to the prompt, "What was one thing you learned about helping others in need?" This question aims to highlight their understanding of empathy and social responsibility. In the "Environment" section, the prompt, "What small action can you take to help the planet?" will encourage students to think about practical, everyday steps they can take toward environmental stewardship. As far as the "Culture" topic, students will reflect on the prompt, "What did you find most interesting about another culture's heritage?" This question fosters appreciation for cultural diversity and the unique aspects of global heritage. Finally, in part 4, which is about Education, the prompt, "What inspired you to learn about students from other parts of the world?" inspires students to share their insights from their cross-cultural educational collaboration and exchange. Students will complete these exit tickets using digital tools such as Padlet or Google Forms, allowing for easy collection of responses. Alternatively, printable cards can be used for a more tactile experience. This reflective activity will not only reinforce the project's learning objectives but also provide valuable feedback for educators to assess student engagement and understanding.

#### 4. Conclusion

This article, which presented an educational project centered on the SDGs and inspired by democratic principles, is deemed more relevant and important than ever in the contemporary social reality, as it is referred by Irina Bokova, Director-General of UNESCO (Unesco: 2017:7):

*«A fundamental change is needed in the way we think about education's role in global development, because it has a catalytic impact on the well-being of individuals and the future of our planet. ... Now, more than ever, education has a responsibility to be in gear with 21st century challenges and aspirations, and foster the right types of values and skills that will lead to sustainable and inclusive growth, and peaceful living together».*

The application of this program fosters collaboration and decision-making, enabling children to grasp concepts of local and global issues. It provides opportunities to practice democratic principles in action through cooperation, discussion, idea negotiation, attentive listening, valuing diverse viewpoints, sharing resources, and contributing their unique insights to the project (Phelan, 2020) having as ultimate goal to mold global citizens who are educated from the early years of their schooling through appropriate actions of an active and holistic nature, fully aligned with the 17 SDGs. Educating students from an early age in such topics educators can lay the groundwork for more equitable societies (Pitsou & Theocharidi, 2024). The paper points out the necessity for more research in this area to develop effective strategies and resources for integrating matters of SDGs into democratic educational contexts.



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## **Degradation Risk Assessment for conservation priorities in Albania's geosites focus on Gradec and Osum canyons, and Pirrogashi Cave**

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### **Abstract**

The assessment of degradation risks in geosites is essential for their preservation, sustainable use, and integration into geotourism and educational activities. This study employs a quantitative risk assessment technique to evaluate the degradation level of geosites, focusing on the Gradec and Osum canyons, and Pirogoshi Cave. The method integrates physical, environmental, and anthropogenic factors to calculate a comprehensive risk index, offering a framework for prioritizing conservation efforts.

Key indicators analyzed include three criteria to assess degradation risk: natural vulnerability (8 indicators), anthropogenic vulnerability (8 indicators), and public use (28 indicators). Results highlight different risk levels underscoring the need for implementing conservation measures to mitigate degradation risks and enhance the long-term sustainability of these geosites.

This research contributes to the development of strategies for balancing conservation with socio-economic opportunities. It represents the preliminary results of a study which is undertaken in this area. Recommendations for stakeholder collaboration and integration of geosite risk assessments into regional planning processes are also discussed.

**Keywords:** Geosite degradation risk assessment, Albania, quantitative assessment, canyons of Osum and Gradec, Pirogoshi cave, natural and anthropogenic vulnerability, public use criteria

## I. Introduction and geomorphosites in study

Geosites are integral elements of the abiotic environment, defined as natural areas with significant geological and geomorphological values within an abiotic geographic landscape. These sites hold immense importance for scientific research, the education of youth and communities, and as critical resources for primary tourism offerings. However, their values are increasingly threatened by degradation resulting from both natural processes and human activities.

In such scenarios, *degradation risk assessment for geosite* plays an important role, ensuring the engagement for their preservation and protection so they can serve future generations. This approach involves the application of a tool aimed at mitigating risks to maintain the valuable integrity of selected geomorphosites.

Albania, a small country in the Western Balkans, is notable for its high geodiversity. According to the Albanian Geological Service website (SHGJSH, 2024)<sup>1</sup>, 1239 geomonuments have been identified across its territory. Despite this wealth, only a fraction of these sites retains formal protection status under the latest natural monument legislation (VKM 303/2019). These geomonuments are classified into local, national, and international categories, highlighting their diverse significance.

According to Prof. Dr. Perikli Qiriazhi (2017, p. 81), national natural heritage is expressed through the term "protected area," which designates the legal status of spaces or objects with unique biodiversity and landscape values. This status, as defined by relevant legislation, mandates the scientific management of such areas to preserve and protect their unparalleled and irreplaceable values. These areas are intended to be passed down to future generations undamaged and scientifically valued as powerful drivers of sustainable development.

Raising awareness among young people is achieved through the promotion of natural resources during the educational process. Students acquire knowledge and develop competencies that enhance their understanding of landscapes, protected areas, natural monuments, and both national and global natural heritage. Educating youth with these concepts and skills not only benefits the region but also contributes to the preservation and sustainable development of its natural resources (Dhimitri et al., 2015).

Natural monuments are a key part of the heritage of a country. Albania has 719 determined *Natural Monuments* (Category III of protection under the IUCN classification), as outlined in the current legal system in Albania (VKM 303/2019). Category III—natural monuments—represents small-scale objects or areas managed to safeguard unique natural and cultural values (Qiriazhi, 2017, p. 89). In this study, only three of these natural monuments have been analyzed: the Gradec and Osum Canyons and the Pirogoshi Cave<sup>2</sup>. These sites hold the status of natural monuments, classified as Category III under the IUCN classification, as defined by VKM 303/2019.

In Albania, numerous studies have been conducted on geodiversity, particularly focusing on their inventory and attributes, such as geographic location, dimensions, causes of formation, and current condition. Another segment of these studies deals with their mapping and the identification of their values. However, fewer studies are dedicated to the assessment of these values and the evaluation of the risk of their degradation.

<sup>1</sup> SHGJSH, (2024), Gjeomeonumentet, retrieved by Shërbimi Gjeologjik Shqiptar (17.12.2024)

<sup>2</sup> VKM, Nr. 303, dt. 10.05.2019, PËR MIRATIMIN E LISTËS SË RISHIKUAR, TË PËRDITËSUAR TË MONUMENTEVE TË NATYRËS

In a recent review study, Vandelli et al. (2024) emphasize that “The reviewed literature on geoheritage degradation risk assessment has shown a significant increase in research efforts since 2016. Most studies have been conducted at local scales, with Brazil and Spain being the most studied regions.”<sup>3</sup>. Specifically, our study focuses on the assessment of degradation risk for the geomorphosites under investigation. The aim is to identify the factors contributing to degradation, evaluate their current state level, and explore and propose management actions for their preservation and protection. Such studies can lead to the implementation of concrete protective measures, particularly for visitors to these monuments, ensuring the preservation of the site's integrity while maintaining its accessibility for tourism. Also, highlighting risks raises public awareness about the importance of protecting geosites, fostering community support for conservation initiatives. Meanwhile the policymakers and stakeholders can make evidence-based decisions to balance development with conservation.

Such a study contributes to the field of geodiversity conservation and, through continuous monitoring, supports the development of appropriate management policies. The greater the threats to geomorphosites—these natural features with scientific, educational, and cultural significance—the more critical the importance of assessing the risk of their degradation becomes.

*The geomorphosites in the study.* The study focuses on three specific geomorphosites. According to Prof. Dr. Afat Serjani (2020), the geomonuments of Albania are grouped as follows:

1. Stratigraphic geomonuments include stratigraphic sections of carbonate, flysch, and molasse formations.
2. Paleoenvironmental and sedimentological forms.
3. Paleobotanical geomonuments.
4. Magmatic, ophiolitic, volcanic, and metamorphic rocks.
5. Metallogenic and economic geomonuments.
6. Tectonic-structural geomonuments.
7. Geomorphological geomonuments including glacial, karstic, erosional phenomena, and landscapes.
8. Astrogeological features.
9. Continental-oceanic features and tectonic plate interactions including the contact zone at Llogara.
10. Underwater geomonuments.
11. Historical geomonuments.
12. Geoarchaeological and geomorphological geomonuments.

This study focuses on geomorphosites belonging to Category 7, classified as geomorphological geomonuments.

This study aims to analyze the risk of degradation for three geomorphosites (*in situ*) as important components of natural monuments, located in the municipality of Skrapar, administrative unit of Qender (SHGJSH - Albanian Geological Service). The selection of geomorphosites for this study is based on the updated final list of natural monuments under VKM No. 303, dated 10.05.2019, and the geomonuments identified by SHGJSH. These are:

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<sup>3</sup> Vandelli, V.; Selmi, L.; Faccini, F.; Ferrando, A.; Coratza, P. Geoheritage Degradation Risk Assessment: Methodologies and Insights. Sustainability 2024, 16, 10336. <https://doi.org/10.3390/su162310336>

Tab. 1. Gjeosites in study, and types.

No.	Name of geomonument	Formation Type	According to SHGJSH	According to VKM, 303/2019, Situation
1	Canyons of Osumi (Çorovoda)	Geomorphological - Fluvial	National	Good
2	Canyon of Gradec	Geomorphological - Fluvial	Local	Good
3	Cave of Pirogoshit	Geomorphological - Karstic	National	Good

Fig.1. Pirogoshi Cave; Fig.2. Osum Canyon (Photo: Ermiona Braholli), Fig. 3. Gradec Canyon (Photo: Krenar Xhaferri)



Fig.1. Pirogoshi Cave; Fig.2. Osum Canyon (Photo: Ermiona Braholli), Fig. 3. Gradec Canyon (Photo: Krenar Xhaferri)

*Cave of Pirrogoshi* (Fig. 1) is a karst cave formed in Cretaceous limestone rocks. This area is part of 25 karst regions of Albania. The karst landscape in Albania covers about 6750 km<sup>2</sup>, approximately 24% of the Albanian territory (Eftimi & Zojer, 2015)<sup>4</sup>. It is located in the valley of the Çorovoda River, 60–70 meters above the riverbed, near the village of Radësh in Skrapar, on the right side of the Gradec Canyon. The cave is situated at an altitude of 500 meters above sea level. Its entrance is arch-shaped, with a length of 1,500 meters, a width of 10–30 meters, and a height of 5 meters. Inside, it features a diverse geomorphology, including chambers, shafts, and galleries extending several hundred meters. The cave is adorned with stalagmites, stalactites, and stalagnates (Mecaj, 2009, pg. 2527)<sup>5</sup>. The cave hosts colonies of bats. It is located 3 km from the town of Çorovoda and can be accessed via the Çorovoda-Gradec motor road, followed by a short walking path. It is a site frequently visited by both local and international visitors, as well as residents. Although locals have often explored the cave, it was extensively studied by Italian speleologists (the “Puglia Grotte” and “Dauno” groups) and Albanian researchers S. Sala and S. Bracellari. The cave has suffered damage to its microforms and is the largest cave in Skrapar (Qiriazi, 2017, 184)<sup>6</sup>.

4 Eftimi, R., & Zojer, H. (2015). Human impacts on karst aquifers of Albania. *Environmental Earth Sciences*, 74, 57-70.

5 Mecaj, N., Academy of Science of Albania “Albanian Encyclopedic Vocabulary”, Vol 3, pg 2527, Tiranë, 2009, ISBN: 978-999 56-10-32-6

6 Qiriazi, P., Academy of Sciences of Albania, 2017. *Trashegimia natyrore e Shqipërisë, vlerat, rreziqet dhe menaxhimi*, pg 184



*Osum (Corovodes) Canyon (Fig.2)* are canyons, narrow passages along the middle course of the Osum River. Osum (Corovodes) Canyons are distinguished for the natural beauty and attract many local and international visitors. Veleshja (2024)<sup>7</sup> estimated that the most beautiful and picturesque part of the canyon starts from the village of Blezënckë to the end of the village Cerenisht. Over millions of years, the river's waters have eroded the Paleogene limestone sections of the mountain ridge down to the riverbed, creating the appearance of a narrow valley with picturesque canyons. They were formed because of two factors: the erosive activity of the Osum River and tectonic movements that shaped the Çorovoda anticline.

The canyons begin near the village of Mican with some interruptions and extend to the town of Çorovoda, spanning a length of 12-13 km and a width of 3-4 meters, widening to 35 meters in some parts. The vertical walls reach depths of 70-80 meters (Qiriazi, 2017)<sup>8</sup>. Within the canyon, there is sparse arboreal vegetation. The Osum River flows through the canyon, with its erosive and dissolving forces penetrating the limestone structure of the Çorovoda anticline, carving out the canyon.

In areas sheltered from the wind, dense trees such as holly, broom, and other deciduous shrubs grow. The canyons hold scientific, educational, sporting, and tourism value (Mecaj, 2009, pg 1908<sup>9</sup>; Kristo, 2009, pg 1107<sup>10</sup>; Neziraj, 2016, pg. 9<sup>11</sup>).

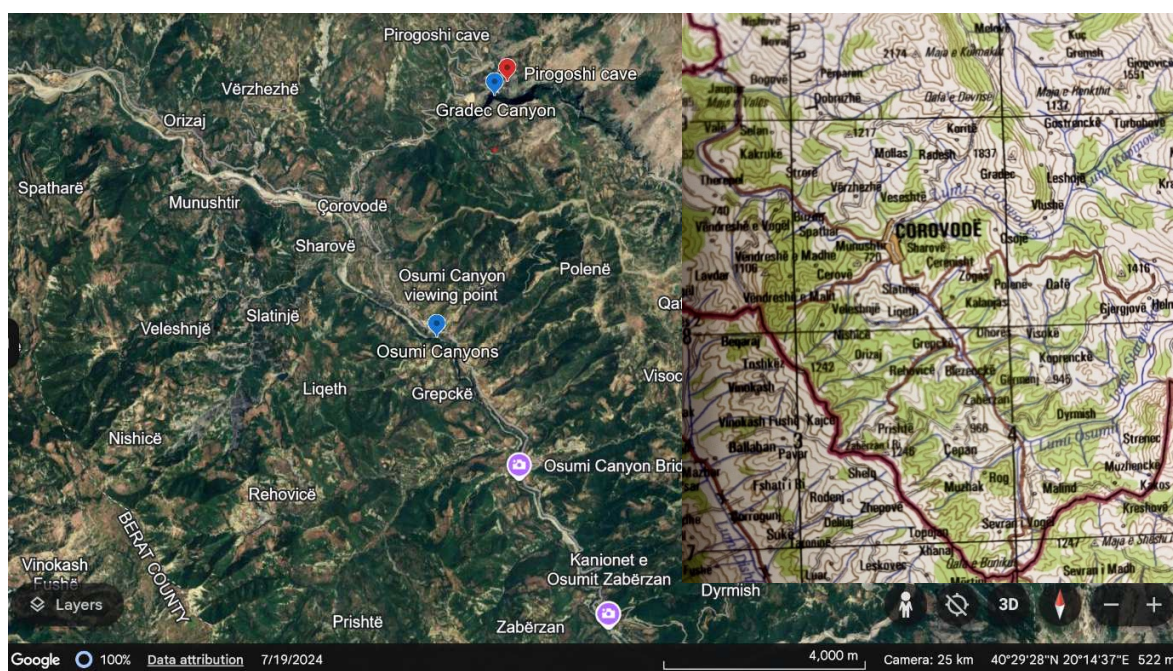


Fig. 4. Geographical distribution of geomorphosites: Gradec and Osumi Canyons, Pirogoshi Cave

<sup>7</sup> Veleshnja, J. (2022, November). Ecotourism and Rural Sustainable Development, Albania Case, Blezënckë Village. In *The International Conference on Cultural Sustainable Tourism* (pp. 109-119). Cham: Springer Nature Switzerland.

<sup>8</sup>Qiriazi, P., Academy of Sciences of Albania, 2017. Trashëgimia natyrore e Shqipërisë, vlerat, rreziqet dhe menaxhimi, pg. 270

<sup>9</sup> Kristo, V., Academy of Science of Albania, "Albanian Encyclopedic Vocabulary", Vol 2, pg 1107, Tiranë, 2009, ISBN: 978-999 56-10-28-9

<sup>10</sup> Mecaj, N., Academy of Sciences of Albania, "Albanian Encyclopedic Vocabulary", Vol 3, pg 1908-1909, Tiranë, 2009, ISBN: 97 8-99956-10-32-6

<sup>11</sup> Neziraj, A., 2016. Gjeomonumentet e Bashkisë Skrapar, pg. 9

*Gradec Canyon* (Fig. 3) Located northeast of the town of Çorovoda, in the middle section of the Çorovoda River's course, this canyon lies at an altitude of 450 meters above sea level. It begins at the Osoja Bridge and ends at Kasabash. Over millions of years, the erosive and dissolving activity of the stream bearing the same name has shaped this highly attractive relief form in the Mesozoic limestone rocks. It is likely that this canyon was once a subterranean karst passage for the Çorovoda River, which eventually emerged on the surface due to the collapse of its roof. This hypothesis is supported by the canyon's morphology, the Pirogoshi Cave, and numerous cavities and galleries on the vertical slopes, which remain unexplored.

The canyon stretches about 3 km, with depths ranging from 100–200 meters. Its width at the bottom varies between 10–15 meters, although there are extremely narrow sections as slim as 2–3 meters. The canyon floor features an irregular relief, making it very challenging to travel on foot. It is also an interesting fluvial and karstic ecosystem. The area surrounding the canyon includes the villages of Osojë, Gradec, Radësh, and Pirogosh<sup>12</sup> (Neziraj, 2016). This monument holds significant scientific, geological, geomorphological, educational, cultural, ecological, and geotouristic value at the local level. For adventure sports enthusiasts, the canyon is ideal for climbing its vertical walls with ropes. To visit the site, follow the rural road from Çorovoda to Gradec, up to the lime production kilns. While there, you can also visit the nearby karstic Pirogoshi Cave. This geomonument has been under legal protection since the decision of the Council of Ministers (VKM) No. 676, dated December 20, 2002.

## II. Methodology

Global studies on the assessment of the geodiversity of a territory are diverse and numerous, both qualitative and quantitative (Brilha, 2016<sup>13</sup>; Brilha, 2018<sup>14</sup>; Coratza, & Hobléa, 2018<sup>15</sup>; Mucivuna, et.al., 2022<sup>16</sup>; Qiriazhi, 2017<sup>17</sup>; Braholli, & Dhimitri, 2022<sup>18</sup>; etc). Starting from the research aim, the nature of the study will be simultaneously: analytical, evaluative, informative and recommending, on assessing the risk of degradation of 3 geomorphosites. It is a study based on a mix methodology, based on quantitative data and qualitative analysis and relies on the evaluation instrument designed according to Selmi, et. al.,<sup>19</sup> (2022), which was originally initiated by Garcia Ortiz et al<sup>20</sup>,(2014). It is structured into criteria, parameters and indicators. It gives a quantitative measurement and allows for possibilities for interpretation and analysis.

12 Neziraj, A., 2016. Gjeomonumentet e Bashkisë Skrapar, pg. 7-8

13 Brilha, J., (2016), Inventory and Quantitative Assessment of Geosites and Geodiversity Sites: a Review. *Geoheritage* 8, 119–134, <https://doi.org/10.1007/s12371-014-0139-3>, Inventory and Quantitative Assessment of Geosites and Geodiversity Sites: a Review

14 Brilha, J., (2018), *Geoheritage: Inventories and Evaluation*. In *Geoheritage: Assessment, Protection, and Management*; Reynard, E., Brilha, J., Eds.; fq. 69–86.

15 Coratza, P., & Hobléa, F., (2018), The Specificities of Geomorphological Heritage. In *Geoheritage: Assessment, Protection, and Management*; Reynard, E., Brilha, J., fq. 87–106.

16 Mucivuna, V.C., Garcia, M.G.M., & Reynard, E., (2022), Comparing quantitative methods on the evaluation of scientific value in geosites: Analysis from the Itatiaia National Park, Brazil. *Geomorphology*, 396, 107988.

17 Qiriazhi, P., Academy of Science of Albania, 2017. Trashëgimia natyrore e Shqipërisë, vlerat, rreziqet dhe menaxhimi.

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19 Selmi, L., Canesin, T. S., Gauci, R., Pereira, P., & Coratza, P., (2022). Degradation Risk Assessment: Understanding the Impacts of Climate Change on Geoheritage. *Sustainability*, 14(7), 4262. <https://doi.org/10.3390/su14074262>

20 García-Ortiz, E., Fuertes-Gutiérrez, I., & Fernández-Martínez, E., (2014), Concepts and terminology for the risk of degradation of geological heritage sites: Fragility and natural vulnerability, a case study. *Proc. Geol. Assoc.* 125, 463–479. **Concepts and terminology for the risk of degradation of geological heritage sites: fragility and natural vulnerability, a case study - ScienceDirect**

This methodology is based on three criteria, which are used to assess the risk of degradation: natural vulnerability (8 indicators), anthropogenic vulnerability (8 indicators) and public use (28 indicators). The evaluation instrument is shown in table 2.

Tab. 2. Criteria, parameters, indicators and scores for the degradation risk assessment of the geomorphosites, according to models offered by Selmi, et. al., (2022)

Criteria	Parameters	Indicators	Points
Natural Vulnerability	Active processes	No active processes affect the geosite	0
		1 active process affects the geosite episodically	1
		1 active process affects the geosite continuously or seasonally	2
		2 or more active processes affect the geosite	3
	Proximity	No possibility of degradation	0
		1 possible active process in proximity of the geosite	1
		2 possible active processes in proximity of the geosite	2
		More than 2 possible active processes in proximity of the geosite	3
Anthropogenic Vulnerability	Economic interest	No geological elements with economic interest	0
		The geosite has one geological element with economic interest	1
		The geosite has two geological elements with economic interest	2
		The geosite has more than two geological elements with economic interest	3
	Private interest	No geological elements of private interest	0
		The geosite has one geological element collectable for private interest	1
		The geosite has two geological elements collectable for private interest	2
		The geosite has more than two geological elements collectable for private interest	3
Public use	Legal protection	The geosite is protected for its geological heritage	0
		The geosite is inside a protected natural area	1
		The geosite is inside an area protected for other values (historical, cultural, etc.)	2
		The geosite is not in a protected area	3
	Human proximity	The geosite is located less than 100 m from a potential degradation activity	3
		The geosite is located less than 500 m from a potential degradation activity	2
		The geosite is located less than 1 km from a potential degradation activity	1
		The geosite is located more than 1 km from a potential degradation activity	0
	Accessibility	The geosite is located less than 100 m from a paved road and bus parking space	3
		The geosite is located less than 100 m from a paved road	2
		The geosite is located less than 100 m from a gravel road or between 100 and 500 m from a paved road	1
		The geosite is located more than 100 m from a gravel road	0



		or more than 500 m from a paved road/ no direct access	
Density of population		The geosite is located in a municipality with less than 100 inhabitants/km <sup>2</sup>	0
		The geosite is located in a municipality with 100-250 inhabitants/km <sup>2</sup>	1
		The geosite is located in a municipality with 250-1000 inhabitants/km <sup>2</sup>	2
		The geosite is located in a municipality with more than 1000 inhabitants/km <sup>2</sup>	3
Degrading use		No degradation from public use	0
		One element of degradation	1
		Two elements of degradation	2
		More than two elements of degradation	3
Control of access		No control at all	3
		The geosite is monitored by one method of control	2
		The geosite is monitored by two methods of control	1
		The geosite is monitored by more than two methods of control	0
Physical protection		The geosite is not protected at all	3
		Geosite with structure for tourists but without physical protection of the geoheritage	2
		Geosite with physical protection but without structure for tourists	1
		Geosite with physical protection of geoheritage features and structure for tourists	0

The assessment highlights the possible geomorphosites to be damaged by public use, or natural processes. It presents a risk gradient separated at several levels, from the lowest to the highest (tab. 3). Applying this methodology can create the possible use of evaluation at the local or national levels in Albania.

Tab. 3. Criteria, points, and risk degradation level, according to models offered by Selmi, et. al., (2022)

Criteria	Partly points	Total points	Total points of risk degradation	Risk level
Natural Vulnerability	0-6	0-33	0-7	Low
Anthropogenic Vulnerability	0-6		>7<15	Average
Public use	0-21		>15<25	High
			>25	Very high

## Result and discussions

The degradation risk assessment for 3 geomorphosites, identified different levels of risk, providing necessary information for their further and specific protection (tab.4).

Table 3 points out that the Cave and Osumi canyons have an average risk level of degradation, while Gradec Canyon presents low risk level, based on natural vulnerability, anthropogenic vulnerability, and public use criteria. Geomorphosites are exposed to fluvial processes (GS-2 and GS-3) and underwater action (GS-1). It is evident that geomorphosites are exposed to opportunities, especially the economic activities of the tourism sector (especially during the summer season).

Rafting and canoeing trips along the Osum Canyon, offered to local and foreign tourists, have not adequately accounted for potential risks. There have been cases of tourists becoming stranded in the canyon, and there is no organized rapid response system in place for sudden and intense floods of the Osum River. Additionally, attention should be given to the impact of tourism on the living organisms inhabiting geomorphological features, particularly during breeding seasons (Qiriaz, 2017, pg. 270).

Tab. 4. The results of the risk assessment

Criteria	Parameters	Pirrogoshi Cave (GS-1)	Osumi canyons (GS-2)	Gradec canyon (GS-3)
Natural Vulnerability	Active processes	1	1	1
	Proximity	1	2	1
Anthropogenic Vulnerability	Economic interest	1	1	1
	Private interest	1	1	1
Public use	Legal protection	0	0	0
	Human proximity	2	3	2
	Accessibility	0	3	0
	Density of population	0	0	0
	Degrading use	1	0	0
	Control of access	2	2	1
	Physical protection	2	0	0
Total		11	13	7

These geomorphosites are characterized by limited human-induced threats. All the sites are natural monuments and stand out for the stability of their conservation status. Osumi Canyons score 3, indicating high accessibility and likely closer interaction with populated areas, road networks, and hospitality services. Pirogoshi Cave and Gradec Canyon score 2, suggesting moderate human proximity. It is primarily impacted by visitor activities and its use for economic purposes, such as quarrying. Osumi Canyons score 3, reflecting well-developed

access routes. Meanwhile Pirogoshi Cave and Gradec Canyon scored 0, indicating limited accessibility. Osumi Canyons are the most accessible and interact heavily with visitors.

Although the geomorphosites are near populated areas, these areas are classified as sparsely populated. Pirogoshi Cave is exposed to potential damage to its karstic formations, and the presence of a quarry poses an additional threat. The geomorphosites are monitored by the National Agency for Protected Areas (ArZM) and local authorities. Visitor activities are carefully managed during tours to these geosites, such as canoeing trips. There are designated observation points for enjoying the natural landscapes, particularly in the Osumi Canyons, and to a lesser extent in the Gradec Canyon.

Access to the cave is supported by auxiliary infrastructure, and informational signs are also in place to guide visitors. This analysis highlights the need for balanced management strategies to safeguard natural features while enhancing their use and accessibility sustainably.

### **Conclusion and recommendation**

The study contributes to the scientific discourse on geodiversity and geoconservation. By operationalizing the assessment of degradation risk, it makes this process measurable and creates opportunities for improved management. Additionally, by identifying and evaluating natural processes (natural vulnerability) and human influences (anthropogenic vulnerability and public use), the study highlights the primary driving forces behind the degradation risks of geomorphosites.

A periodic assessment using this methodology ensures the proper implementation of management actions and opportunities. Furthermore, the study results guide interventions by indicating which areas require priority action. The findings suggest that the most urgent interventions should focus on Pirogoshi Cave and the Osumi Canyons, followed by the Gradec Canyon.

Improved accessibility for educational and touristic purposes is beneficial, provided protections are maintained. Meanwhile, increased management efforts toward sustainable tourism are essential. To support these goals, it is recommended to conduct studies on the carrying capacities of geomorphosites, particularly from a seasonal perspective. It is important to conduct detailed studies on the seasonal carrying capacities of these sites to regulate the number of visitors and reduce overuse during peak seasons.

Continuous communication, education, and awareness-raising about the sites, their values, and associated risks among youth, local populations, and diverse visitors remain important for fostering a sense of responsibility. It is recommended to promote educational initiatives targeting youth and local communities about the significance of geomorphosites and their conservation.

The more sustainable the management practices are, the more secure the long-term protection of these natural values becomes. In the viewpoint of tourism development, it is encouraging eco-tourism practices by working with tour operators to design environmentally responsible activities.

Meanwhile a strong relationship between local governments, private stakeholders and conservation organizations would be pointed out, by putting them together in decision-making processes. Taking actions based on the results and recommendations will put the balance between the conservation and protection of the geomorphosites and their sustainable use especially for tourism and economic use.

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# The Integration of Gender Identity in Social Work Education: Ethical and Deontology

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## **Abstract**

The integration of gender identity in social work education is a multifaceted challenge that demands a thoughtful, principled, and comprehensive approach.

By grounding this work in ethical considerations of autonomy, beneficence, non-maleficence, and justice, as well as a deontological commitment to the profession's core values, social work educators can (Yan et al., 2021) (Franco, 2020) cultivate a more inclusive, equitable, and transformative educational experience for all students.

Building on the ethical and deontological foundations established in the previous sections, the integration of gender identity in social work education should also be informed by (Simon et al., 2021) a critical examination of intersectionality and the ways in which multiple, intersecting identities and systems of oppression impact the experiences and outcomes of gender diverse individuals.

To fully integrate gender identity into social work education, it is essential to foster a "brave space" within the classroom and curriculum that encourages critical reflection, dialogue, and a willingness to engage with discomfort and (Simon et al., 2021) challenge existing power structures.

**Keywords:** Gender Identity, Social Work, Education, Ethics, Deontology

## **1 -Ethical Considerations**

The ethical framework of social work, as outlined by the International Federation of Social Workers, emphasizes the paramount importance of human rights, social justice, and respect for diversity (Quzack et al., 2021). These ethical guidelines mandate social workers to actively confront systems of oppression, discrimination, and marginalization, including those targeting gender identity.

The integration of gender identity into social work education represents a fulfillment of ethical obligations. This inclusion enables students to develop competencies and knowledge necessary to advocate for the rights of transgender, non-binary, and gender non-conforming individuals. Students gain understanding of the unique challenges faced by

these populations while learning the significance of implementing affirming language and practices.

Furthermore, the ethical principle of self-determination, which serves as a cornerstone of social work practice, demands a comprehensive understanding of how gender identity intersects with and shapes an individual's lived experiences and autonomy. To honor this principle effectively, social work practitioners must actively support their clients' right to self-identification while ensuring their gender identity is both recognized and respected within the therapeutic relationship and broader social context. This necessitates a deep understanding of the unique challenges and systemic barriers encountered by transgender, non-binary, and gender non-conforming individuals, alongside ensuring that social work interventions and services are designed to be inclusive and supportive of all gender identities. Social work practitioners must also demonstrate awareness of the intersectionality between gender identity and other social determinants such as race, socioeconomic status, and disability, working diligently to address the compounded discrimination and inequities faced by individuals at these intersections. By centralizing gender identity within social work education and practice, the profession can play a pivotal role in empowering clients to make informed decisions about their identity expression while fostering environments that promote safety, dignity, and success for all.

## **2 -Deontological Considerations**

From a deontological perspective, the integration of gender identity into social work education represents both an ethical imperative and a professional duty. The educational framework and curriculum designed for future social work practitioners must reflect the diverse spectrum of clients they will serve, including individuals across the gender identity continuum and various modes of gender expression.

The identified gap in human rights and social justice education within U.S. social work programs (Sousa-Meixell et al. 2021) presents an opportunity to strengthen the profession's commitment to protecting fundamental rights and dignity regardless of gender identity. The incorporation of gender identity perspectives can equip future practitioners with the knowledge, competencies, and ethical reasoning required to deliver culturally responsive and inclusive services to clients of all genders. By centering the experiences and needs of transgender, non-binary, and gender non-conforming individuals within social work curricula, educators can prepare students to effectively challenge discrimination, bias, and exclusionary practices based on gender identity.

Moreover, the ethical principle of professional competence and the social work code of ethics mandate practitioners to maintain currency with emerging knowledge, research, and best practices in the field.

The integration of gender identity across the social work curriculum, from foundational human behavior and social environment courses to advanced clinical practice, enables students to develop the essential knowledge, skills, and ethical decision-making capabilities necessary to provide competent, affirming, and inclusive services to clients.

## **3 -Integrating Human Rights into Social Work Education**

Integrating human rights principles into social work education serves as a fundamental catalyst in equipping students with the necessary tools to effect transformative change within their profession. The International Federation of Social Workers' ethical

framework emphasizes that "principles of social justice, human rights, collective responsibility, and respect for diversities are central to social work." (Quzack et al. 2021) This human rights-centered approach provides a robust foundation for incorporating gender identity considerations into educational curricula, enabling students to comprehend the ethical obligations social workers hold in advocating for the rights and welfare of individuals across the gender spectrum.

#### **4 -View of Gender Identity in Social Work**

The evolving landscape of social work necessitates a comprehensive examination of gender identity. This involves shifting from peripheral consideration to central focus, ensuring the distinct requirements of individuals across the gender spectrum are recognized and addressed both in academic settings and professional practice. Through embracing this paradigm shift, the social work profession can strengthen its commitment to advancing social justice, human rights, and the empowerment of traditionally marginalized populations.

#### **5 - Recommendations for Integration**

Following careful consideration of ethical implications, moral imperatives, and the necessity for intersectional understanding, here are strategic recommendations for incorporating gender identity into social work education:

1. Integrate gender identity content throughout the entire curriculum, rather than isolating it to specialized courses. This ensures comprehensive exposure to gender identity considerations across all areas of study.
2. Provide comprehensive professional development and support for educators to enhance their expertise and comfort in facilitating discussions around gender identity and related topics.
3. Actively recruit and support gender-diverse individuals as students, faculty, and staff members. This ensures educational environments reflect the diverse communities served by social workers.
4. Establish partnerships with gender-diverse community organizations and advocates to develop educational resources, facilitate guest presentations, and create field placement opportunities. This centers the perspectives and lived experiences of gender-diverse individuals.
5. Regularly evaluate and update curricular content, institutional policies, and practices to ensure continued relevance to the evolving needs and experiences of gender-diverse populations (Mehrotra, 2010; Srikummoon et al., 2022; Robinson et al., 2016; Vincent, 2012).
6. Develop and implement inclusive policies and practices that safeguard rights and affirm identities of gender-diverse individuals within social work programs, including preferred name and pronoun usage, and gender-inclusive facilities.
7. Design and implement comprehensive training initiatives for faculty and staff to enhance cultural competency, skills, and awareness in working with gender-diverse populations.
8. Foster student-led initiatives and organizations that provide platforms for gender-diverse students to share experiences, articulate needs, and collaborate with faculty and administration on curriculum and policy development.

9. Prioritize the recruitment, retention, and professional development of gender-diverse faculty and staff members who can serve as mentors, role models, and guides for the student body.
10. Social work educators can implement several specific strategies to incorporate gender identity into their pedagogical approach: Initially, they should conduct a thorough assessment of current curriculum content, teaching methodologies, and institutional policies to identify and address potential barriers and challenges faced by gender-diverse individuals.
11. Incorporate diverse learning materials, including scholarly readings, real-world case studies, and guest speaker presentations that highlight the lived experiences and perspectives of gender-diverse individuals, particularly those representing intersecting marginalized identities (Todd & Coholic 2007)(Vincent, 2012).
12. Implement comprehensive professional development programs for faculty and staff focusing on gender identity awareness, proper pronoun usage, and inclusive language practices.
13. Establish strategic partnerships with student organizations, community stakeholders, and advocacy groups to develop and implement gender-affirming initiatives and support services.
14. Through these strategic actions, social work education can advance toward a more inclusive, equitable, and transformative approach to gender identity that aligns with the profession's ethical principles and core responsibilities.

## 6- Conclusion

The incorporation of gender identity into social work education represents a vital and essential step toward fulfilling the profession's ethical obligations and fostering a more equitable and inclusive society. By positioning the experiences and perspectives of gender-diverse individuals at the forefront, social work education can better prepare students to understand and address the complex intersections of gender, race, class, and other social identities that influence the lived experiences of the individuals and communities they serve.

The integration of gender identity within social work education plays a fundamental role in realizing the profession's ethical commitments and building a more just and inclusive society. When social work education centers the experiences and perspectives of gender-diverse individuals, it empowers students to better comprehend and address the intricate intersections of gender, race, class, and other social identities that shape the lives of the people and communities they support. (Franco 2020)(Henrickson et al. 2020)

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# In the Context of Allegory and the "Other," Emir Alper's Cinema from beyond the Hill to Burning Days

## *Alegori ve Öteki Bağlamında Tepenin Ardından Kurak Günlere Emin Alper Sineması*

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### **ABSTRACT**

In a cinematic narrative, concepts such as allegory, metaphor, and the "other" can be understood and interpreted through various components. With an interdisciplinary perspective, it is possible to perform more nuanced readings of these elements using a semiotic approach. In a cine-society, the protagonist enters the narrative from a specific point of view. During this process, their level of consciousness is shaped by the distinction between "us" and "the other," depending on temporal, geographical, cultural, and political factors. Often, the protagonist is marginalized within the cine-society to which they belong, but at times, they may assume a position that marginalizes the society itself. In this context, the protagonist, as the subject of a cine-narrative, undergoes significant transformations as a result of their experiences on their journey. The dynamics and social fabric of the province they travel to often evoke a sense of alienation and marginalization—both toward themselves and their environment. This study aims to provide valuable insights to researchers from this reading perspective. Analyzing allegorical and metaphorical signs situated in the countryside through concepts such as literal and connotative meanings is essential to understanding the impact of communication mechanisms via a cinematic agent. This analysis also facilitates a comprehensive interpretation of the films. In this context, the selected films serve as ideal examples for exploring the intricate relationship between social impact and cinematic narrative. The scope of this study, which seeks to examine and discuss the concepts of allegory, metaphor, and the "other" from a semiotic perspective, is defined by Emin Alper's cinema. His works as a screenwriter and director form the sample for this analysis. Specifically, "*Beyond The Hill*" (2012) and "*Burning Days*" (2022) are selected as the primary research objects, offering a rich basis for discussing the construction and representation of these concepts within the specified framework.

**Keywords:** Cinema, Emin Alper's Cinema, Allegory, Other, Semiotic Film Analysis

## ÖZET

Sinemasal bir anlatıda, alegori, metafor ve öteki gibi kavramları birçok bileşen üzerinden anlaşılabilir ve yorumlanabilir. Disiplinler arası bir bakış açısıyla bu bileşenleri, göstergebilimsel bir yaklaşımla daha nitelikli okumalar gerçekleştirmek mümkündür. Bir sine-toplumda, kahramanımız belirli bir bakış açısıyla anlatıya dahil olur. Bu süreçte, zamansal, coğrafi, kültürel ve politik faktörlere bağlı olarak 'biz' ve 'öteki' ayrımı üzerinden kahramanın bilinç düzeyi şekillenir. Çoğu zaman, kahraman dahil olduğu sine-toplumda ötekileştirilir; ancak bazen de içinde bulunduğu toplumu ötekileştiren bir konuma da geçebilir. Bu bağlamda, bir sine-anlatıda özne konumunda olan kahraman, çıktığı yolculukta yaşadığı deneyimler sonucu belirli dönüşümler geçirir. Kahraman gittiği taşranın dinamikleri ve sosyal dokusu sebebiyle, hem kendisine hem de çevresine karşı bir yabancılaşma ve ötekileştirme hissi uyandırır. Bu çalışma, böyle bir okuma perspektifinde araştırmacıya önemli veriler sunmayı amaçlamaktadır. Taşrada geçen alegorik ve metaforik göstergelerin düzanlam veya yananlam gibi kavramlarla analiz edilerek bir sinematik eyleyen üzerinden iletişim mekanizmalarının etkisini anlamak ve bir okuma gerçekleştirmek önem taşımaktadır. Bu bağlamda, ele alınacak olan filmler, toplumsal etki ve sinemasal anlatı arasındaki bu ilişkiyi derinlemesine incelemek için ideal birer örnektir. Buradan hareketle, alegori, metafor ve öteki kavramlarını göstergebilimsel bakış açısıyla anlamayı ve tartışmayı amaçlayan bu çalışmanın evrenini Emin Alper sineması; bir senarist/yönetmen olarak Emin Alper'in üretimleri ise örneklemini oluşturmaktadır. Ele alınan inşayı ve temsili, ilgili bakışla tartışmayı mümkün kılacak olan "Tepenin Ardı" (2012) ve "Kurak Günler" (2022) filmleri bu çalışmanın araştırma nesnelere konumundadır.

**Anahtar Kelimeler:** Sinema, Emin Alper Sineması, Alegori, Öteki, Göstergebilimsel Film Çözümlemesi

## GİRİŞ

Sanat, insanlık tarihi boyunca önemli bir rol oynamış, yaratıcılık ve estetik değeri bir araya getirerek insanlara duygusal bir deneyim sunmuştur. Bu yönüyle sanat, yaşamımızın ayrılmaz bir parçası haline gelmiştir. Ancak, sanatın geniş kitlelere ulaşması ve etkisini artırması, sinemanın icadıyla mümkün olmuştur. Sinema, insanların duygusal ve estetik deneyimlerini besleyen güçlü bir sanat formudur. Sinemanın icadı, sanatın daha geniş kitlelere ulaşmasını sağlamış ve insan hayal gücünü harekete geçirerek yeni dünyaların kapılarını açmıştır. Sinema yalnızca bir eğlence aracı değil, aynı zamanda duyguları harekete geçiren, düşünceleri tetikleyen ve zihni besleyen bir sanat biçimidir. Sanatın kitlelerle buluştuğu bir platform haline gelen sinema, toplumsal etkisini artırarak insanların farkındalığını yükseltmiştir. Sinemanın gücü, insanları farklı düşünmeye ve hissetmeye yönlendirerek yaşamları üzerinde derin etkiler bırakmaktadır. Bu nedenle, sinema sadece bir eğlence aracı olarak değil, aynı zamanda bireylerin duygusal ve estetik deneyimlerini zenginleştiren bir sanat formu olarak değerlidir. Sonuç olarak, sinema, sanatın geniş kitlelere ulaşmasını sağlayan önemli bir araçtır. İnsanların duygusal ve estetik deneyimlerini beslerken, onların hayal dünyalarını genişletir ve toplumsal etkisini derinleştirir. Bu nedenlerle, sinema sanatın en önemli parçalarından biri olarak kabul edilmelidir.

Sinema, görsel bir sanat formu olarak sosyal, kültürel ve siyasi konuları izleyicilere aktarma gücüne sahiptir. Bu sanatsal dil, izleyiciyi düşünmeye teşvik eder ve yeni anlama biçimlerine ulaşmasını sağlar. Aynı zamanda, farklı perspektifler sunarak izleyicileri sosyal, kültürel ve siyasi konularda bilinçlendirir. Filmler aracılığıyla sunulan göstergeler, toplumsal farkındalığın oluşmasına katkıda bulunur. Sinema, bir ideolojik araç olarak da

işlev görmektedir. Belirli bakış açılarını ve değerleri yansıtan sinema, izleyicilerin algılarını ve düşüncelerini şekillendirme potansiyeline sahiptir. Bu nedenle, toplumsal konularda güçlü bir iletişim aracı olarak önemli bir rol üstlenir. Aynı zamanda, izleyicilerin duygu ve düşüncelerini harekete geçirerek onlara yeni bakış açıları kazandırır. Emin Alper'in "*Tepenin Ardı*" ve "*Kurak Günler*" filmleri, bu bağlamda incelenmeye değer önemli örneklerdir. Bu filmlerde, sosyolojik ve felsefi kavramların göstergeler aracılığıyla nasıl aktarıldığı ve izleyicilerin bu kavramları nasıl anlamlandırdığı tartışılmaya değer bir alan sunmaktadır. Sonuç olarak, sinema, izleyicileri düşünmeye yönlendiren ve onlara yeni yorumlama ile değerlendirme fırsatları sunan bir sanat formudur. Sosyal, kültürel ve siyasi konularda güçlü bir ifade aracı olarak, toplumsal meselelerin ele alınmasında etkili bir platform işlevi görmektedir.

Sinema, görsel ve işitsel unsurların bir araya gelerek anlamın iletilmesini sağlayan bir sanat dalıdır. Barthes'in de belirttiği gibi, sinemada anlamın iletilmesini düzenleyen göstergeler düz anlam ve yan anlam olmak üzere ikiye ayrılır. Düz anlam, izleyicinin filmde gördüğü şeyi doğrudan algılamasıdır. Yani filmde ne gösteriliyorsa, başka bir anlam aramadan, doğrudan algılanması söz konusudur. Bununla birlikte, sinema izleyicilere yalnızca düz anlamı sunmaz; aynı zamanda yan anlamı keşfetmeleri için bir fırsat da yaratır. Film öyküsü sürecinde izlenen görüntülerin ötesine geçerek, gizli anlamlar aramak ve gerçeği daha derinlemesine anlamak mümkün hale gelir. Bu sayede yalnızca yüzeysel olaylar değil, aynı zamanda karakterlerin duyguları, toplumsal mesajlar ve sembollerin anlamları da keşfedilebilir. Sinemanın sunduğu bu zenginlik, izleyicilere farklı perspektifler kazandırarak düşünme ve yorumlama becerilerini geliştirmelerine yardımcı olur. Bu nedenle film izlerken sadece görsel unsurları algılamakla yetinmemeli, aklımızı kullanarak yan anlamları keşfetmeye özen göstermeliyiz. Böyle bir yaklaşım, izleyicinin filmi yalnızca yüzeysel bir düzeyde değil, aynı zamanda derinlemesine anlamaya çalışmasına olanak tanır. Sinemada göstergebilimsel film çözümleme yöntemi, bütün sanat dalları içinde anlam üretimi bakımından en güçlü araçlardan biridir. Çünkü bu yöntem, öykü üretme sürecinde diğer sanat dallarını da içine alarak anlamlandırma ve yorumlama olanağı sunan zengin bir içerik sağlamaktadır. Sinema araştırmaları, 1950'li yıllardan 1960'lı yıllara kadar "dil" olarak geliştirilememiştir. Göstergebilimciler, yazılı ve sözlü dil anlayışını yeniden tanımlayarak sinemanın bir dil olarak geliştirilmesini önermişlerdir (Monaco, 2014: 154). Ancak, sinemanın bir dili olduğu konusunda farklı görüşler de bulunmaktadır. Örneğin, sinema göstergebilimcisi Christian Metz'e göre, iyi öykülerin anlatılması sinemanın bir dili olmasına bağlı değildir; aksine, iyi öyküler anlattığı için sinema bir dil olmuştur (Monaco, 2014: 154).

Sinemanın, yan anlam bakımından diğer sanat dallarından temel farkı, tüm sanat dallarını kaydetme özelliğine sahip olmasıdır. Sinema, diğer sanat dallarından yararlanarak yan anlam oluştururken, aynı zamanda kendi özgün dilini de kullanır. Bu özelliğiyle sinema, anlam üretimi açısından diğer sanat dallarına kıyasla daha kolay bir dile sahip olduğu düşünülmektedir. Ancak, Metz'e göre, sinema kolay bir sanat olma özelliği nedeniyle bu kolaylığın kurbanı olma tehlikesi taşır. Sinema bu anlamda fazlasıyla bir sanat dalıdır; bu da çözümlemeyi zorlaştırır. Metz, sinemayı açıklamanın zor olduğunu, çünkü anlamının kolay olduğunu ifade eder (Akt. Monaco, 2014: 157). Sinema sanatı, kendine özgü bir anlatım biçimine sahip olup yan anlamsal anlatım tekniklerini kullanarak derinlik kazanır. Sinemacılar, teknik tercihlerine göre farklı seçimler yaparak anlam oluşturma sürecini şekillendirirler. Bu teknik seçimler, filmlerde kullanılan metaforik ve alegorik anlatım biçimlerinin izleyiciye nasıl aktarıldığını belirler. Sinemada izleyiciler, gördükleri unsurları açıklamak ve yorumlamak için göstergelerden faydalanır. Göstergeler, izleyicilere filmdeki olayları ve karakterleri daha iyi anlamaları için bir rehberlik sağlar. Düz anlamda görünen göstergeler ve imgeler, izleyiciler tarafından yorumlanır ve açıklanmaya çalışılır. Bu süreç, izleyicinin filmin derinliklerine inerek daha fazla anlam çıkarmasına olanak tanır.

Göstergeler, filmin anlatısını güçlendiren ve izleyiciyi yönlendiren araçlardır. İzleyiciler, bu göstergeleri doğru bir şekilde yorumladıklarında filmi daha etkili bir şekilde deneyimleyebilirler. Bu nedenle, göstergelerin ve imgelerin doğru bir şekilde anlaşılması, sinema deneyimini zenginleştiren önemli bir unsurdur.

Göstergebilimsel bir bakış açısıyla incelenen Emin Alper'in "*Tepenin Ardı*" ve "*Kurak Günler*" adlı filmleri, akademik literatürde önemli bir araştırma konusu olarak öne çıkmaktadır. Bu çalışma, belirtilen filmleri nitel bir araştırma deseni kullanarak göstergebilimsel film eleştirisi çerçevesinde analiz etmeyi amaçlamaktadır. Alper'in sinemasal evrenindeki alegori ve öteki kavramlarının nasıl inşa edildiği derinlemesine incelenerek filmlerin temel unsurları ortaya konulacaktır. Emin Alper'in son dönem çalışmalarının incelenmesi gerekliliği, literatür taraması sonucunda tespit edilmiştir. Akademik çalışmaların bu alanda niceliksel olarak yetersiz olduğu belirlenmiş ve çalışmanın önemi vurgulanmıştır. Alper'in filmleri, Türk sinemasında önemli bir yere sahiptir ve göstergebilimsel bir bakış açısıyla ele alınmayı hak etmektedir. Bu analiz, yönetmenin sinematik dilini, sembollerini ve anlatım biçimlerini detaylı bir şekilde ele almayı; böylece filmlerin derinliklerine inerek anlam katmanlarını çözümlemeyi hedeflemektedir.

Çalışmanın ilk bölümünde, sinema sanatında kullanılan sosyolojik ve felsefi kavramların nasıl ele alındığı incelenecektir. Bu bağlamda, alegori ve metafor gibi kavramların sinema sanatında hangi yöntemlerle işlendiği ve ne tür amaçlar doğrultusunda kullanıldığı tartışılacaktır. Sosyolojik ve felsefi açıdan önemli bir kavram olan ötekinin sinema bağlamında nasıl temsil edildiği de ayrıntılı bir şekilde analiz edilecektir. Alegori, semboller aracılığıyla derin anlamların aktarılmasına olanak sağlarken, metafor benzetme yoluyla çok katmanlı anlamların ortaya çıkarılmasında önemli bir rol oynamaktadır. Çalışma, bu kavramların sinema dilinde nasıl kullanıldığını ve izleyiciye nasıl aktarıldığını örneklerle destekleyerek açıklamayı hedeflemektedir. Öteki kavramı, genellikle farklılıklar üzerinden ayrımcılık ve dışlama pratiklerine karşı duran bir olgu olarak tanımlanmaktadır. Bu bağlamda, sinema sanatında "öteki" kavramının nasıl temsil edildiği, hangi perspektiflerden ele alındığı ve bu temsillerin toplumsal algıya olan etkileri incelenecektir. Ayrıca, öteki kavramının sinema sanatında hangi bağlamlarda değişkenlik gösterdiği ve bu değişimlerin hangi amaçlar doğrultusunda kullanıldığı da tartışmaya açılacaktır. Bu çalışma, sinema sanatında sosyolojik ve felsefi kavramların nasıl işlendiğini ve bu kavramların bireysel ve toplumsal düzeyde nasıl etkiler yarattığını anlamak isteyen okuyucular için önemli bir kaynak sunmayı hedeflemektedir. Aynı zamanda, sinema sanatının derinliklerine inmek ve farklı kavramların nasıl işlendiğini keşfetmek isteyen sinema öğrencileri ve araştırmacıları için de değerli bir referans olacaktır. Çalışmanın son bölümünde, alegori, metafor ve öteki gibi sosyolojik ve felsefi temelli kavramların sinema alanında nasıl işlendiği ve anlamlandırıldığı, "*Tepenin Ardı*" ve "*Kurak Günler*" filmleri üzerinden incelenecektir. Çalışmanın amacı, önemi, yöntemi, kapsamı ve sınırlılıkları belirlenerek göstergebilimsel bir bakış açısıyla analizler yapılacaktır. Bu analizler, filmlerin derinliklerine inerek yönetmenlerin toplumsal eleştirilerini ve vermek istedikleri mesajları ortaya koymayı hedeflemektedir. Aynı zamanda, göstergebilimsel yaklaşımla yapılan analizler, filmlerin imgelerini ve sembollerini değerlendirerek izleyicilere farklı açılardan bakış imkânı sunacaktır. Sonuç olarak, bu çalışma, sinemanın sosyolojik ve felsefi boyutlarını ele alarak alegori, metafor ve öteki kavramlarının filmlerde nasıl kullanıldığını anlamayı ve bu kavramların sinematik anlatıya kattığı derinlikleri ortaya koymayı amaçlamaktadır.

Bu çalışma, Emin Alper'in "*Tepenin Ardı*" ve "*Kurak Günler*" filmlerini göstergebilimsel bir yaklaşımla derinlemesine incelemeyi amaçlamaktadır. Nitel bir araştırma yöntemiyle gerçekleştirilen bu analiz, filmlerdeki alegori, metafor ve diğer kavramları çözümlenerek sinemasal anlatının toplumsal yansımalarını ortaya koymayı

hedeflemektedir. Araştırma, Roland Barthes ve Christian Metz gibi göstergebilimcilerin teorik yaklaşımlarını temel almıştır. Bu bağlamda, filmlerde yer alan alegorik anlatımlar, toplumsal "öteki" kavramı ve karakterlerin etkileşimleri detaylı bir şekilde incelenmiştir. "Tepenin Ardı" ve "Kurak Günler" filmleri, Türkiye'nin toplumsal ve politik bağlamını yansıtan güçlü alegorik ve metaforik unsurlar barındırmaktadır. Çalışma, bu filmler üzerinden sinema alanında yeni perspektifler sunmayı ve sinema dilini daha iyi anlamamıza katkı sağlamayı hedeflemektedir. Bu kapsamda, araştırmanın, sinemasal anlatıların toplumsal ve kültürel eleştirilerdeki rolünü anlamlandırmaya yönelik önemli bir katkı sunması beklenmektedir.

### 1.1. Alegori Kavramı

Alegori, bir görüntü, bir yaşantı ya da bir davranışın daha iyi kavranmasını sağlamak için, sembollerle göz önünde canlandırılıp dile getirilmesidir. Bu anlamıyla Fransızcadan dilimize geçen alegoride, dolaysız soyut anlatım yerine doğrudan somut anlatım kullanılması söz konusudur (Türk Dil Kurumu (TDK), 1971, s. 734). Alegori, bütünüyle linguistik bir özelliğe sahiptir; ama birçok durumda cümlede kullanımın ötesine uzandığı veya ifadeyi daralttığı için mecazdan ayrılır. Çünkü mecazın ayırt edici özelliği, dilin sadece süslenmesi değil, gerçekliğin yeniden tasviri için dayanak sağlamak anlamında bir referansa dâhil olmasıdır (Koç, 1998, s. 122). Alegori, Grekçe "allos" (ἄλλος) ve "agoreuein" (ἀγορεύειν) kelimelerinden müteşekkil bir sözcüktür (Whitman, 1987, s. 263; Bibliissima, ἀλληγορία). Bu sözcük, Grekçeden Latinceye "allēgor a", bu dilden de Fransızcaya "all gor e", Almancaya "allegor e" ve İngilizceye "allegory" formlarında geçmiştir (Patridge, 2006, s. 68; Dvds, allegorie). Alegori sözcüğü etimolojik açıdan incelendiğinde terkinde bulunan Grekçe "allos" kelimesinin kökeninin, "öte, ötesi" anlamına gelen "all" (ἄλλ) sözcüğüne uzandığı görülmektedir (Liddel; Scott, 1940, s. 67-8).

Alegori, bir şeyin görünür hale gelmesini sağlayarak onun mekânını belirleme ve otantikliğini ortaya çıkarma sürecidir. Bu süreç, bir nesnenin varlığını ve önemini vurgulamak için etkili bir yöntem olarak kullanılır. Alegoride, bir şeyi göstermek, izleyicilere o şeyi daha yakından inceleme ve anlama fırsatı sunar. Gösterme eylemi, aynı zamanda bir nesnenin değeri ve estetiğinin daha iyi anlaşılmasına katkıda bulunur. Bir şeyi göstermek, sadece onun görülmesini sağlamakla kalmaz; aynı zamanda, onun değerini ve güzelliğini vurgulayarak anlamını güçlendirir. Bu bağlamda, alegori, bir sanat eserinde semboller, metaforlar veya imgeler aracılığıyla, anlatılanın ötesinde derin anlamlar taşıyan bir anlatım biçimidir. Alegorik anlatım, genellikle somut bir hikâyeye ya da görüntü aracılığıyla soyut kavramları, fikirleri veya mesajları temsil etmek amacıyla tercih edilir.

Alegori, okuyucunun veya izleyicinin daha derin bir anlayışa ulaşmasını sağlayarak, genellikle eleştirel ya da felsefi bir mesajın iletilmesine katkıda bulunur. Bu anlatım biçimi, sembolizm, metafor ve ironi gibi edebi tekniklerle sıkça ilişkilendirilir. Alegorinin etkili bir anlatım biçimi olmasının temel sebeplerinden biri, izleyiciyi veya okuyucuyu düşünmeye ve analiz etmeye teşvik etmesidir. Alegorik eserler yüzeyde kolayca anlaşılabilir ve bu nedenle alıcının derinlemesine düşünmesini gerektirir. Alegori, okuyucuya veya izleyiciye olayların ve karakterlerin ötesindeki gizli anlamları keşfetme olanağı sunarak daha fazla düşünce ve anlayışa katkı sağlar. Ayrıca, alegorik anlatım birden fazla yorumlama seçeneği sunarak esere zenginlik ve derinlik kazandırır. Semboller ve metaforlar genellikle tek bir yoruma indirgenemez ve farklı okuyucular tarafından farklı şekillerde değerlendirilir. Bu durum, alegorik eserlerin farklı seviyelerde anlam kazanmasını sağlar ve izleyicilere veya okuyuculara, kendi bakış açıları doğrultusunda eseri değerlendirme fırsatı sunar.

Jameson 'ın tanımına göre alegori, öznel ve psikolojik olanla kamusal ve politik olanın örtüşmesidir (Jameson, 2008, s. 372). Bu tanıma göre alegorinin tür mü, yoksa janr mı olduğu belirsizdir. Öte yandan Jameson 'ın da kabul ettiği ve kökeni Roma

İmparatorluğu'na dayanan klasik alegori tanımı özenle kurulmuş bir dizi söz sanatı ile kişileştirmenin birebir örtüşen bir denklik çizelgesine göre okunmasıdır (Jameson, 1986, s. 73). Jameson 'ın görüşleri bağlamında alegori kavramını ilk başta geleneksel ve modern alegori diye tanımlayabiliriz. Geleneksel alegori, eğitimli bir gözün elindeki bilgiler ışığında deşifre ettiği ve anlamların yerli yerine oturduğu bir tür bulmaca sunmaktadır. Anlatı malzemesi geçmişte deneyimlerle sınırlıdır ve metin bu malzemeyi sadece vermek istediği mesajlara hizmet edecek şekilde kullanır. Başka bir deyişle cevaplanmayan sorular yoktur ve cevaplanmayan soruların olması bu çeşit alegoriye aykırıdır. Metindeki her öge alegorik çerçevenin vazgeçilmez bir parçası olarak önemlidir. Bu alegorilerin üst kültürün pedagojik aracı olarak ortaya konmuş öğretici metinleri oldukları unutulmamalıdır. Jameson 'ın ele aldığı ve modern alegori diyebileceğimiz çeşit ise yorumu belirleyen farklı bakış açılarına bağlıdır. Özellikle kendisine yabancı bir kültürde üretilmiş metni okuyan kişinin onu alegorik olarak nitelendirebilmesine dayalıdır (Jameson, 1986, s. 68).

Alegoriler, gizli veya sembolik anlamlar taşıyan metinler ya da sanat eserleridir. Biçimsel açıdan, alegoriler kusursuz ve kusurlu olmak üzere iki farklı kategoriye ayrılabilir. Kusursuz alegoriler, birebir denklilikleri koruyan ve bu denklik kümelerini tarihsel değişime karşı sabit tutan eserlerdir. Genellikle zamansız öğretileri ya da alegorik karşılıklarını temsil eden kusursuz alegoriler, tek bir anlamı vurgular ve bu anlamı açıkça ifade eder. Bu özellikleri nedeniyle, kusursuz alegoriler yorumlama açısından daha sınırlıdır ve belirli bir mesajı sabit bir şekilde iletmeyi hedefler. Kusurlu alegoriler ise genellikle birden fazla anlam kümesi içerir ve çoklu yorumlamalara olanak tanır. Bu tür eserler, belirsizlik ve katmanlı anlamlar taşıdığı için okuyucular veya izleyiciler tarafından farklı açılardan değerlendirilebilir. Kusurlu alegoriler, daha karmaşık yapıları sayesinde derin düşüncelere yol açar ve sanatın ya da edebiyatın farklı yönlerini keşfetmek isteyenlere geniş bir potansiyel sunar. Bu tür eserler, izleyiciler arasında farklı düzeylerde yorumlanabilir ve bu özellikleriyle genellikle daha geniş bir kitleye hitap eder. Kusursuz alegori, tarihsel değişime referanslarla sınırlıdır ve açık bir şekilde yorumlanabilir bir yapı sunar. Ancak, eser sonrası gelişmelere kapalıdır ve belirli bir tür içinde kolayca sınıflandırılabilir. Öte yandan, kusurlu alegori, daha fazla yoruma açık olup özellikle tarihsel ironiye başvurarak eser sonrası gelişmelere uyum sağlayabilir. Kusurlu alegorilerin sınıflandırma zorluğu, bu türün anlam açısından zenginliğini ortaya koyar. Genel olarak, kusurlu alegoriler, kusursuz alegorilere kıyasla daha fazla yoruma açık olup, zamanla değişen koşullara daha kolay adapte olabilir. Ayrıca, türleşmeye ve yeni bağlamlara uyum sağlamada daha esnek bir yapı sergiler. Bu özellikleri, kusurlu alegorilerin sanat eserlerinin yorumlanmasında ve anlamlandırılmasında daha geniş bir alan sunduğunu göstermektedir. Bununla birlikte, her iki tür alegorinin de sanatın ve edebiyatın yorumlanmasında önemli bir yere sahip olduğu söylenebilir.

Alegori, sanatın farklı alanlarında, bireylerin düşünme süreçlerini şekillendiren önemli bir araç olarak kabul edilmektedir. Özellikle toplumsal ve siyasi konular bağlamında, alegoriler güçlü mesajlar ileterek izleyicileri derin düşüncelere yönlendirmektedir. Hikâyeler ve görseller aracılığıyla aktarılan anlamlar, izleyicilerin zihinlerinde tartışma ve analiz süreçlerini tetikler. Alegoriler, sanatın evrensel bir dili olarak değerlendirilmekte olup, farklı kültürlerde ve zaman dilimlerinde insanların düşünme biçimlerini etkileme gücüne sahiptir. Toplumsal sorunlar, politik çatışmalar ve insan ilişkileri gibi temalar, alegorik anlatımlar aracılığıyla işlenerek izleyicinin kendi deneyimleriyle ilişki kurmasına olanak tanır. Bu bağlamda, sinema sanatı, alegorilerin etkisini ve gücünü göstermek için önemli bir platform olarak öne çıkmaktadır. Filmler, görsel ve kavramsal anlatımlar aracılığıyla derin anlamlar ileterek izleyicileri düşünmeye teşvik eder. Özellikle belirli bir konunun ele alınmasında, filmler alegorik unsurları kullanarak izleyicilere alt metinler sunmakta ve onları farklı perspektiflerden düşünmeye sevk etmektedir. Bu özellikleriyle sinema, sadece bir eğlence aracı değil, aynı zamanda toplumsal farkındalığı artıran, bireylerin olayları ve kavramları

çok boyutlu olarak değerlendirmesine olanak sağlayan güçlü bir sanat formu olarak değerlendirilebilir.

## 1.2. Metafor Kavramı

Metafor (Fr. métaphore, İng. metaphor) kelimesi, Eski Yunancada bir kavramı, bir olguyu, kendinden daha öteye taşımak, olduğundan daha fazlasını yüklenmek anlamındaki Yunanca "phérō" sözcüğünden gelmektedir (Dur, 2016, s. 123). Kelimenin etimolojisini yapanlara göre de Metafor kelimesi, meta: öte ve pherein: taşımak, yüklenmek kelimelerinden mürekkeptir" (Lakoff ve Johnson, 2015, s. 15). Bu yaklaşıma göre kelimenin morfolojisine bakıldığında "phérō " kelimesine "meta" ön eki getirilerek türetilmiş olduğu anlaşılmaktadır. Metafor kelimesinin kökenine bakıldığında "Eski Yunan dilinde "öte" anlamındaki meta sözcüğüyle bir yerden başka bir yere taşıma, bir alandan başka bir alana götürme, bir şeyi başka bir şeye aktarma gibi anlamlara gelen "phoros" sözcüğünün birleştirilmesiyle oluşturulmuş "metapherein" sözcüğünden türetilmiştir (Uzun, Yolsal, 2003, s. 459). Metaforun Türkçe karşılığı olarak genellikle eğretileme kabul edilmektedir. Ancak, Türkçe sözlüklerde, eski dilde kullanılan istiare terimi eğretilemeyi karşılık olarak vermektedir. Bu durum, bir kelimenin anlamını geçici olarak başka bir yerde kullanma ve daha sonra asıl anlamına geri döndürme anlamına gelmektedir. Metafor, anlamın bir yerden başka bir yere taşınmasını ifade ederken, eğretileme ise ödünç alınan bir anlama işaret etmektedir. Dolayısıyla, eğretileme terimi, metaforun tam anlamını yansıtamamaktadır ve genellikle istiare terimiyle eş anlamlı olarak kabul edilmektedir. Bu nedenle, eğretileme ve istiare terimleri genellikle birbirinin yerine kullanılmaktadır.

Metafor çeşitli disiplinlerde geniş bir kavramsal alan yaratmış ve insan zihninin işleyişi ile dil arasındaki doğrudan bağlantıyı ifade etmektedir. Bu bağlantı, sinemanın görsel anlatımında da güçlü bir şekilde kendini gösterir. Ancak, sözlüklerde kısıtlı bir şekilde açıklanabilen bu terim, İngilizce ve Türkçe kaynaklarda sorunlarla karşılaşmaktadır. Bir aktarma olarak kullanılan metafor, benzetme üzerine kurulmuş ve örnekler ile açıklanmıştır. Bu nedenle, metaforun felsefeden edebiyata, matematiğe, psikolojiye ve reklamcılığa kadar geniş bir alanda kullanılması kaçınılmaz hale gelmiştir. Her disiplinde farklı bir anlam ve işlev kazanan metafor, insan düşüncesinin ve iletişiminin karmaşıklığını yansıtan önemli bir kavramdır. Aristoteles, metaforu bir sözcük sorunu olarak değerlendirerek, "*kavramı literal olarak ele almakta ve metaforu bir terimin has anlamından sapma bir şeyi başka bir şeyle çağırarak*" olarak tanımlamaktadır. En basit şekilde metafor; "*bir varlığı, başka bir varlığa dayanarak görmek, daha iyi bilinen alandan, az bilinen alana bilgi taşımak*" demektir (Burke, 1945, s. 5).

Nietzsche'ye göre metafor, bir şeyin bir diğerine benzetilerek anlaşılmasını ifade eder. Bu şekilde metafor, bir şeyin benzerliklerinin vurgulanarak diğer bir şey ile özdeşleştirilmesini sağlar. Nietzsche'nin metafor anlayışı, Aristoteles'in "*Poetika*" eserinden etkilenmiştir. Aristoteles'e göre metafor, bir kelimenin asıl anlamından farklı bir şeyi temsil etmesidir. Bu bağlamda, metafor kullanımı türler arası benzerlikler, türlerden türe geçişler veya oranlara dayalı bir şekilde gerçekleşir. Bu bakımdan metaforlar, dilin gücünü ve zenginliğini ortaya koymak için önemli bir araç olarak değerlendirilebilir. Metaforun, yalnızca dilin bir karakteristiği olarak görülmemesi gerektiğini gündelik kavram sistemimizin temelde doğası gereği metaforik olduğunu ileri süren Lakoff ve Johnson 1980'de yazdıkları "*Yaşamamızı Yönlendiren Metaforlar*" kitabında metaforu; "*entelektüel bir soyutlama ya da teori değil en derin anlamıyla kavrayışın bilgisidir*" şeklinde yorumlayarak "*metaforun özü, bir tür şeyi başka bir tür şeye göre anlamak ve tecrübe etmektir*" (Lakoff, 2005, s. 25) düşüncesini savunmuşlardır. Metaforun esnek ve girişken yapısı kavrandıkça, yaşam ile sanatın sınırlarını zorlayan pek çok düşünür metafor üzerine çözümler geliştirmiştir. Düş dünyasının, kelimelere yer değiştirttiği ve sanatçının bunları şeylere dönüştürdüğü evrende metafor oldukça derin ve zengin bir alandır. Umberto Eco metafor'u düşüncenin



biçim ile açıklanması olarak görürken (Eco, 2000, s. 79), A. Ziss metaforu; *“Sanatçının düşüncesinin nesnesini, duyulur dünyanın nesnelere ve olaylarına benzetme olanağı sağlayan yöntem; dışsal benzer özellikleri olan iki olayın, birinin içsel özünü, ötekini yardımıyla gün yüzüne çıkarmak için sanatsal karşılaştırılması”* (Ziss, 1984, s. 292) olarak tanımlar.

Metafor ilk başta yazınsal bir kategori olarak, Aristoteles’in *“Poetika”* adlı eserinde niteliklerine ve türlerine göre ayrılmış, Platon’dan Derrida’ya kadar *“derin ve yaygın bir alana yayılan yaklaşımlar bütünü”* (Erem, 1997, s. 63) olarak yazın dilinde var olmuştur. Metaforlar, temelde bağdaştırılmaz gibi görünen iki dizgeyi birleştirerek bir dizge aracılığı ile diğer dizgenin gizli kalmış yanlarını ortaya çıkarırken, çoğul anlamlar yaratırlar. Yazın dilindeki metaforun gücü ve algıda yaratacağı yenilik bu özelliğine bağlıdır. A. Genç, metafor yapmanın altta yatan örüntü dışında hiçbir ortak özelliği olmayan nesnelere bileşimi aracılığı ile okurun şeyler dünyasının somut kabuğunu yararak içine girebilmesini sağladığını belirtir (Genç, 1990:138). Metaforları işlevlerine göre ve başarılı ya da başarısız olarak kategorize eden ilk isim Aristo, metaforu bir öğretim aracı olarak görmüş ve bir metaforu anlayabilmek için kişinin, konu ve metaforun kendisi arasında ortak bir nokta bulmak zorunda olduğunu söylemiştir. Metaforun sadece bir şeye atıfta bulunmakla kalmayıp o şeyin karakteristiğini de tanımlama özelliğinden dolayı Aristo, yeni olan şeyleri en kolay öğrenme yolunun metafor ile olduğunu söylemiştir (Aristo, Rhetoric, 2004).

Edebiyatta olduğu kadar görsel sanatlarda da kullanılan metaforların; gerçeğin algılanmasında geliştirilen modellere katkısı, sezginin doğasındaki rolü ve sanatsal imgelemi canlandırmadaki işlevi de dikkat çekmektedir. Nietzsche bu konuda şöyle der; *“İçimizdeki her türlü duygulanımın başlangıcı olan, sanatsal anlamda metafor üretimi, bu formları öngörür ve onlardan gerçekleşir. Metaforların kendilerinden, nasıl olup da daha sonra kavramsal bir yapı inşa edilebileceğini açıklamanın tek yolu, bu özgün formların kararlılığına başvurmaktır”* (Nietzsche, 2009, s. 87). G. Thomson’a göre sanatçılar; bütün dillerde varlığını sürdüren bir çağrışım kümesi biçimi olan metaforu öyle bir düzen içinde öyle bir ustalıklarla kullanırlar ki *“bize birbirleriyle bağıntısız gibi görünen bu imgeler çok daha büyük etki yaratır, çünkü onları birbirine bağlayan halkaları kavramaktan çok sezinleriz”* (Thomson, 1991, s. 83) der. Metaforlar, adeta görünmez bağlarla, hiçbir anlamsal kaynaktan yararlanmadan imgeleri birleştirir. Metaforu yapmayı öğreten yönergeler yoktur. Bir metaforun ne anlama geldiğini ya da ne söylediğini anlatan el kitapları da yoktur, zevksiz metaforu ayırmada kullanılacak bir denektaşısı da bulunmaz. Metafor, sanatsal başarıda bir türü ve bir dereceyi ima eder (Davidson, 1997, s. 85).

Metaforik anlatım, sinemayı zenginleştiren ve gerçek hayatı aşarak daha derin anlamlar sunan unsurlardan biridir. Metaforlar, film izleyicisine farklı bir bakış açısı kazandırır ve insanın varlığı, duyguları ve ilişkileri üzerine derinlemesine düşünmeyi teşvik eder. Bu sayede film, yalnızca bir eğlence aracı olmaktan çıkarak izleyiciyi yaşam ve varoluş üzerine düşünmeye yönlendirir. Metaforlar, filmleri yalnızca hikâye anlatan araçlar olmaktan çıkarıp birer sanat eseri haline getirir. Bu sayede izleyiciler, filmleri hem eğlence hem de derin bir düşünme ve sorgulama süreci olarak algılayabilir. Sinemanın bu gücü, insanın varlığını anlamlandırma ve sorgulama süreçlerine katkıda bulunarak izleyiciyi derin bir düşünsel yolculuğa çıkarır. Sinema, edebi öykülerden film anlatılarına kadar sanatın bir dalı olarak insanın varoluşunu anlamlandırmayı ve sorgulamayı hedefler. Düşünen, yaşayan ve varlığının anlamını arayan insan, hem kendisiyle hem de çevresindeki diğer varlıklarla iletişim kurarak bu süreçte zenginleşir. Bu süreçte, insan hem duygularını hem de kendi varlığını ve evrenle olan ilişkisini sorgular. Sinema, bu insanı konu alan sorgulama sürecine aracılık eden önemli bir sanat formudur. Pek çok film, insanın varlığı ve anlamı üzerine derin düşünceler sunar. Yönetmenler, bu düşünceleri iletmek için çeşitli anlatım biçimlerine başvurur. Bu biçimlerden biri de metaforik anlatımdır.

### 1. 3. Öteki Kavramı

Tarih boyunca "öteki" kavramı, sosyoloji, psikoloji, tarih, siyaset bilimi, uluslararası ilişkiler ve felsefe gibi pek çok disiplinde önemli bir tartışma konusu olmuştur. Bu kavramın önemi, insanlığın varoluşundan itibaren bireylerin kendilerini diğerleriyle karşılaştırma gereksinimi duymasıyla yakından ilişkilidir. Söz konusu karşılaştırmalar, toplumsal düzenin, politik yapıların, kültürel gelişimin ve bireyler arası ilişkilerin şekillenmesinde belirleyici bir rol oynamıştır. "Öteki" kavramı, bireyin kimlik oluşturma sürecinde, gruplar arasındaki ayrımların belirlenmesinde ve toplumsal ilişkilerin dinamiklerinde kritik bir öneme sahiptir. Sosyal bilimler alanında yapılan araştırmalar, öteki kavramının insan ilişkilerinin temel bir unsuru olduğunu ve toplumların yapısını ve işleyişini derinden etkilediğini ortaya koymaktadır.

Tarihsel süreç incelendiğinde, geleneksel toplumlardan modern toplumlara doğru gerçekleşen dönüşümlerle birlikte kimlik algısının ve "öteki" kavramının da değişime uğradığı görülmektedir. Modernleşme süreci, bireyleri homojenleştirme ve benzeştirme çabalarını artırmıştır. Bu süreç, toplumsal düzenin değişimiyle birlikte kimlik kavramının önem kazanmasına ve öteki kavramının sosyal bilimlerin temel tartışma konularından biri haline gelmesine yol açmıştır. Günümüzde küreselleşme ve modernizasyon süreçleri, toplumların kimlik algıları üzerinde derin etkiler yaratmaktadır. Bu süreçler, toplumların kendilerini tanımlama ve diğerlerini algılama biçimlerini dönüştürmüştür. Kimlik ve öteki kavramları, toplumların iç dinamikleri ve kültürel çeşitliliği açısından kritik bir öneme sahiptir. Toplumlar giderek daha karmaşık hale gelirken, kimlik ve öteki kavramları da bu karmaşıklık içinde giderek daha merkezi bir konuma yerleşmektedir. Her toplum ve birey, kendine özgü bir "öteki" yaratmaktadır. Ancak modern dönemde bu kavramların anlamı değişmiş ve daha fazla vurgulanır hale gelmiştir. Öteki, bir toplumun kendini tanımlarken başvurduğu bir işaret veya referans noktası olarak kabul edilebilir. Geleneksel anlamıyla öteki, genellikle kendine benzemeyen, farklı kültürel özelliklere sahip olan ve dışlanan bir grup olarak algılanmıştır. Bununla birlikte, modern dönemde öteki kavramının anlamı genişlemiş ve daha kapsamlı bir perspektiften ele alınmaya başlanmıştır. Artık öteki, yalnızca dışlanan bir grup olmanın ötesinde, toplumun kimlik oluşturma sürecinde önemli bir rol oynayan bir faktör olarak değerlendirilmektedir. Bu bağlamda, öteki kavramı, bir toplumun veya bireyin kendini tanımlama ve farklılıklarını belirleme süreçlerinde vazgeçilmez bir referans noktası haline gelmiştir.

Öteki ile olan iletişimin etkili bir şekilde sağlanması önemli bir unsurdur. Bu noktada, kalıpyargı (stereotip), önyargı ve iç-dış grup bariyerleri gibi faktörlerin iletişimi nasıl etkilediği üzerinde durmak önem arz etmektedir. Stereotip (kalıpyargı) kavramı, Yunanca stereos (katı) ile typos (damga) sözcüklerinden türetilmiştir (Marshall, 2005: 701). Genel itibarıyla stereotip, diğer insanları içine yerleştirdiğimiz sınırları ve kategorileri ifade eder. Bu nedenle stereotipleri içine dahil olduğumuz veya olmadığımız gruplardaki kişileri tanımlamak için kullandığımız basit betimsel kategoriler olarak niteleyebiliriz (Bilgin, 2003: 367). Kalıpyargılar nedeniyle diğerlerini birey olarak değil belli bir grubun üyesi olarak değerlendirir, ilişkilerimizde onları kişisizleştiririz. Öncesinde sahip olunan çeşitli yargılar davranışlara yön verdiği için diğerlerinin bireysel niteliklerine çok az önem verilir (Gudykunst, 2015: 138-139). Ancak ötekiler dahil oldukları grupların tipik üyesi olmayabilirler. Diğerleri kişisizleştirmek yerine bireysel olarak değerlendirmeye çalışıldığında zihnimizdeki etiketlerin ötesinde olan özelliklerini fark edebileceğimiz yadsınamaz bir gerçekliktir. Önyargı, olumsuz inançlardan oluşan bir taraf tutma, bir tutum biçimidir. Aynı zamanda ötekileştirme sürecinin de temel öğelerinden bir tanesidir.

Önyargılar "*bireyin ya da toplumun diğerlerine karşı oluşturduğu düşünceler topluluğu*" olarak tanımlanabilir (Ulağı, 2006, s. 103). Peşin hüküm verme anlamına gelen önyargılar

olumlu veya olumsuz olabilmektedirler. Ancak çoğu zaman olumsuz oldukları kanısı hakimdir (Gudykunst, 2015, s. 145). Kişiler kendilerini ve çevresindekileri tanımlarken çoğu zaman gruplara bölme eğilimi içerisindedirler. Herhangi bir gruba aidiyet, grup üyeliği önemli bir motivasyon kaynağıdır. Bu durum iki "taraf" için de belirsizliği ortadan kaldırır ve kişilerin davranışlarını yönlendirmesi noktasında yardımcı olur. İç grup ve dış grup ayrımı, gruplama konusundaki görülen en genel ayrımdır. İç gruplar, mutlu olmalarını istediğimiz, eşit oranda karşılık beklemeden iş birliği yapmaya gönüllü olduğumuz, kendilerinden ayrılığın mutsuzluk hatta acı verdiği insan gruplarıdır. Dış gruplar ise ortaklık kurmamamızın, dost olmamızın öğretildiği gruplardır; bu grubun üyelerinin mutlu olup olmamalarını mesele edilmez, iş birliği yapmak için karşılık beklenir. Gruplar arasında ayırım yapma eğilimi evrensel olduğunu söylemek mümkündür (akt Gudykunst, 2015, s. 89-90). Dış gruba karşı hissedilen kuşku, güvensizlik, düşmanlık ve saldırganlık önyargıyı doğurur. "Önyargı, 'onlar' ve 'biz' ayrımını kapsayan iç gruplar ile dış grupların varlığının hem bir sonucudur hem de onu güçlendirmektedir" (Marshall, 2005, s. 559-560). Bu bağlamda önyargı ve dış grup oluşturma arasında aslında iki yönlü bir ilişki bulunduğunu söylemek mümkündür. Önyargılar, dış grup üyelerinin niyetlerinin iyi olabilmesi ya da ne söylemişlerse salt onu söylemiş olabilecekleri ve uzlaşma önerilerinin samimi olması ihtimalinin kabulünü engeller (Bauman, 2015, s. 58). İç grup ve dış gruptakilerin davranışlarının değerlendirilmesi, bu gruplardaki kişilere yaklaşım önyargılar sebebiyle değişkenlik gösterir. Dış gruptakiler söylemleri ve davranışları üzerinden değil önyargılar neticesinde söylem ve davranışlarına yüklenen anlamlarla değerlendirilirler.

Öteki kavramı, felsefi açıdan ele alındığında, Kierkegaard, Heidegger, Sartre gibi düşünürlerin görüşleri önemli bir rol oynamaktadır. Bu düşünürler, öznenin ve ötekinin ilişkisinin derinliklerine inerek, toplumsal yönü daha iyi anlamamıza yardımcı olmaktadır. Ötekinin varlığını ve değerini anlamak, insan ilişkileri üzerinde derin bir etkiye sahiptir ve bu düşünürlerin felsefi görüşleri bu konuda bizlere önemli bir rehberlik sunmaktadır.

Søren Kierkegaard, Martin Heidegger ve Jean-Paul Sartre felsefelerinde insanı ve insanın sorunlarını ele almışlardır. Onlara göre felsefe, insan sorunlarıyla ilgilenmelidir. Kierkegaard'a göre (Kierkegaard & Estvad, 1945) öteki kavramı, bir bireyin kendi benliğini ve varoluşunu şekillendiren önemli bir unsurdur. Ona göre, öteki bireyin benliğiyle etkileşime girerek kendi varoluşunu tanımlar ve anlamlandırır. Kierkegaard, Hegel'in zorunluluk vurgusuna karşı özgürlüğü savunur. Örneğin, "anımsama" yerine "yineleme", "açıklık" yerine "gizlenme", "edimsellik" yerine "olanak" gibi kavramlarla öteki ile ilişkiyi tanımlar. Öteki'nin bakışı, bireyin dünyasını etkiler ve varoluşsal kaygıyı tetikler. Heidegger'e göre (Heidegger, 2011) öteki kavramı, Dasein (varlık, varoluş) kavramıyla yakından ilişkilidir. Heidegger'in temel eseri "Varlık ve Zaman"da (Sein und Zeit), Dasein, "orada olmak" ya da "varlık" anlamında kullanılır ve insanın kendi varoluşunu sorgulayan bir varlık olarak tanımlanır. Dasein, dünya içinde var olan ve dünyayla etkileşim halinde olan bir varlıktır. Sartre'ın varoluş felsefesinde öteki, dünyayı algılayışımızı donuklaştıran, kavrayışımızı zorlaştıran, bir başkasının olumsuz bakışını ifade eder. Varoluşçu felsefenin en büyük başarısı, öteki ile ilişkiyi gerçek bir zemine oturtmasıdır. Sartre, "Cehennem Başkalarıdır" sözüyle iç içe geçmiş üç önemli konuyu inceler; öteki, özgürlük ve yabancılaşma. Sartre için bizim öteki ile sorumluluğumuz, hepten imkansız bir zeminde değildir. Öteki ile olan ilişkimiz kısıtlayıcı ve sorunluysa o zaman "öteki" cehennemdir. Bu yüzden ilişkilerimizde ve kararlarımızda öteki'nin bakışını sürekli üzerimizde hissetmek cehennemde olmaktır, kendi olamamak, kendi özgürlüğünü kavrayamamaktır. Bu da bireyin kendi olanaklılığı karşısında kendisine yabancılaşmasıdır.

Sosyolojik ve felsefi tabanlı görüşler bağlamında ele alınan "öteki" kavramının incelenmesi ve anlaşılması için sinema, güçlü bir araç olarak öne çıkar. Sinema, ötekiyle olan ilişkilerimizi ve ötekinin varoluşsal, sosyal ve psikolojik boyutlarını keşfetmemize olanak tanır. Bu bağlamda sinema, farklı kimliklerin ve ötekilerin temsiline imkân sağlayarak, çeşitli etnik, cinsel, kültürel ve sosyal kimlikleri izleyicinin karşısına çıkarır. Bu temsiller, izleyicilerin öteki olarak gösterilen kahramanı anlamalarına ya da anlamamalarına neden olabilir. Sinema, izleyiciyi yarattığı sine-anlatıda kahramanın dünyasına çekerek empati kurulmasını sağlayabilir veya bu empatiyi zorlaştırabilir. Kahramanın sine-toplumda yaşadığı duyguları deneyimlemesi, izleyicinin öteki olarak gösterilen karakteri anlamlandırmasına katkıda bulunur. Aynı zamanda sinema, toplumsal normları ve önyargıları belirli ideolojiler çerçevesinde sunar. Öteki olarak gösterilen kişi veya grupların maruz kaldığı adaletsizlik, ayrımcılık ve dışlanma gibi deneyimler, filmler aracılığıyla izleyicinin bakış açısına taşınır. Bu durum, toplum olarak izleyicilerde farkındalık artışına ve değişim taleplerinin ortaya çıkmasına vesile olabilir. Filmler, kişi ya da grupların ötekileştirilme ve yabancılaşma deneyimlerini ele alabilir. Ele alınan sine-anlatılarda, kahramanın sine-toplum içinde nasıl yalnızlaştığı, dışlandığı ve ötekileştirildiği sıklıkla işlenir. Aynı zamanda, bu süreç kahramanın aidiyet ve kabul arayışını da beraberinde getirir. Filmlerde gösterilen yabancılaşma, yalnızca sosyal bir durum değil, aynı zamanda varoluşsal bir süreç olarak da karşımıza çıkar. Böylece, kahramanın kendisini ve dünyayı anlama çabası, ötekiyle olan ilişkisi üzerinden şekillenir ve derinlemesine incelenir.

## 2. Tepenin Ardından Kurak Günlere Emin Alper Sinemasına Bir Bakış

Emin Alper'in sineması, özellikle "*Tepenin Ardı*" (2012) ve "*Kurak Günler*" (2022) filmleri, alegori, metafor ve "öteki" kavramlarını derinlemesine işleyen önemli örnekler sunmaktadır. Bu filmler, toplumsal eleştirileri ve varoluşsal temaları öne çıkararak izleyicilere çok katmanlı bir anlatı sunar. Alegori, bir hikâyenin yüzeydeki anlamının ötesinde daha derin bir anlamı veya mesajı ifade eden edebi bir teknik olarak tanımlanabilir. Emin Alper'in filmlerinde, toplumsal ve politik olayların alegorik bir dille işlendiği görülmektedir. Yönetmen, bu teknik aracılığıyla izleyiciyi yalnızca hikâyenin görünen yüzeyiyle değil, aynı zamanda altında yatan toplumsal ve siyasal eleştirilerle de buluşturur. Metafor, bir şeyi başka bir şeyle kıyaslayarak daha derin bir anlam katmanını ortaya çıkaran bir anlatım tekniğidir. Alper, filmlerinde metaforları sıkça kullanarak anlatsal derinliği artırmaktadır. Bu teknik, izleyicinin filmdeki olayları ve karakterleri farklı perspektiflerden değerlendirmesine olanak tanır. Ötekileştirme ise bireylerin veya grupların, kendilerinden farklı olanları dışlama, marjinalleştirme ve düşmanlaştırma süreci olarak tanımlanabilir. Alper'in filmleri, ötekileştirme süreçlerini karakterler ve sine-toplum bağlamında ele alarak izleyiciye derin bir analiz sunar. Bu süreçler, yalnızca bireylerin birbirleriyle olan ilişkilerini değil, aynı zamanda toplumsal yapıların işleyişini de sorgulayan bir anlatı sunar. Emin Alper'in sineması, bu üç kavramı bir araya getirerek izleyiciyi düşünsel bir yolculuğa çıkarır. Toplumsal ve bireysel düzeyde ele alınan bu temalar, yönetmenin sinematik anlatımındaki çok katmanlı yapının temel taşlarını oluşturur.

Emin Alper'in filmlerinde, alegori, metafor ve öteki kavramları, karakterler arasındaki ilişkiler ve toplumsal yapılar üzerinden derinlemesine işlenmektedir. Yönetmen, "*Tepenin Ardı*" (2012) ve "*Kurak Günler*" (2022) filmlerinde bu kavramları ustalıkla kullanarak izleyiciye, toplumsal ve bireysel çatışmaları derinlemesine düşünme fırsatı sunmaktadır. Bu filmler, yalnızca belirli bir sine-anlatıyı yansıtmakla kalmayıp, aynı zamanda izleyiciyi kendi toplumsal ve kişisel önyargılarını sorgulamaya ve bunları aşmaya davet etmektedir. Bu çalışma, alegori, metafor ve öteki kavramlarının sunduğu sosyolojik ve felsefi ideolojiler bağlamında, Alper'in yönettiği bu iki filmi ele alarak izleyiciyi düşünsel

katılıma sevk eden örnekler olarak değerlendirmektedir. Alper'in filmleri, sinema sanatının yalnızca bir anlatı aracı değil, aynı zamanda toplumsal ve bireysel farkındalık yaratmada güçlü bir araç olduğunu gözler önüne sermektedir. Sonuç olarak, Alper'in sinema eserleri, sosyolojik ve felsefi düşünce açısından sinema için önemli birer referans noktasıdır. Bu eserler, sinemanın hem bireysel hem de toplumsal düzeyde düşünsel bir dönüşüm sağlayabilme potansiyelini vurgulayan çarpıcı örnekler sunmaktadır.

## 2.1. Örnek Film Çözümlemeleri

### 2.1.1. Tepenin Ardı Filminin Künyesi

Filmin İsmi	Tepenin Ardı
Yönetmen	Emin Alper
Senaryo	Emin Alper
Yapımcı	Emin Alper, Enis Köstepen, Nikos Moutselos, Seyfi Teoman
Vizyon Tarihi	2012
Süre	94 dk.
Oyuncular	Tamer Levent, Reha Özcan, Mehmet Özgür, Berk Hakman, Banu Fotocan, Furkan Berk Kıran.

### 2.1.2. Tepenin Ardı Filminin Çözümlemesi

Filmin açılış sahnesi, izleyiciyi tüm filme hâkim olan bir paranoya ve gerilim atmosferine hazırlayan bir giriş niteliğindedir. Kamera, kavak dallarını hırsıyla kıran bir karaktere odaklanırken, izleyiciyi bu eylemin tanığı ve dolaylı olarak bir parçası haline getirir. Yönetmen bu sahneyle izleyiciyi hem fiziksel hem de psikolojik bir gerilimin içine çeker. Filmin genelinde hissedilen bu gerilim, izleyiciyi karakterlerin yaşadığı dünyaya dâhil ederken, aynı zamanda toplumsal çatışmaların soyut bir yansımalarını da sunar. Emin Alper, filmde toplumsal normların, güç ilişkilerinin ve ötekileştirme süreçlerinin alegorik bir anlatımını yapar. Faik, otoriter ve müdahaleci tavırlarıyla devleti temsil ederken, Yörükler ise marjinalleştirilmiş ve ötekileştirilmiş bir grup olarak kurgulanır. Faik'in arazisine izinsiz girdikleri gerekçesiyle Yörüklere şiddet uygulaması, güçlü olanın zayıf üzerindeki baskısını temsil eder. Faik'in keçiyi alıkoymakla kendi mülkü haline getirmesi, izleyiciye adalet ve mülkiyet kavramlarını sorgulama imkânı sunar.

Mehmet ve Faik arasındaki ilişki, bireysel ve toplumsal düzeyde güven sorununun karmaşıklığını ortaya koyar. Mehmet'in Faik'e borcunu ödeyememesi, finansal ilişkilerin bireyler arasında yarattığı gerginlikleri yansıtır. Mehmet'in kavak fidanlarını kırdığı sahne, içsel çatışmalarının bir dışavurumu olarak okunabilir. Bu durum, karakterin uzun süredir biriken öfkesini ve çaresizliğini simgeler. Filmin ilerleyen bölümlerinde Nusret'in Meryem'e yönelik tacizinin Süleyman tarafından fark edilmesi ve sonrasında Nusret'in ayağından vurulması, karakterler arasındaki güvensizliği ve şiddetin nasıl yayıldığını gözler önüne serer. Ancak bu saldırının failinin kim olduğu net bir şekilde gösterilmez; bu belirsizlik, filmin genelinde hissedilen paranoya ve güvensizlik atmosferini güçlendirir. Faik'in Yörükleri suçlaması ve ardından altı koyunu öldürmesi, toplumsal çatışmaların şiddetle sonuçlanabileceğini gösterir. Zafer'in asker postunu andıran keçi postunu giymesi ve sonrasında vurularak öldürülmesi ise, bireylerin toplumsal çatışmalardan nasıl etkilendiğini ve kişisel dönüşümlerinin trajik sonuçlarını temsil eder.

Emin Alper, filmdeki bu çatışmaları alegorik bir çerçevede sunarak izleyiciyi düşünsel bir katılıma davet eder. Faik'in otoriter tavırları, toplumdaki güç yapılarını ve bu yapıların bireyler üzerindeki etkisini simgeler. Yörükler, ötekileştirilen ve marjinalleştirilen gruplar olarak, toplumsal ayrışmayı ve çatışmayı görünür kılar. Alper'in alegorik anlatımı, yalnızca bireysel hikâyelere değil, toplumsal yapıların işleyişine dair derin eleştiriler sunar. Bu yaklaşımıyla yönetmen, izleyiciyi yalnızca hikâyenin yüzeysel bir katmanında değil, aynı zamanda toplumsal ve psikolojik düzeyde düşünmeye teşvik eder. Faik'in manipülatif doğası ve diğer karakterlere olan müdahaleleri, bir otoritenin bireyler üzerindeki etkisini temsil ederken, bu durum izleyicilere zamansız ve evrensel bir anlatım sunar. Sonuç olarak, *Tepenin Ardı*, bireysel ve toplumsal düzeydeki çatışmaları, şiddeti ve güvensizliği derinlemesine irdeleyen bir alegori olarak karşımıza çıkmaktadır. Alper'in bu yaklaşımı, izleyiciye yalnızca olayların görünür yüzeyini değil, aynı zamanda toplumsal ve felsefi anlam katmanlarını da sunar. Bu film, alegorik anlatımıyla yalnızca Türkiye'nin değil, evrensel toplumsal dinamiklerin de bir eleştirisini yapar.



Görsel 1-2: Tepenin Ardı Filminden Sahneler

"Tepenin Ardı" filminde sine-anlatının politik ve alegorik tonu, bir taşra hikâyesi bağlamında oldukça önemli bir yere sahiptir. Emin Alper, taşrada geçen sine-toplum yapısı içerisinde özgün kahramanlar ve hikâyeler yaratarak kendine has bir sinemasal evren inşa etmektedir. Bu bağlamda filmde öteki ve ötekileştirilme temalarının belirgin bir şekilde ön plana çıktığı görülmektedir. Filmde, tepenin bu tarafındaki karakterlerin birbirlerine duyduğu güvensizlik, paranoya ile birleşerek ötekine üstün bir biçimde yansıtılmaktadır. Yaratılan sine-anlatıda, tepenin ardında Yörüklerin konuşlandığına dair inanç, belirsiz silüetler, taşların yuvarlandığı tepeler ve kayalıklar gibi unsurlarla desteklenir. Bu öğeler, Mehmet'in kavaklıkların arasında yaptığı yolculuk ve Zafer'in gerçeklik ile hayal arasında gidip gelen algı dünyası bağlamında izleyiciye aktarılır. Bu noktada Slavoj Žižek'in "İdeolojinin Yüce Nesnesi" adlı eserinde öne sürdüğü, bireylerin düzenlerinin ve varlıklarının ontolojik bir yokluk üzerine inşa edildiği fantezi kurgusu kavramı, filmi anlamlandırmada önemli bir referans noktasıdır.

Žižek'e göre, fantezi kurgusu, basit anlamda bir kaçış ya da hayali bir kurtarıcı dünya yaratmaktan ziyade, bireylerin gerçeklik algısını şekillendiren ve gerçekliği mümkün kılan bir yapıdır. Fantezi, gerçekliğe tutarlılık kazandıran ve onun varlık dayanağı olarak işlev gören bir yapılanmadır (Žižek, 2004, s. 59). Bu bağlamda fantezi, gerçekliğin destek mekanizmasıdır ve onun var olabilmesi adına zorunlu bir unsur olarak değerlendirilir. Žižek, insanların fantezi işlevini genellikle yanlış anladığını ve gerçeklik ile kurdukları ilişkiyi yapılandıran yanılsamaları fark edemediklerini belirtir. Ona göre, bireylerin gözden kaçırdığı şey, kendi toplumsal faaliyetlerini ve gerçekliklerini biçimlendiren bilinçdışı yanılsamalarıdır. Bu bilinçdışı yapı, Žižek tarafından "ideolojik fantezi" olarak adlandırılır (Žižek, 2004, s. 48). Filmin anlatısında, tepenin ardına dair oluşturulan paranoyanın, Žižek'in



ideolojik fantezi kavramıyla açıklanabilecek bir işlev gördüğü söylenebilir. Tepenin ardında somut bir tehdit olup olmadığı belirsizdir, ancak bu belirsizlik, tepenin bu taraftaki karakterlerin kendi gerçeklik algılarını kurmasına olanak sağlar. Bu durum, hem bireysel hem de toplumsal düzeyde, gerçekliğin dayanak noktalarını oluşturma sürecinin bir temsili olarak değerlendirilebilir. Sonuç olarak, *Tepenin Ardı*, hem ideolojik fantezi hem de ötekileştirme süreçlerini derinlemesine irdeleyen bir sine-anlatı olarak, izleyiciyi düşünsel bir sorgulamaya davet etmektedir.



Görsel 3-4: Tepenin Ardı Filminden Sahneler

*Tepenin Ardı* filminde, toplumsal zihniyetin bireyler arası ilişkilerin inşasında belirleyici bir rol oynadığı açıkça görülmektedir. Özellikle Faik karakteri, hâkim toplumsal anlayışın bir temsilcisi olarak öne çıkmaktadır. Filmde, iktidar ilişkilerinin kurulması, korunması ve işlevselliğinin sürdürülmesi Faik karakteri üzerinden somutlaştırılmaktadır. Faik'in rolü, toplumsal normların ve değerlerin bireyler üzerindeki etkisini görünür kılmakta ve bireylerin toplumla kurduğu ilişkilere dair önemli bir analiz sunmaktadır. Film, bireylerin toplumla olan ilişkilerini anlamamıza katkı sağlarken, aile kurumunun bu ilişkilerdeki kritik rolünü de vurgular. Aile, yalnızca bir sosyal yapı değil, aynı zamanda iktidar mekanizmalarının temel bir aracı olarak işlev görmektedir. Michel Foucault'nun disipliner iktidar, bilgi-iktidar ve biyo-iktidar kavramları, aile içindeki ilişkilerde açık bir şekilde görülebilmektedir. Aile, toplumsal zihniyetin oluşumu, üretilmesi ve nesiller boyunca aktarılması sürecinde bilgi-iktidarının etkili bir aracı olarak karşımıza çıkar.

Bu bağlamda, aile kurumu, toplumsal düzenin devamlılığını sağlayan derin ve güçlü bir mekanizma olarak değerlendirilebilir. Disipliner iktidar, bireylerin davranışlarının denetimi ve şekillendirilmesinde aile aracılığıyla işlerlik kazanır. Aynı şekilde, bilgi-iktidar, aile içinde bireylerin sosyalleşme sürecini etkileyerek toplumsal normların yeniden üretilmesini sağlar. Biyo-iktidar ise, bireylerin yaşamlarının yönetimi ve düzenlenmesinde aileyi bir aracı olarak kullanır. Sonuç olarak, *Tepenin Ardı*, toplumsal zihniyetin bireyler arası ilişkiler ve aile yapısı üzerindeki etkisini tartışırken, aynı zamanda Foucault'nun iktidar kavramlarının bu bağlamdaki işleyişini anlamamıza katkı sunmaktadır. Film, aile kurumunun iktidar mekanizmalarıyla olan entegrasyonunu derinlemesine ele alarak, bireylerin toplumdaki konumlarını ve güç dinamiklerini nasıl algıladıklarına dair kapsamlı bir analiz ortaya koymaktadır.

Aile içindeki ilişkiler, normlar ve roller, yalnızca bireylerin davranışlarını şekillendirmekle kalmaz, aynı zamanda toplumun genel yapısına da önemli katkılar sağlar. Bu bağlamda, aile kurumunun, iktidar aygıtları arasında hem işlevsel hem de köklü bir konuma sahip olduğu söylenebilir. Toplumun en temel yapı taşı olarak değerlendirilen aile, bireylerin üretime katılımını teşvik eden biyo-iktidarın önemli bir aracı olarak işlev görür. Aile içindeki güç ilişkileri ve disiplin mekanizmaları, fertler arasında gözetleme ve denetleme

süreçlerini içerir ve böylece disiplinler iktidarın somut örneklerini sunar. Aile, bir yandan bireylerin sosyal yaşamını düzenlerken, diğer yandan toplumsal normların ve değerlerin aktarılmasında kritik bir rol üstlenir. Bu dinamikler, toplumun istikrarını ve düzenini sağlamak için güçlü bir temel oluşturur. Bu nedenle, aile kurumunun işlevleri ile biyo-iktidarın etkileri arasındaki ilişki, hem sosyolojik hem de felsefi açıdan önemli bir araştırma alanıdır.

*Tepenin Ardı* filmi, aileler arasındaki gerilim ve dış tehdit algısını merkeze alarak, düşman olarak algılanan ötekiyi film boyunca görünmeyen bir varlık olarak temsil eder. Bu yaklaşım, filmin alegorik yapısını güçlendirir. Filmde toplumsal paranoya ve içsel çatışmalar, anlatının temel mekanizmaları olarak öne çıkar. Yaratılan bu sine-anlatı, izleyiciyi bireylerin toplumsal normlarla, aile yapısıyla ve öteki kavramıyla olan ilişkilerini sorgulamaya davet eder. Film, alegorik bir yaklaşımla toplumsal ve politik gerilimlere, iç düşman yaratma ve ötekileştirme süreçlerine güçlü göndermelerde bulunmaktadır. Bu bağlamda, tepe hem fiziksel bir mekân hem de bilinçaltında yatan korkuların ve çatışmaların bir metaforu olarak işlev görmektedir. Kahramanlar, tepenin ardında bir öteki ararken, aslında kendi içsel dünyalarındaki ötekileştirme eğilimleri ve iletişimsel önyargılarla yüzleşmektedir. Filmde yer alan kurtlar, gerçek bir tehditten ziyade, bireylerin içsel bir düşman yaratma ihtiyacını ve ötekileştirme eğilimini sembolize etmektedir. Aileler arasındaki gerilimler ve şüpheler, ötekiyle olan ilişkiyi ve bu ilişkinin toplumsal psikoloji üzerindeki etkilerini ortaya koyar. Öteki kavramı, bireylerin kimliklerini ve toplumsal rollerini anlamlandırmaları açısından önemli bir referans noktası sunar. Film, toplumsal cinsiyet rolleri, etnik kimlik, yabancı/düşman algısı ve yerel statü gibi kavramlar üzerinden ötekileştirme süreçlerini çok boyutlu bir şekilde ele almaktadır. Toplumda "akıl", "akılsızlık" karşısında bir üstünlük ölçütü olarak görülürken; akıl ve otorite alanının dışında konumlanmak, otoriteden sapma bağlamında "sapkınlık" ya da "delilik" olarak değerlendirilmektedir. Bu bağlamda film, bireylerin ve toplumların normatif çerçevede belirlenen "öteki" algısına dair kalıplaşmış düşüncelerini eleştirerek izleyiciyi bu yapıların altında yatan ideolojik temelleri sorgulamaya davet etmektedir.

### 2.1.3. Kurak Günler Filminin Künyesi

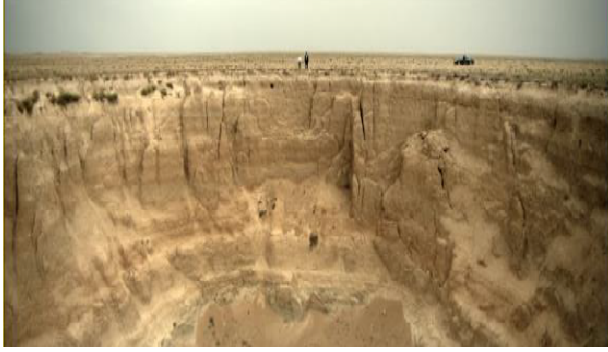
#### 2.1.4. Kurak Günler Filminin Çözümlemesi

Filmin İsmi	Kurak Günler
Yönetmen	Emin Alper
Senaryo	Emin Alper
Yapımcı	Kerem Çatay, Nadir Öperli
Vizyon Tarihi	2022
Süre	128 dk.
Oyuncular	Selahattin Paşalı, Ekin Koç, Selin Yeninci, Erol Babaoğlu, Erdem Şenocak, Ali Seçkiner Alıcı, Eylül Ersöz

Film, izleyiciyi merak uyandıran bir açılış sahnesiyle başlar ve daha ilk sahnelerden itibaren dikkati üzerine çekmeyi başarır. Savcı Emre ve Hâkime Zeynep'in yer aldığı bu sahne, hikâyenin temel dinamiklerini sunarak izleyiciyi anlatıya dâhil eder. Açılış sahnesi, obruğun alegorik anlamını sorgulatarak, kahramanların burada ne yaptığını ve neden burada olduklarını merak ettirir. Bu gizemli başlangıç, izleyiciyi hikâyeye hemen bağlar ve film boyunca düşünsel bir katılımı hedefler. Filmin olay örgüsü, karakter odaklı bir



yapıya sahiptir ve Savcı Emre'nin etrafında şekillenir. Olay örgüsü, bir yandan Savcı Emre'nin iç dünyasını keşfetmeye odaklanırken, diğer yandan onun toplumla olan ilişkisini derinlemesine incelemektedir. Emre, filmin baş kahramanı olarak hikâyenin merkezinde yer almakta ve toplumun sorunlarıyla yüzleşen bir özne konumunda bulunmaktadır. Savcı Emre'nin toplumsal etkileşimleri ve içsel çatışmaları, filmin temel temalarını şekillendirir. Film, bireysel ve toplumsal düzeylerde, Emre'nin deneyimleri üzerinden bir düşünsel yolculuk sunar. Bu bağlamda, hem bireysel arayış hem de toplumsal eleştiri, filmin anlatsal yapısını derinleştirir ve izleyiciyi daha geniş bir anlam dünyasına davet eder.



Görsel 5-6: İç Anadolu bölgesinde yeraltı sularının aşırı kullanımı sonucu meydana gelen obruklar, can ve mal güvenliğini ciddi şekilde tehdit eden doğal afetlerdendir. Bu coğrafyalarda yaşanan obruklar, ani çöküntüler ve büyük çukurlar oluşturarak insanların hayatını riske atar. Obruğun genel planda gösterilmesi, coğrafyada su sorununun ciddiyetini vurgulamakta ve obrukların yarabileceği olası tehlikelere, obruğun başında duran Savcı Emre ve Hakime Zeynep'in obruğun yaratmış olduğu derinliğe bakması ise sorunun büyüklüğüne ve bu işin devlet meselesi haline dönüşmesine göndermede bulunmaktadır. Burada obruk alegorik anlamda bir konunun bir konunun derinliklerine inerek o konuyu anlamayı ve keşfetmeyi sembolize etmektedir. Sinema sanatında önemli bir kavram olan film-zaman kavramı bir filmin zamansal yapısını ifade etmektedir. Filmin gerçek zamandan bağımsız olarak, kendi iç zamansal yapısını oluşturduğunu ifade eder. Bu kavram, bir filmin anlatı yapısını, ritmini, süresini, zamansal süreçleri ve gerçek zamandan sapma gibi unsurları ele alır. David Bordwell ve Kristin Thompson'ın "*Film Sanatı*" (2012) adlı eserinde detaylı bir şekilde anlatılmaktadır. Bu açıdan film-zaman içinde obrukların anlamlandırılması da değişikliğe uğramaktadır. Bu noktada obruklar, adaletin çöküşünü, hukukun çelişkilerini ve adaletsizliği sembolize ederken, aynı zamanda karakterlerin iç dünyalarını yansıtmaktadır.

Bir film anlayışı, sine-anlatıda yer alan sine-toplumun kültürel bağlamlardaki deneyimlerini aktaran bir ifade biçimi olarak değerlendirilebilir. Bu bağlamda, *Kurak Günler* filminde taşra atmosferinin yansıtılması, o toplumun özgün özelliklerini ve karmaşıklıklarını açığa çıkaran bir unsur olarak öne çıkmaktadır. Filmde Savcı Emre'nin köye gelişi, vahşi bir törenle ve holiganvari bir gösteriyle resmedilmektedir. Bu tören sırasında bir grup, silahlarını kullanarak bir tür terör estirir ve kanlı bir domuz avı düzenler. Söz konusu sahne, filmin genelinde hissedilecek olan taşra düzenindeki kaosun bir göstergesi niteliğindedir. Bu noktada filmi, politik ve siyasi alegori kavramları üzerinden yorumlamak mümkündür. Gün Zileli'nin *Komün: Geleceğe İlişkin Bir Politik Alegori* (2007) adlı eserinde de ele aldığı üzere, politik alegoriler, toplumsal değişimi teşvik etmek veya mevcut yapıları eleştirmek amacıyla etkili bir araç olarak kullanılmaktadır. Sembollerin gücü sayesinde, politik alegoriler yüzeyde basit bir öykü gibi görünse de, altında derin siyasi anlamlar barındırır. Bu çok katmanlı yapı, izleyiciler veya okuyucular üzerinde güçlü bir etki bırakabilmektedir.

Siyasal alegori, gerçekliği semboller aracılığıyla yeniden yorumlayarak politik bir perspektif sunan bir sanat ve anlatı biçimi olarak tanımlanabilir. Bu tür, belirli bir zaman ve mekânla sınırlı olmaksızın, siyasi olayları ve durumları analiz ederek onlara yeni boyutlar kazandırır. Ayrıca, siyasi alegoriler, gerçek dünyadaki politikacıların ve olayların yerine kurgusal karakterlerin ve hikâyelerin kullanımını içerir. Bu yönüyle siyasi alegoriler, politik olayları eleştirel bir perspektifle değerlendirme imkânı sunar. Sonuç olarak, siyasi alegoriler, politik düşüncenin gelişimine katkıda bulunan güçlü bir anlatım aracı olarak işlev görür. *Kurak Günler* filmi, taşranın toplumsal düzenini ve politik gerilimlerini alegorik bir çerçevede sunarak izleyiciyi hem bireysel hem de toplumsal düzeyde derin bir sorgulamaya davet eder. Filmin politik alegorik yapısı, yalnızca yerel olaylarla sınırlı kalmaz; aynı zamanda evrensel bir perspektifle güç, otorite ve toplumsal çatışma temalarını ele alır.

Deleuzeyen bir bağlamda politik alegori kavramını tartışmak, Gilles Deleuze ve Félix Guattari'nin felsefi kavramlarını politik ve sanatsal anlatılarla ilişkilendirerek daha derinlemesine bir analiz yapma imkânı sunar. Deleuze, sabit kimlikler ve tek bir anlamla sınırlı yapılar yerine, sürekli değişim, farklılaşma ve çoklu anlamlara açık olan süreçlere vurgu yapmaktadır. "Fark ve Tekrar" (2021) adlı eserinde, Deleuze, sabit bir temsil anlayışını reddederek, fark kavramıyla her bir anlatının izleyici veya okuyucuda farklı yankılar uyandırabileceğini savunur. Politik alegoriler bu bağlamda, sabit bir mesaj vermektense ziyade, çoklu anlam katmanlarıyla her izleyici için farklı bir düşünsel ve duygusal alan açar.

"Hareket-İmge" (2022) ve "Zaman-İmge" (2021) adlı eserlerinde, Deleuze, imgeler ve temsil arasındaki ilişkiyi sorgular ve geleneksel temsil anlayışını aşan bir yaklaşım geliştirir. Politik alegoriler, Deleuze'e göre, yalnızca politik gerçeklikleri semboller ve imgeler aracılığıyla temsil etmekle kalmaz; aynı zamanda yeni düşünme biçimlerine olanak tanır. Alegorik imgelerin sabit anlamlar taşımaktan ziyade, farklı politik ve düşünsel imkânlar yarattığını ifade eder. Bu görüş, politik alegorilerin her defasında yeniden yorumlanabilen ve evrilen bir yapıya sahip olduğunu ortaya koyar.

Deleuze ve Guattari'nin "Bin Yayla" (2024) adlı eserinde tanımlanan rizom kavramı, politik alegorilerin doğrusallıktan uzak, çok katmanlı yapısını anlamak için önemli bir çerçeve sunar. Rizom, köksap gibi yatay ve çok merkezli bağlantılar oluşturan, doğrusal olmayan bir yapıyı ifade eder. Bu bağlamda, politik alegoriler de rizomatik bir doğaya sahiptir; merkezi bir anlatıdan çok, dallanıp budaklanan, farklı yönlerde açık çoklu bağlantılar kurar. Alegorik anlatılar, Deleuzeyen bir perspektifle değerlendirildiğinde, merkezi olmayan bir yapı içerisinde sürekli hareket ve değişim hâlinindedir. Nomadizm kavramı ise, Deleuze ve Guattari'nin "Kapitalizm ve Şizofreni" (2005) adlı eserinde geliştirilmiş, sabit kimlikler ve sınırların reddi üzerine kuruludur. Nomadizm, hareketin, akışın ve geçişkenliğin bir ifadesi olarak, politik alegorilere de uygulanabilir. Politik alegoriler, sabit bir mesaj veya kimlik önerisinden ziyade, dinamik, değişen ve sürekli evrilen politik anlamlar sunar. Bu doğası gereği, alegoriler her defasında yeniden yorumlanabilir ve mevcut bağlama uyum sağlayabilir.

Deleuze ve Guattari'nin "Kafka: Azınlık Bir Edebiyat Yönünde" (2015) adlı eserinde ele aldıkları "azınlık edebiyatı" kavramı, politik alegorilere yeni bir boyut kazandırır. Azınlık edebiyatı, baskın kültür karşısında alternatif ve marjinal seslerin ifadesini vurgular. Politik alegoriler de bu bağlamda, dominant yapılar karşısında bir direniş ya da karşı-anlatı üretme işlevi görür. Alegoriler, marjinalleşmiş ya da azınlıkta kalan seslerin görünür kılınmasında etkili bir araç olarak değerlendirilir. Sonuç olarak, Deleuzeyen bağlamda politik alegoriler, sabit ve kapalı yapıların aksine, sürekli değişim ve farklılaşmaya açık, dinamik ve çok merkezli anlatı biçimleri olarak öne çıkar. Bu yapılarıyla politik alegoriler, hem mevcut gerçekliklerin eleştirel bir analizi hem de alternatif düşünce biçimlerinin keşfi için güçlü bir araç sunar.

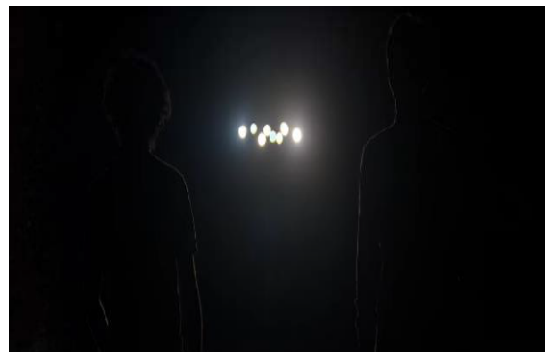


Görsel 7-8: Filmde gösterilen bu imajlar bağlamında taşranın sakil görünümü ve bir domuzun traktör tarafından kasabanın dışına atılmasının gösterilmesi, kırsaldaki kişilerin yeri geldiğinde vahşileşebileceği ve öteki olarak gösterilen hiçbir varlığı kasabalarında barındırmak istemediklerini göstermektedir. Burada görülen az gelişmişlik, militarizmin yüceltilmesi ve eğlence anlayışının tehlike oluşturarak modern hukuk sisteminin getirmiş olduğu yasakları çiğneyen zihniyet aslında Jean Baudrillard'ın "*Simülakrlar ve simülasyon*" (2010) adlı eserinde de detaylı işlenen simülasyon kuramı çerçevesi bağlamında değerlendirilerek modernleşme çabasına karşın filmde yoğun bir ötekileştirme dilinin kullanıldığı görülmektedir.

Filmde yönetmen, obrukların yanı sıra balçık imgesini kullanarak mevcut yapıdaki çatlakların örtbas edilmesi ve yok edicilik temalarını alegorik bir şekilde ele almaktadır. Bu temanın en çarpıcı örneği, Savcı Emre'nin balçıklı gölde yıkanma isteğidir. Söz konusu sahne, kahramanın mevcut yapıdaki belirsizliğe ve yok ediciliğe doğru çekilmekte olduğunu simgelemektedir. Yönetmen, balçık imgesini ustalıkla kullanarak izleyiciyi daha derin bir düşünce ve yoruma davet eder. Bu yaklaşım, filmin sadece yüzeydeki olayları anlamlandırmakla kalmayıp, alt metindeki daha derin anlamları da açığa çıkarmaya çalıştığını gösterir. Emin Alper, filmde alegorik anlatımını metaforik ve sembolik unsurlarla zenginleştirerek siyasi atmosferi etkileyici bir şekilde yansıtmaktadır. Filmde domuzlar, ötekileştirilen kesimi temsil eden bir metafor olarak karşımıza çıkar. Bu sembol, politik gerçekliklere atıfta bulunarak ötekileştirme süreçlerini görünür kılar. Benzer şekilde, ölü farelerin sık sık ortaya çıkması, toplumda mevcut bir sıkıntı veya sorunun habercisi olarak yorumlanabilir. Bu imgeler, siyasi gerilimi artıran bir sembolik anlatı oluştururken, sinekler belirsizlik ve kötülüğü simgeleyen bir başka metafor olarak filmin atmosferine katkıda bulunur. Yönetmen, metaforik ve sembolik unsurları ustalıkla kullanarak politik ve toplumsal atmosferi vurgulamakta ve izleyiciye gerçekçi bir anlatı ile alegorik yapının birleştiği bir sinematik deneyim sunmaktadır. Bu yaklaşım, filmin hem toplumsal eleştiri boyutunu güçlendirmekte hem de izleyiciyi, yüzeydeki olayların ötesine geçerek alt metindeki derin anlamları keşfetmeye teşvik etmektedir.



Görsel 9-10: Savcı Emre, belediye başkanı tarafından yemeğe çağrılır ve bu çağrıyı kabul eder. Alper, filmde bu sahne ve sonraki sahnelerde dramatik yapı kurarak eyleyenler arasında çatışmayı başlatır. Marcel Mauss'un "*Armağan Üzerine Deneme*" (2018 ve "*Sosyoloji ve antropoloji*" (2005) adlı eserlerinde Armağan kuramını ele almaktadır. Burada film bağlamında bu kuram ile şu söylenmektedir: Armağan ilişkisinde armağanı kabul etmek ister ve karşılığında bir armağan vermek ya da armağanı verene karşı sadakat ve hizmet sunarak ödeşmek gereklidir (Burke, 2008:50). Taşrada potlaç şenlikleri genellikle bir geçiş döneminde gerçekleştirilmektedir. Burada potlaç ile kastedilen şey armağan kültürünün aksine vermeden çok, kaybetme ilkesi hakimdir. Bir kişinin kendisiyle eşit ya da öteki olarak konumlandığı kişileri, değerli eşyalarının parçalanıp yağmalanmasına tanık olmaları için davet ettiği toplumsal şöenler olarak tamamlandığında; burada cömertlik sahip olunan eşyanın elde kalmaması gibi ritüellerle, aynı zamanda bir güç gösterisi ve ötekileştirdiği kişiye gözdağı ve onları alt etme durumudur. Burada belediye başkanının da savcuyu davet ettiği yemekte böyle bir özellik taşımaktadır. Burada aslında savcının obruklar ve belediyenin yürütmüş olduğu proje ile ilgili düşüncesini öğrenmek ve gerekirse bu düşüncüyü manipüle etme hedefi taşımaktadır. Bölgede yaşanan gerçeklik ile savcının geldiği yer arasındaki geçeklik farklıdır. Armağan kuramı açısından bakıldığında da taşra kesiminde armağan kültürüne özgü zihniyetin çarpık bir hal aldığı ve yerel insanın kendi dışındaki farklılıklara tahammül edemediklerini ve ötekiyi yok etmeye odaklandıklarını göstermektedir. Bu yok etme kültürünü taşrada var olan ataerkil zihniyetin metalaştırdığı eğlence anlayışının cinsellik ve avcılıktan ibaret olduğunu ve girilen toplumun dayattığı zihniyetten sıyrılmaya çalışan Savcı Emre'nin bir devlet temsili olarak sıyrılmaya çalışırken eşcinsel olarak ötekileştirilmesini ele alır.



Görsel 11-12: İmajlar bağlamında simülasyon kuramı açısından medyanın kitlelerin algısını istediği gibi manipüle ederek aslında var olmayan bir gerçekliği haber yaparak Savcı Emre'ye olan tepkilerin büyümesini sağlamıştır. Kasabada yaşanan su sorununun bitmeyeceğini düşünen halkın çıkan gazete haberlerinin de etkisiyle savcuyu ötekileştirildiği

görülmektedir. Bu ötekileştirilme onu yok etmekten geçmektedir. Taşrada yaşanan belediye başkanlığı seçiminden sonra uygulanan dezenformasyon tekniği ile kitlelerin hassas oldukları konular üzerine tepki göstermeleri sağlanmıştır. Hakime Zeynep'in çabalarına simülasyon kuramı açısından bakıldığında bu durum gerçekliğin yeniden üretimine işaretler. Savcının temsil ettiği değerlerin taşrada hiçbir anlam ifade etmediğini kornalarla, meskûn mahalde yapılan silah sesleriyle fark etsek de savcının kararlı ifade ve çarpık zihniyete karşı tek başına kalsa da bu ötekileştirici zihniyetle uzlaşma yoluna gitmeyeceğini görürüz. Siyasi ideolojinin popüler bir imgeye dönüşmesi rasyonalizmden uzak holiganizmi getirmiştir. Ötekinin yadsınmasına dayalı bu anlayış çerçevesinde seçim zaferini sınırsız özgürlükle kutlamak, öteki olarak addedilen kimlikleri cezalandırmak bir hak olarak görülmüştür. Burada devlet güçlerinin bu holiganlaşan ortama uyum sağladıkları noktada toplumsal güvenlik tehlikeye girmektedir. Bu tehlikeden en çabuk nasibini alanlar ise adalet önünde hakkını savunamayacak ötekilerdir. Pekmeze ve evine yapılanlar bunun somut bir örneğidir. Murat'ın gazetesinin basılması ve tüm gazetelerin yakılmasının bir şenlik havasında kutlanması ve savcının evine atılan ölü farelerin kasabada ötekileştirilen kişilere yer olmadığına işaret etmektedir. Taşrada diğer bir devlet temsili olan Hakime Zeynep'in de bu ötekileştirici, yabancılaştırıcı zihniyetin içinde olmasına rağmen savcının ve Murat'ın kalabalığın üzerine gidildiğinde ne yapacaklarını bilememesi ancak kendilerinden kaçıldığında saldırganlaşmaları toplumsal yapının keskin bir biçimde ayrıldığına işaret eder. Filmde ilkel içgüdüğü ötekine duyulan nefreti armağan kuramı çerçevesinde değerlendirdiğimizde belediye başkanının kurduğu sofrada aslında savcının bir meze olduğu anlaşılmalıdır. Armağan kuramı ve simülasyon kuramı çerçevesine göre taşranın zihniyet ve gerçeklik bağlamında artık dönülmez bir yola girdiğini, aradaki uçurumun iki kitle arasındaki farklılıkları temsil ettiğini ve aynı coğrafyada ortak değerler üzerine milli bir kimlik idealinin kurgulanamayacağını görürüz. Murat ve savcının kovalamadan sonra bir anda obruğun diğer tarafında belirmesi toplumdaki gerçeklik tezahürünün radikal bir biçimde birbirinden ayrıldığını ve aradaki boşluğun ise kapatılması zor olan farklılıklara vurgu yaptığını ve iki farklı sahip zihniyet anlayışının gerçekliğinin dönüşüme uğradığını görürüz.

Emin Alper'in "*Kurak Günler*" filmi, nedensellik ilişkisi bağlamında incelendiğinde, Savcı Emre'nin disiplinli bir görev bilinciyle hareket eden bir eyleyen olduğu görülmektedir. Emre, kasabada yaşayanların çıkarlarını gözetmeye çalışırken, aynı zamanda kendisine yapılanlarla yüzleşmekte ve bu sebeple ortaya çıkan sonuçlara göre hareket etmektedir. Kahramanın perspektifinden bakıldığında, filmde belirgin bir sebep-sonuç ilişkisi izlenmektedir. Film, patriarkal yapı, kadın karakterlerin temsiliyeti ve LGBT+ konularında derinlemesine bir inceleme sunarak toplumsal cinsiyet eşitsizliklerine dair çarpıcı bir eleştiri getirmektedir. Erkek karakterlerin baskın olduğu ve güç sembolleri olarak tasvir edildiği filmde, kadın karakterlerin ise sınırlı ve pasif rollerle arka planda bırakıldığı gözlemlenmektedir. Bu durum, filmin toplumsal cinsiyet rolleri üzerine yaptığı eleştirileri ve patriarkal yapıya yönelik sorgulamalarını görünür kılmaktadır. Aynı zamanda LGBT+ temsili, toplumsal normların ve ötekileştirme pratiklerinin eleştirel bir incelemesini sunarak filme ayrı bir derinlik kazandırmaktadır. Emin Alper, "*Kurak Günler*" filminde toplumsal ve siyasi meseleleri incelleme alan bir sinematik yapı ortaya koymaktadır. Yönetmen, alegori, metafor ve öteki kavramını ustalıkla kullanarak hikâyeyi çok katmanlı bir yapıya kavuşturur. Alegorik ve metaforik anlatım, izleyiciyi yalnızca olayların yüzeyinde tutmakla kalmaz; aynı zamanda toplumsal eleştirileri ve siyasi alt metinleri sorgulamaya yönlendirir. Bu yaklaşımla film, yalnızca bir anlatı olmaktan öte, izleyiciyi düşünsel bir katılıma davet eden etkileyici bir yapıt olarak değerlendirilebilir.

Emin Alper, "*Kurak Günler*" filminde semboller aracılığıyla izleyiciye düşünsel bir katılım sunmakta ve güçlü mesajlar iletmektedir. Film, toplumun ve siyasetin



karmaşıklıklarını tartışmak için etkili bir araç olarak değerlendirilir. Yönetmen, alegori kavramını karakterler, olaylar ve hikâye üzerinden somutlaştırarak toplumsal eleştirilerini izleyiciye aktarır. Film, su kıtlığı çeken Yanıklar adlı bir kasabada geçmektedir. Bu kasaba, yalnızca bir mekân değil, daha geniş çaplı toplumsal sorunların bir mikrokozmosu olarak işlev görür. Su kıtlığı, hem fiziksel hem de metaforik anlamda kasabanın bozulmuş düzenini ve ahlaki çöküşünü temsil eder. Kasaba halkı arasında su kaynakları üzerindeki çekişmeler, yerel düzeydeki sosyal ve siyasi çatışmaların bir yansımasıdır. Bu bağlamda Yanıklar, ülkenin genel durumuna yönelik geniş kapsamlı bir eleştiriyi alegorik bir şekilde sunar. Yerel yöneticilerin su kaynaklarını kontrol etme çabaları, iktidar mücadelesinin ve otoritenin kötüye kullanılmasının bir temsili olarak değerlendirilebilir. Su kıtlığı, metaforik anlamda toplumsal ve ahlaki kuraklığı ifade eder. İnsan ilişkilerindeki gerginlikler ve çatışmalar, toplumun geneline yayılan anlaşmazlıkları ve bozulmuş değerleri simgeler.

Baş kahraman Savcı Emre'nin suyu arama çabası, adalet ve dürüstlük arayışının bir metaforudur. Bu arayış, kasabanın yozlaşmış yapısına karşı verilen bir mücadele olarak okunabilir. Su, aynı zamanda arınma ve yenilenme sembolüdür. Dolayısıyla suyun eksikliği, kasabanın arınma ve yenilenme ihtiyacını temsil eder. Bu bağlamda su, yalnızca fiziksel bir ihtiyaç değil, aynı zamanda ahlaki ve toplumsal bir dönüşümün sembolüdür. Filmde "öteki" kavramı, kasaba halkının dışlanan veya marjinalleştirilen üyeleri üzerinden işlenir. Öteki, hem sosyal hem de politik anlamda, kasabada yerleşik düzenin dışında kalan bireyleri temsil eder. Kasabadaki ayrışmalar ve dışlanmalar, öteki kavramının somut örnekleri olarak öne çıkar. Özellikle yerel otoritelerin kendi çıkarlarını koruma adına diğerlerini ötekileştirmesi ve dışlaması, filmde çarpıcı bir şekilde işlenmektedir. Bu durum, toplumdaki güç dinamiklerinin ve iktidar ilişkilerinin eleştirisini içerir. Sonuç olarak, *Kurak Günler*, alegori, metafor ve öteki kavramlarını kullanarak toplumsal ve siyasi yapıyı çok katmanlı bir şekilde analiz eden bir yapıt olarak öne çıkmaktadır. Film, kasabanın sembolik yapısı üzerinden, bireysel ve toplumsal yozlaşmayı eleştiren bir anlatı sunarken, izleyiciyi adalet, arınma ve yenilenme temaları üzerinde düşünmeye davet eder.

## Sonuç

Sinemasal bir anlatıda alegori, metafor ve diğer kavramların kullanımı ve yorumlanması son derece önemlidir. Emin Alper'in filmlerinde alegorik ve metaforik unsurların kullanımı, izleyiciyi düşünsel bir katılıma yönlendirir. Toplumsal ve politik mesajlarını özgün ve yaratıcı bir dille aktarırken, Türkiye'nin sosyal, ekonomik ve politik gerçekliklerine atıfta bulunur. Alper, alegorik ve metaforik anlatım unsurlarını güçlü bir şekilde kullanarak izleyiciye farklı perspektifler sunar. "*Tepenin Ardı*" ve "*Kurak Günler*" filmleri göstergebilimsel bir bakış açısıyla incelenmiş ve yönetmenin toplumsal eleştirilerini açığa çıkarmak için kullanılan metaforlar vurgulanmıştır. Bu filmlerdeki metaforlar, izleyicilere farklı perspektifler sunarak filmlerin derinliklerine inmelerine olanak tanır. Alegori, metafor ve diğer kavramların temsili için önemli bir laboratuvar olan bu iki film, sinemanın sosyolojik ve felsefi boyutlarıyla ele alındığında, bu kavramların nasıl işlendiğini daha iyi anlamamıza yardımcı olur. Göstergebilimsel bir bakış açısıyla yapılan analizler, filmlerin imgelerini değerlendirerek izleyiciye farklı açılardan bakma imkanı sunduğunu vurgular. Göstergebilimsel analiz tekniği, filmlere yüzeysel odaklanmak yerine, derinlikli bir bakış açısı sunarak düz ve yananları çözmeyi amaçlar. Alper'in sinema anlayışı çerçevesinde bu yöntem, izleyicilere yananları keşfetme fırsatı sunar. Alegori ve metafor gibi kavramlar, filmlerdeki önemli temaları ve sorunları ele alırken, öteki kavramı ise konuları farklı bakış açılarıyla ele alma imkanı sağlar. Emin Alper'in sinemasında alegori, metafor ve öteki kavramların nasıl kullanıldığını ve bu kavramların filmlere kattığı derinlikleri ele alan bu çalışma, sinema sanatı için farklı kültürlerin ve sosyal sınıfların

mesajlarını iletmek için güçlü bir araçtır. Emin Alper'in filmlerini göstergebilimsel bir bakış açısıyla ele alan bu çalışma, film izleme deneyimlerinde farklı açılar kazanma fırsatı sunar. Sonuç olarak, göstergebilimsel analizlerin sinema dünyasında önemli bir yere sahip olduğu ve film izleyicilerine yeni perspektifler sunarak sinema dilini daha iyi anlamamıza ve alana katkı sağlamayı hedeflemektedir.

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# A comprehensive Evaluation Approach using Geosite Assessment Model, the case of Sotira and Bogova Waterfalls in Albania

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## ABSTRACT

The evaluation of geosites is an important step in understanding and promoting geodiversity while fostering sustainable tourism and environmental management. The Geosite Assessment Model (GAM) is a structured and quantitative methodology designed to assess geosites the scientific, educational, aesthetic, and functional values of geosites. This paper presents the application of the GAM technique to selected geosites of the Bogova and Sotira waterfalls, providing insights into their potential for geotourism development and conservation strategies. The results highlight the importance of integrating scientific evaluations with socio-economic factors to establish geosites as tools for education and sustainable regional development. Furthermore, the findings underscore the GAM's flexibility and applicability across diverse geological and geomorphological settings, making it a valuable tool for researchers, planners, and policymakers.

This research contributes to the growing body of literature on geosite evaluation and provides a replicable framework for assessing geosites at both local and national levels. Recommendations for improving geosite conservation and promoting geotourism through interdisciplinary approaches are also discussed.

**Keywords:** Geosite Assessment Model, geodiversity, Bogova waterfall, Sotira waterfall, sustainable development

## 1. Introduction

Geomorphosites are geosites of geomorphological significance, with a now well admitted distinction between central or scientific values on the one hand, and additional values such as ecological, economic or aesthetic values on the other hand. Among the scientific values, some are directly linked to the climatic forcings through geomorphological processes in the case of active geomorphosites, for example the meaning of a waterfall in a post-glacial trough valley. In the case of passive geomorphosites, the central values rather lie in structural features, ancient landforms, inherited regoliths etc.<sup>1</sup>

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<sup>1</sup> (1) (PDF) *Geomorphosites and the history of geomorphology*

Geomorphosites as in situ elements are defined as parts of geospace that represent a special and complete importance of the history of the earth.<sup>2</sup> In Albanian literature, the terms geomonument and hydromonument are widely known, defining geological, geomorphological, hydrological objects of local, national and international importance. Among the geomonuments that are a natural asset in terms of geotourism are also waterfalls.

Waterfalls are among the most beautiful parts of nature and have been consistently tourist attractions. In order to preserve scientific and aesthetic values and to enable sustainable development, some of the waterfalls are legally and institutionally protected, including them in the Protected Areas of Albania. According to the IUCN (International Union for Conservation of Nature) classification, waterfalls have become part of hydromonuments, a subcategory of Natural Monuments.<sup>3</sup>

This paper presents the application of the GAM technique to selected geosites of the Bogova and Sotira waterfalls, providing insights into their potential for geotourism development and conservation strategies. These two waterfalls are located in the Tomori National Park, known for its high scientific value, rich biodiversity, and great historical and cultural values.

The results highlight the importance of integrating scientific assessments with socio-economic factors to create geosites as tools for education and sustainable regional development. Furthermore, the findings highlight the flexibility and applicability of GAM in different geological and geomorphological settings, making it a valuable tool for researchers, planners, and policymakers.

## 2. Description of the natural conditions of Tomorr National Park

Tomorri National Park is a green area, mainly with beech and pine forests, and large alpine pastures throughout the area. This area is known for its specific and ecological values of biodiversity. The combination of drinking water sources, especially the Bogove and Kërpica springs, the Sotira waterfall, the green valleys and the high mountains of the park create a relaxing landscape and the perfect place for a rich flora and fauna.

The park is located in the municipalities of Berat, Poliçan and Skrapar (Berat District) and in the municipality of Gramsh (Elbasan District), on the homonymous mountain at height from about 300 m to 2415 m.<sup>4</sup>

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<sup>2</sup> Serjani, A, Neziraj, A. (2003). *Geomonuments and Geotourism in Albania*, Wimbelton, Tirana, page 259.

<sup>3</sup> (PDF) GEOINFORMATION OF WATERFALLS IN ALBANIA GEOINFORMACIONI I UJËVARAVE NË SHQIPËRI

<sup>4</sup> Qiriazi, P.(2020). *Natural Heritage of Albania*. Tirana, page 180.



Tomorri National Park view (Photo Xh.Zdrava September 2024)

The territory consists of limestone in the central part, flysch in the lower part of the slopes. Tomorri Park rises like a castle above the hilly area and the surrounding valleys. Its ridge is flat and sometimes steep, with karst forms. There are many underground karst formations, such as caves and deep wells, which have been declared natural monuments. On the northern and northeastern slopes, there are glacial landforms and large cirques.<sup>5</sup>

The climate of Mount Tomorri National Park is mountainous with short and cool summers, while winters are long and very harsh.<sup>6</sup> The park has natural forests and three vegetation belts are distinguished due to the influence of climatic factors.<sup>7</sup> It receives about 1200 mm of rainfall per year. For several months its ridge is covered with snow, which also enables white tourism.<sup>8</sup>

The hydrographic system, which is very rare, consists of temporary streams. Two streams that flow into the Devoll River are distinguished: the Sotira and Tomorrica streams, which originate on the eastern side of Mount Tomor. In the Tomorrica valley there are several karst springs, the waters of which come from Mount Tomor and emerge at the contact between limestone and flysch.<sup>9</sup>

The Kërpica and Sotira springs are distinguished, while the Ujanik springs are associated with moraine deposits. There are also springs at the base of the western slope, among which the Tomor and Bogova springs stand out. The water is used by local communities as drinking water for irrigation, electricity, aquaculture and recreational activities.<sup>10</sup>

Tomorri National Park is distinguished by its high biodiversity. All plant generations are found there and the animal world in the park is also rich and diverse.<sup>11</sup> In the park there are several natural monuments with scientific, didactic and touristic values such as: Sterra e Katafiqit, Sterra e Prosekut, Pirogoshit Cave, Ujanik glacial moraines, Kulmakut Pass, etc.

<sup>5</sup> Zylyftar, P. Berati encyclopedia. "Jonalda" publishing house. Page 576.

<sup>6</sup> On the same page.

<sup>7</sup> Tomorri Mountain National Park Management Plan, 2014.

<sup>8</sup> Qiriazhi, P.(2020). *Natural Heritage of Albania*. Tirana, page 182.

<sup>9</sup> On the same page.

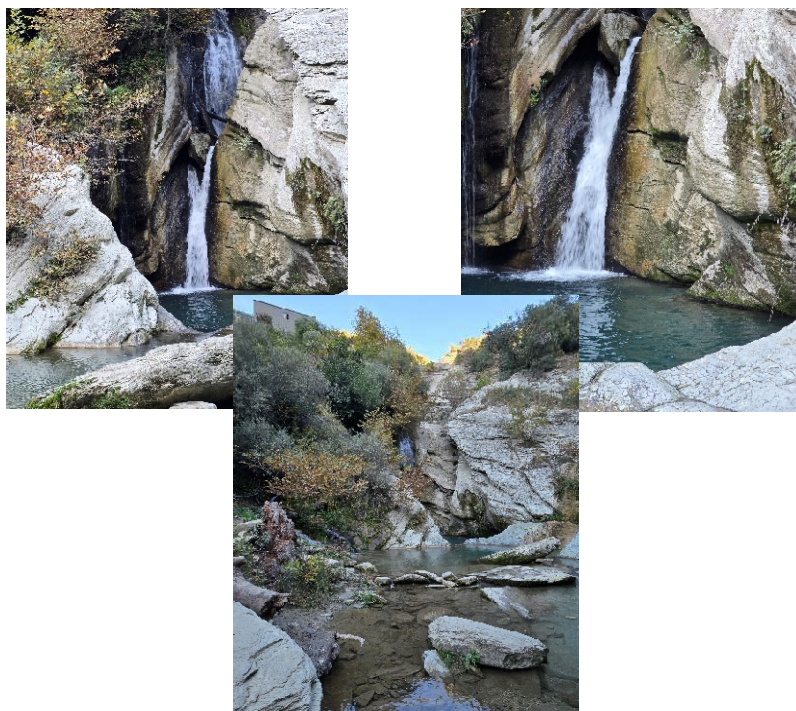
<sup>10</sup> On the same page.

<sup>11</sup> Zylyftar, P. Berati encyclopedia. "Jonalda" publishing house. Page 576.

The famous springs of Bogova and Kërpica, the Sotira waterfall, the green valleys and the high mountains of the park create a relaxing landscape and a perfect place for diverse tourist activities. The natural beauty of the mountain in every season of the year is complemented by numerous cultural and historical heritage sites such as: Abaz Ali's tomb (Kulmakut's tomb - a place of worship), the tekke, etc.<sup>12</sup> All of these constitute a high potential for recreation and sustainable development of ecotourism.

### 3. Waterfalls

**Bogova Waterfall**, a natural monument in the Tomori National Park, is increasingly being ranked as one of the most visited attractions by local and foreign tourists. It is located within the Tomori Mountain National Park at an altitude of 315 m above sea level. This waterfall has high tourist values with an amazing beauty and is very popular with local and foreign visitors in almost all seasons of the year. It has a height of 20 m and a water basin with a depth of 10-12 m, it is a natural gem surrounded by diverse vegetation.<sup>13</sup> The waters of this spring are used for irrigation and the production of electricity for the water supply of the city of Berat through the construction of an aqueduct with a capacity of 800l/s.<sup>14</sup> This geomonument has scientific, geological, geomorphological, hydrogeological, didactic and geotourism importance. This geomonument was declared a protected site by Council of Ministers No. 676 dated 20.12.2002. It can be visited via the Berat-Çorovodë road to Bogovë-Ura e Sirakës, from where the pedestrian route is taken.<sup>15</sup>



View from Bogova Waterfall (Photo Xh.Zdrava November 2024)

<sup>12</sup> Qiriazhi, P.(2020). *Natural Heritage of Albania*. Tirana, page 182.

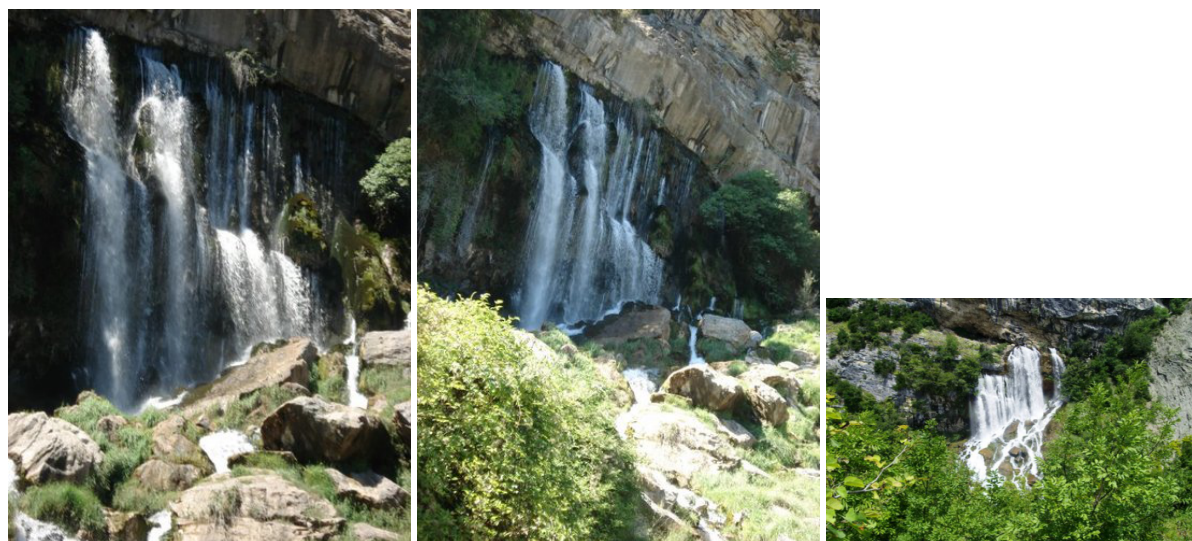
<sup>13</sup> Berat Regional Administration of Protected Areas

<sup>14</sup> Kazazi, M., *Academy of Science of Albania" Albanian Encyclopedic Vocabulary"*, pg 273, Tirana, 2009.

<sup>15</sup> Neziraj, A., 2016. *Geomonuments of the Municipality of Skrapar*



**Sotira Waterfall** is located in the Gramsh municipality, Kushovo administrative unit, near the village of Sotira. Sotira is located inside the Tomorri National Park.<sup>16</sup> It is formed by a large spring that emerges from a longitudinal crack in the steep limestone rock, over 5 m long and up to 20 m high.<sup>17</sup> The landscape of the slope where the water emerges has several steps with a difference in level of 150 m, the waterfall is surrounded by oak forest and rich vegetation. This waterfall is a beauty that leaves you speechless, incomparable but like everything rare and magical, this waterfall also has its tricks, it is advisable to visit in the spring and early summer, because it is fed by underground water sources, which when they fall below a certain level also cause the waterfall to dry up.<sup>18</sup> Around it grow wild horse chestnuts and other trees.<sup>19</sup> The water of the waterfall creates the Tomorica River, a tributary of the Devoll River, the watershed of the Seman River. This waterfall constitutes a geomonument of national importance, with scientific, geological, geomorphological, didactic and geotourism values of rare beauty.<sup>20</sup> According to (Beisel, 2006), the Sotira waterfall is of the segmented type, since several separate falls are formed. The Sotira waterfall is located only 100 km from the capital and to reach the destination, the Tirana-Elbasan-Gramsh-Sotirë-pedestrian road is traversed.<sup>21</sup>



Different views of the Sotira Waterfall (Source Berat Regional Administration of Protected Areas)

<sup>16</sup> (1) (PDF) GEOINFORMATION OF WATERFALLS IN ALBANIA GEOINFORMACIONI I UJËVARAVE NË SHQIPËRI

<sup>17</sup> Qiriaz, P.(2020). *Natural Heritage of Albania*. Tirana, page 185.

<sup>18</sup> Neziraj, A., 2016. *Geomonuments of the Municipality of Gramsh*

<sup>19</sup> Mecaj, N., *Academy of Science of Albania" Albanian Encyclopedic Vocabulary"*, pg 2791, Tirana, 2008.

<sup>20</sup> Berat Regional Administration of Protected Areas

<sup>21</sup> [https://www.researchgate.net/publication/342897838\\_GEOINFORMATION\\_OF\\_WATERFALLS\\_IN\\_ALBANIA\\_GEOINFORMACIONI\\_I\\_UJËVARAVE\\_NE\\_SHQIPËRI](https://www.researchgate.net/publication/342897838_GEOINFORMATION_OF_WATERFALLS_IN_ALBANIA_GEOINFORMACIONI_I_UJËVARAVE_NE_SHQIPËRI)

#### 4. Methodology

This paper presents the application of the GAM (Geosite Assessment Method) technique, created by (Vujicic et al., 2011), for the assessment of selected geosites of the Bogova and Sotira waterfalls, providing insights into their potential for geotourism development and conservation strategies. The GAM model consists of two sets of values: main values and additional values, which are divided into 12 and 15 indicators, where each is rated from 0.00 to 1.00. This division is made according to two general types of values: main values which are a consequence of the natural characteristics of the microforms, and additional values which are mostly influenced by humans and developed by modifying their use by visitors. Main values comprise three indicators: scientific/educational values (SEV), scenic/aesthetic values (SAV) and protection values (PV), each of with four subindicators. Scientific and educational values (SEV) are the basic qualities for classifying an abiotic geoh heritage site and consist of four sub-indicators. Scenic and aesthetic values (SAV), also with four sub-indicators, are included in the main values, as they do not change over time. Protection value (PV) with four sub-indicators, is seen as a main value, as it is an important activity prior to the promotion and development of tourism as a whole. In total, the main values consist of 12 sub-indicators. The additional values (AV) are divided into two groups of components, functional (FnV) and tourist values (TrV). The additional values (AV) are divided into two subgroups (indicators), functional and tourist values. The functional values (FnV) consist of six sub-indicators, while tourist values (TrV) assess the current state of tourist services and consist of nine sub-indicators. In total, there are 12 sub-components of the main values and 15 sub-components of the additional values, which are rated from 0.00-1, which determine the GAM with this equation:

$$\text{GAM} = \text{MV} + \text{AV}$$

$$\text{Where: } \text{MV} = \text{SEV} + \text{SAV} + \text{PV}$$

For each sub-indicator there will be a numerical evaluation option, starting from the lowest value to the highest value: 0.00, 0.25, 0.50, 0.75 and 1.00. The numerical evaluations are presented in Table 1. To determine the main values of geomorphosites, the sum of scientific/educational values with aesthetic/ethical values and protection values is performed, while to determine the complementary values of waterfalls, the sum of functional values with tourist values will be performed.

$$\text{AV} = \text{FnV} + \text{TrV}$$

The mathematical data obtained will be placed on a graph consisting of an X- matrix (horizontal matrix) and a Y- matrix (vertical matrix). The 12 main values are placed on the X- matrix and the 15 additional values are placed on the Y-matrix.

The sum of the main and additional values is shown in a single graph, where the matrix X has the main values, and the matrix Y the additional values. The matrix X contains 12 units and the matrix Y 15. The graph is divided into nine zones, indicated as: Z11, Z12, ... Z33. The main grid lines that create zones for the matrix X have a value of 4 and for the matrix Y 5 units. According to this estimate, each waterfall will be drawn in the matrix field. Moving from the

zone Z11 to the zone Z33, an increase in the main and additional values of the geosites is observed, in this case waterfalls.

Table 1: Assessments of the condition of Bogova Waterfall and Sotira Waterfall

Indicators/sub-indicators	Values given by experts	
	Bogova Waterfall	Sotira Waterfall
<b>Main indicators (MI)</b>		
<b>1. Scientific/educational values (SEV)</b>		
Rarity (SIMV1)	0.75	0.75
Representativeness (SIMV2)	0.75	0.75
Knowledge on geoscientific issues (SIMV3)	0.75	0.75
Level of interpretation (SIMV4)	0.25	0.25
<b>2. Scenic/aesthetic (SAV)</b>		
Viewpoints( (SIMV3)	0.5	0.25
Surface (SIMV6)	0.5	0.5
Surrounding landscape and nature (SIMV7)	0.75	0.75
Environmental fitting (SIMV8)	0.5	1
<b>3. Protection Values (PV)</b>		
Current condition (SIMV9)	0.75	0.75
Protection level (SIMV10)	0.75	0.75
Vulnerability (SIMV11)	0.5	0.5
Suitable number of visitors ( (SIMV12)	1	1
Additional values (AV)		
<b>1. Functional Values (FnV)</b>		
Accessibility (SIAV1)	0.5	0.5
Additional natural values( (SIAV2)	0.25	0.25
Additional anthropogenic values (SIAV3)	0.5	0.25
Vicinity of emissive centers (SIAV4)	0.5	0.25
Vicinity of important road network (SIMV5)	0.75	0.5
Additional functional values (SIAV6)	0.25	0.25
<b>2. Touristic values (TrV)</b>		
Promotion (SIAV7)	0.75	0.75
Organized visits (SIAV8)	1	1
Vicinity of visitors center (SIAV9)	0.25	0.25
Interpretative panels (SIAV10)	0.75	0.25
Number of visitors (SIAV11)	0.5	0.5
Tourism infrastructure ( (SIAV12)	0.5	0.5
Tour guide service (SIAV13)	0.25	0.25
Hosterly service (SIAV14)	1	0.25
Restaurant service (SIAV15)	0.75	0.25

## 5. Results and discussions

The GAM method used in this paper proved to be suitable for showing the current state of the waterfalls in Tomori Park. In order to achieve the most accurate results, field visits were conducted near these geomorphosites and field specialists who are responsible for their

preservation and well-being were also interviewed. These findings and objective assessments obtained have been converted into numerical values from 0.00 to 1.00 for each sub-indicator as shown in the table above. In table 2 below, the summaries of the main values and the supplementary values have been calculated, simultaneously determining the area where the geomorphosites are located. Bogova and Sotira waterfalls have high main values as a result of scientific values created by nature, aesthetic values appear average, protective values appear positive since the waterfalls are under constant observation of the centers that preserve them, functionality values are low inasmuch the infrastructure to reach these destinations is a little difficult and far from paved roads, and tourist values appear above average, therefore high inasmuch these two waterfalls are tourist attractions for local residents and not only since in recent years they have been massively frequented by foreign tourists. The only problem consists in services such as those of the tourist guide or hotels and restaurants which are located a little further away. Bogova waterfall presents somewhat higher values in terms of evaluation indicators inasmuch as it is closer to the service infrastructure, while Sotira waterfall presents more difficulties in reaching and in indicators such as signpost or other guides. Despite the problems encountered, these waterfalls are a great natural asset not only for the park where they are located but for the entire region, as more and more visitors are choosing to visit them every year.

Table 2: Zoning of waterfalls based on the GAM model.

Waterfalls (geomorphosite)	Main Values (SEV+SAV+PV=VM)	Additional values (AV=FnV+TrV)	Zoning
Bogova Waterfall	$2.5+2.25+3=7,75$	$2,75+5,75=8,5$	Z22
Sotira Waterfall	$2.5+2.5+3=8$	$2+4=6$	Z22

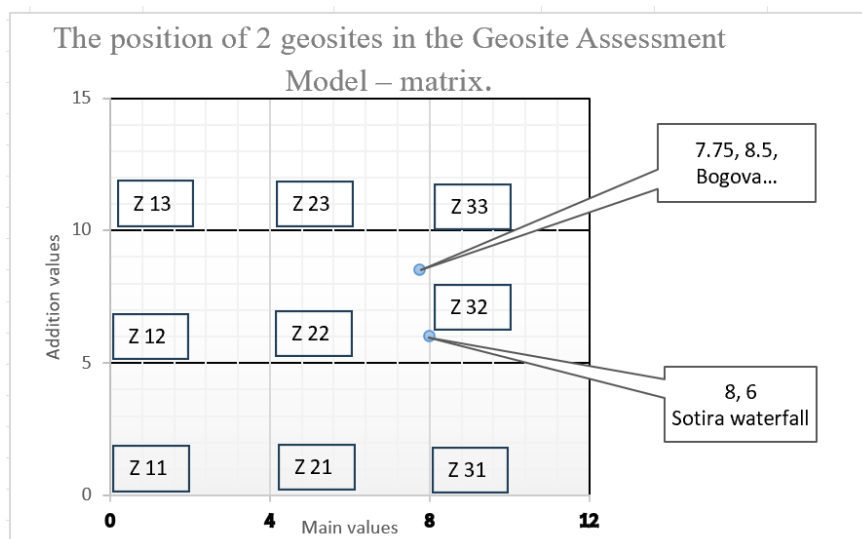


Figure 1. Position of waterfalls on the GAM graphic



## 6. Conclusions and recommendations

The use of the GAM model consists of collecting geoscientific information; analysis, observation, field visits and consultations with experts in the field. The Bogova and Sotira waterfalls in the Tomorr National Park offer an opportunity to increase the development of the areas where they are located, inasmuch as they are quite frequented by a high number of tourists. Inasmuch as geomonuments have high scientific, geological, geomorphological, hydrogeological, didactic and geotourism values, they must have a high level of protection, institutional management, geoeducation, awareness of the local community, which is low to preserve and promote them.

That which is observed regarding these waterfalls is the low level of funding in the infrastructure to reach them and also the lack of signage brings difficulties in finding the waterfalls for tourists who visit them for the first time. This is more obvious in the Sotira waterfall where there is almost no information board. The methods for developing geotourism in this park are: forming a geoinformation network through digital GIS maps, integration into environmental policies and local and national programs. Geotourism, as part of ecotourism, aims to protect the environment and increase the well-being of the local population. For the sustainable development of geotourism, a high level of scientific information, the necessary infrastructure, the preservation of the natural landscape and qualitative and continuous promotion are important.

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- Applying the show cave assessment model (SCAM) on cave tourism destinations in Serbia
- (2) (PDF) Comparative Analysis of Two Assessment Methods for the Geoeducational Values of Geosites. A Case Study from the Volcanic Island of Nisyros, SE Aegean Sea, Greece

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# The Holy Eucharist and the Eschaton

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## **ABSTRACT**

The Lord Jesus Christ instituted the Holy Eucharist.

The Eschaton and the Holy Eucharist intersect in eternity.

**Keywords:** The Holy Eucharist and the Eschaton

## **Report**

The **purpose** is the correct understanding of the essence of the Holy Eucharist and the Eschaton. The **subject** of the study is the Holy Scripture of the New Testament and the **object** is the Holy Eucharist, where the Lord Jesus Christ utters the founding Eucharistic words: "...take, eat: this is My Body... drink of it, all of you; for this is My Blood of the New Testament..." (Matt. 26:26-28).

The **method** that I use in this report is historical-critical.

The **task** is to show through the Holy Scripture of the New Testament that in the sacrament of the Holy Eucharist, in which the offered holy gifts, bread and wine are transformed during the Eucharistic prayer of the priest, (επίκλησις) through the Holy Spirit into the body and blood of Christ, are a mystical - real sacrifice, which we accept within ourselves through living faith in God.

The **hypothesis** is that we, through faith in the founding words of the Savior (Matt. 26:26-28), which are actually received by Christians through the transformed holy gifts of the Holy Spirit, are united in a living relationship with God through the sacrament of the Holy Eucharist. Which is both a remembrance (ἀνάμνησις) of Christ's sacrifice and suffering on the cross, but it is also joy in Christ's resurrection, victory over death and hell. Holy Communion is not imaginary (symbol and image) nor is it just a memory, but is a living and

real communion (κοινωνία) with the body and blood of Christ; it is also gratitude (Mark 14:23), "εὐχαριστία" for the sacrifice on the cross.

### 1. The Holy Eucharist and the New Testament.

The Holy Eucharist is the Passover (τὸ πάσχα), of the New Testament (καινή διαθήκη). The Synoptics describe in the Gospels of (Matt. 26:17; Mark 14:14; Luke 22:7-8) that it originates from the Jewish Passover in the Old Testament (Ex. 12:1; Deut. 16:1), (חַדְשׁ אֶתְנֵן לַיהוָה), which is alive and continues in God's kingdom of eternity (Luke 22:29-30).

The sacred text tells us: "And when he had taken the cup and given thanks...", (εὐχαριστία), he gave thanks (Matt. 26:27; Mark 14:23; Luke 22:19). "Through the Supper the risen Jesus Christ is present among His people in every generation"<sup>1</sup>. All three evangelists (Synoptics), (Matt; Mark and Luke) call the Last Supper "Passover". In the church, the priest presents the Holy Gifts through prayer, remembrance (ἀνάμνησις) and then, at the Eucharistic canon, he prays to the Holy Spirit to transform the bread and wine into the body and blood of Christ, (epiklesis). During the prayer for the consecration of the bread and wine before God, the holy gifts are transformed into the flesh and blood of the Lord Jesus Christ in a mystical-real sacrifice.

Thanksgiving in the Last Supper is the basis of the Holy Eucharist. The whole service received its name "eucharist" - thanksgiving, thanksgiving service"<sup>2</sup>. St. Justin Martyr and Philosopher writes: "... Do not believe that at the coming of Christ, gifts of blood and drink will be offered on the altar, but true and spiritual: praise and thanksgiving"<sup>3</sup>. This action of the Holy Spirit through the Holy Eucharist in praise and thanksgiving leads the Christian to a profound inner change and develops in him faith and love for God and neighbor.

### 2. The essence of the Holy Eucharist.

The Holy Eucharist of the Last Supper, as a remembrance (ἀνάμνησις), (Luke 22:19; 1 Cor. 11:26) according to the words recorded in the sacred text of St. Apostle Paul. "According to the testimony of Tertullian, the commemorations of the dead at that time were not made on the day of their death, as it is today, but on the day of their birth"<sup>4</sup>. We remember the death of the risen Christ Jesus, which causes joy and gratitude deep within us for the victory over death. "At the liturgy, the words of the Lord Jesus are said: "Do this in remembrance of Me (Luke 22:19)." "At the Last Supper, before being crucified, the Lord Jesus Christ blessed the bread and wine, calling them His body and blood: "Take, eat, this is My body, broken for you..." and "Drink from it, all of you, this is My blood..." with the command "Do this in remembrance of Me..."<sup>5</sup>.

The Last Supper, the Holy Eucharist, represents a mystical and real sacrifice, not only a memory of His death, but also a sacrifice (θύσιον), for His miraculous resurrection and victory over death and hell. "... the perfect action of the Church, which is the new humanity

1 THE INTERNATIONAL STANDARD BIBLE ENCYCLOPEDIA. FULLY REVISED. ILLUSTRATED. IN FOUR VOLUMES. VOLUME THREE: K-P. Geoffrey W. Bromiley, Everett F. Harrison, Roland K. Harrison, William Sanford LaSor, Lawrence T. Geraty, Edgar W. Smit, Jr. William B. Eerdmans Publishing Company Grand Rapids, Michigan, 1986, p. 169.

2 Makariopolski, Bishop Dr. Nikolay. The Holy Eucharistic Sacrifice. S. I. Sofia, 1968, p. 159.

3 St. Justin the Philosopher. Dialog. 118.

4 Kozhuharov, Bishop Nikolay of Makariopol. The Holy Eucharist (Origin and Essence of the Holy Eucharist). S.I. Sofia, 1955, p. 39.

5 Christ, through the Holy Eucharist in the material elements, bread and wine, offers Himself in advance to His disciples (τὸ σῶμά μου) His Body and (τὸ αἷμά μου) His Blood in (Matt. 26:26-28) in a mystical - real sacrifice. Auxentius, Archimandrite, Liturgical Part Three. Publishing House. "BLAKOM". Plovdiv, 2010, p. 11.

restored by Christ, is the Eucharist - an action of love, gratitude and sacrifice"<sup>6</sup>. Christ through the Holy Eucharist in bread and wine offers His disciples (τὸ σῶμά μου) His body and (τὸ αἷμά μου) His blood in (Matt. 26:26-28). "Not another sacrifice, as the high priest once did, we offer, but always the same; or, better said: we make a memorial of the sacrifice."<sup>7</sup> both historically - really on the rough cross of Golgotha, and mystically - really in the Holy Eucharist.

"The Golgotha sacrifice is the summit and center of God's economy for the salvation of the world"<sup>8</sup>. Since the Church is the body of Christ, united with the Head through mystical and real union"<sup>9</sup>. Mystically - real union with Christ through this bloodless sacrifice, which is offered on the Holy Altar by the priests in the epiclesis when the Holy Spirit transforms the offered holy gifts, bread and wine, into the body and blood of Christ.

The Savior redeems and saves us through His covenant, this is an important moment from a soteriological point of view, because at the supper through the Holy Eucharist, He concluded a New Covenant (καινή διαθήκη) with His disciples and with us today. "The relationship of this New Testament to the Old is the same as the relationship of the Last Supper as a New Testament Passover to the Old Testament - fulfillment, realization of the old in the new and nullification, termination of the old"<sup>10</sup>. The New Testament (καινή διαθήκη) is also used as a covenant, contract, law (Rom. 11:27) and testament (Heb. 9:16-17; Gal. 3:15-19). "but more - as the establishment of order, the establishment of order, the establishment of a new order, a new kingdom"<sup>11</sup>. "... and I bequeath to you, as My Father has bequeathed to Me, a kingdom" (Luke 22:29).

The Last Supper is not a traditional Jewish Passover (τὸ πάσχα), (pesah), but it is the institution of a sacrament (μυστήριον), (sacramentum), (Eph. 5:32; 3:9), Christ and the Church "...At this moment of His life, the evening before His sufferings, Christ wants to clarify the essence, meaning and fruit of His sufferings and death on the cross, to present them, to give them and make them forever accessible"<sup>12</sup>. Christ specifies that the Holy Eucharist is a new rite, it is a world-saving sacrament (μυστήριον), a mystery (mysterium), (Eph. 5:32; 3:9), Odo Casel, says that the mysteries are originally an expression of the aspiration of the human soul towards greater spirituality"<sup>13</sup>.

For the believer, the essence of the Holy Eucharist is thanksgiving, remembrance, sacrifice, covenant and sacrament. It is a living communion for the Christian with God through the offered holy gifts of bread and wine, which are transformed into the "epiclesis" of the body and blood of Christ.

6 Schmemmann, Protopr. Al. Liturgy and Life. Lectures and Essays on Christian Education and Growth through Liturgical Experience. Praxis Publishing House, Tarnovo, 2002, p. 56.

7 St. John Chrysostom. 82 Miles from the interpretation of Matthew. Kozhuharov, Bishop Nikolay of Makariopol. The Holy Eucharist (Origin and essence of the Holy Eucharist). S.I. Sofia, 1955, pp. 44-45.

8 Makariopolski, Bishop Dr. Nikolay. The Holy Eucharistic Sacrifice. S. I. Sofia, 1968, p. 35.

9 THE INTERNATIONAL STANDARD BIBLE ENCYCLOPEDIA. FULLY REVISED. ILLUSTRATED. IN FOUR VOLUMES. VOLUME THREE: K-P. Geoffrey W. Bromiley, Everett F. Harrison, Roland K. Harrison, William Sanford LaSor, Lawrence T. Geraty, Edgar W. Smit, Jr. William B. Eerdmans Publishing Company Grand Rapids, Michigan, 1986, p. 167.

10 Old Testament (berit - ברית ), New Testament (καινή διαθήκη). Kozhuharov, Bishop Nikolay of Makariopol. The Holy Eucharist (Origin and Essence of the Holy Eucharist). S.I. Sofia, 1955, p. 46.

11 Lopukhina, Prof. Al. So much Bible. T. VIII, 1911, p. 419.

12 Kozhuharov, Bishop Nikolay of Makariopol. The Holy Eucharist (Origin and Essence of the Holy Eucharist). S.I. Sofia, 1955 p. 50.

13 Odo Casel calls the Holy Eucharist, a sacrament of consecration (μυστήριον), a mystery (mysterium). Kozhuharov, Makariopolsky Ep. Dr. Nikolai. The Holy Eucharist (Origin and Essence of the Holy Eucharist). S.I. Sofia, 1955, pp. 50 - 51.

### 3. The Eschatona.

The eschatological understanding of the Holy Eucharist in the Last Supper is a hope for believers to look through Christ's agonizing death on the cross to the messianic table and joy in the future with Him. "According to St. Theodoret the Studite, the Holy Eucharist contains the entire Dispensation of Salvation"<sup>14</sup>. Christ prepares His disciples for the future messianic table, which will take place in the Kingdom of God (Luke 22:29-30). "Jesus Christ instituted the sacrament of the Eucharist shortly before His suffering on the cross, establishing it at the Last Supper"<sup>15</sup>. The Lord's Table, the Holy Eucharist, the Messianic Passover (πάσχα) refers to all believers throughout the ages who participate together in the unity of the Body of Christ, which is the Church. The eschatological moment is also emphasized at the Last Supper by St. Eucharist in (Matt. 26:29) where the Lord Jesus Christ says that he will eat with His disciples the new Messianic Passover in the Kingdom of God. "Y. Zizioulas, when speaking of time, the Eucharist determines that the future is not separated from the present and the past"<sup>16</sup>. Through the Holy Eucharist we foretell the future age (eon). "As the Church confesses her faith in the Second Coming of the Son of God, in the Holy Eucharist we foretell the Second Coming and where the Kingdom of God comes into power"<sup>17</sup>. In the words of Metropolitan John Zizioulas, "It contains all the elements that point to the existence of the world in the Kingdom of God"<sup>18</sup>. Through the Holy Eucharist, the Kingdom of God is among us in the Church. Prof. Alexander Lopukhin writes about (μαρτύριον): It is translated differently: "The Lord is coming", "The Lord will come", "The Lord came", "Our Lord is coming", "Come Lord", "The Lord will come soon", etc. "<sup>19</sup>. Christ shares Himself with us in the Holy Eucharist through the accompanying holy gifts, bread and wine transformed by the Holy Spirit into the body and blood of Christ in a mystical - real sacrifice that abides throughout the centuries in the Eschatona. From the Holy Eucharist in the Eschatona flows faith and love that floods us on the path of salvation. It is a sharing of new life, power for the forgiveness of sins and reconciliation with God.

### Conclusion

The Holy Eucharist is celebrated in the Church where the Holy Spirit dwells and our faith in God produces a soul-saving and life-saving influence on the humble Christian. There the holy gifts are offered before God through the priest's prayer, "remembrance" (ἀνάμνησις) and then at the Eucharistic canon he prays the Holy Spirit to transform the bread and wine into the body and blood of Christ, "epiklesis" (ἐπίκλησις). During the prayer for the consecration of the bread and wine before God the holy gifts are transformed into the flesh and blood of the Lord Jesus Christ in a mystical-real sacrifice. In St. The Eucharist is the body and blood of Christ for salvation and the forgiveness of sins (John 6:54; 1 John 1:7; 5:6-8; Rev. 12:11; Col. 1:14; Matt. 1:21). The essence of the Holy Eucharist is remembrance (ἀνάμνησις), thanksgiving (εὐχαριστία), sacrifice (θύσιαν), covenant (διαθήκη), and sacrament (μυστήριον).

The prayer of thanksgiving (εὐχαριστία) of the Lord Jesus Christ at the Last Supper is the basis of the Holy Eucharist.

14 Peno, Zdr. Foundations of the Orthodox Faith (Catechism). I.K. "Syntagma". V. Tarnovo, 2008, p. 138.

15 Koev, T. Kirov, D. A Brief Theological Encyclopedia. Published by "Bulvest 2000". Sofia, 1993, p. 88.

16 Zizioulas, I. Eucaristia e Regno di Dio. Comunita di Bose, Magnano, 1996, p. 46-47.

17 Peno, Zdr. Foundations of the Orthodox Faith (Catechism). I. K. "Syntagma". V. Tarnovo, 2008, p. 137.

18 Kozhuharov, Makariopolski Ep. Dr. Nikolai. The Holy Eucharist (Origin and essence of the Holy Eucharist). S.I. Sofia, 1955, p. 143.

19 Lopukhin, Prof. A. P. Biblical history in the world of the latest research and discoveries: the New Testament. T. 1. SPB, XXXII, Ed. bookseller I.L. Tuzova, St. Petersburg, 1895, p. 1184.

The Holy Eucharist in the Eschatona, as remembrance (ἀνάμνησις), (Luke 22:19; 1 Cor. 11:26) is “the proclamation of the Lord’s death.” It is also a living communion (κοινωνία) with Christ through His flesh and blood through the transformed saints. Gifts (1 Cor. 10:16). We remember the death of the risen Lord Jesus Christ, which brings joy and thanksgiving within us for the ultimate victory over death and hell. The early church of Christ took the Holy Eucharist with joyful and thankful hearts (Acts 2:46).

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# Intertwining Threads of Sustainability: A Comparative Study of Ryukyu Bingata and Kasuri with Terengganu Batik and Songket

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## **ABSTRACT**

Sustainability has emerged as a prominent issue in recent years. The existing strategy for sustainability in cultural assets demonstrates how present developmental requirements are seen to address future demands more effectively. The emphasis on sustainability in cultural heritage management is both challenging and stimulating. Notwithstanding the obstacles in growth, motivation is on the rise in the sector. This study examines contemporary sustainability in the cultural history of Ryukyu Bingata and Ryukyu Kasuri textiles in Japan and Terengganu Batik and Songket in Malaysia. A qualitative analysis of specific case studies examines the cultural heritage sector's growing emphasis on sustainability, initiated by the UN 2030 Agenda for Sustainable Development Goals. Cultural heritage conservation, a niche discipline within a limited industry, must adhere to the same sustainable development criteria as other sectors (Japan and Malaysia). Irrespective of individual sustainability philosophies, societal norms dictate the parameters for cultural heritage management. The condition of cultural heritage differs globally. Maintaining big collections at museums and art institutions is costly, and trained cultural heritage conservators hinder cultural heritage management. Consequently, cultural heritage conservators may facilitate sustainable social, economic, and environmental advancement. Nonetheless, sustainable conservation practices and novel materiality methods may contradict current conservation ideas, necessitating a reevaluation of these theories to uphold elevated professional standards. Professionals in cultural heritage conservation possess extensive worldwide networks and facilitate sustainable development via international collaboration and sustainable methodologies.

**Keywords:** Ryukyu Bingata, Ryukyu Kasuri, Batik Terengganu, Songket Terengganu, Sustainable Development

## **1. Introduction**

Sustainability has become a significant concern since the United Nations established the Global Sustainable Development Goals 2030 (SDG 2030). This has led to the development of new approaches to cultural heritage management, which requires advancement in the cultural heritage sector. Cultural heritage conservation is one of the most resource-intensive areas of cultural asset management, with significant issues such as energy and water use, material consumption and waste, and hazardous substance disposal. Despite its small relative impact on world development, the cultural heritage sector is much smaller than other sectors like manufacturing and transportation [1].

This project aims to investigate contemporary approaches to sustainable cultural heritage management in the manufacturing of Ryukyu Bingata and Ryukyu Kasuri textiles and its implications for the field of cultural heritage conservation. The goal is to provide the foundation for future individual endeavors that will lead to scientific investigation and contribute to an anthology of writings on approaches to sustainability in cultural heritage conservation that the Sustainability in Conservation network will disseminate [2].

The Ryukyu Bingata, a traditional Okinawan textile dyeing method, is characterized by recurring nature-inspired patterns, including fish, flowers, and animals, shown in vibrant colors. It was used during the Ryūkyū Kingdom era in the 14th century when Okinawa had a large inflow of foreign commodities and industrial know-how. The dyeing technique is believed to have started as a synthesis of Javanese, Chinese, and Indian dyeing techniques, possibly influenced by mainland Japanese dyeing patterns and techniques, as well as "urashi gata," a Chinese stencil dying technique [3].

During the Ryūkyū Dynasty, "Ryukyu Bingata" was used to make clothing for the ruling class and was also a valuable commodity. The art of "Ryukyu Bingata" was introduced to mainland Japan between 1688 and 1704 and quickly became well-known. However, the Ryukyu Dynasty's disintegration in 1879 and eventual dismantling during World War II caused a sharp drop in output, which was subsequently recovered after the conflict [4].

Malaysian batik, a type of batik cloth art, is primarily found in the states along Malaysia's east coast, specifically Kelantan, Terengganu, and Pahang. The most common themes are greenery and flowers, with human or animal motifs being rare due to Islamic restrictions on animal imagery. Butterfly motifs are another notable exception. Malaysian batik has a more pronounced and simpler style than Indonesian Javanese batik, with elaborate patterns rarely created using canting. The main technique for adding color to fabrics is brush painting, and the colors are brighter and more dazzling than Javanese batik [5].

Malaysia's batik manufacturing history dates back to the 13th century, with trade relations between Javanese coastal cities and the Melayu Kingdom in Jambi. The northern coastal batik-producing districts of Java have impacted Jambi batik, while the Malay Peninsula's batik industry has been influenced by Javanese and Jambi (Sumatra) batik. The Oslo Museum of Cultural History claims that Malay batik-making was influenced by Javanese design development and technique [6].

The commercial manufacturing of Malaysian batik began in the 1960s, and it has evolved throughout time. The craft is unique to Malaysia in both look and design, with hand-painted batiks being a part of Javanese culture. The east coast states of Kelantan, Terengganu, and Pahang are where Malaysian batik is made, while Johor's batik is influenced by southern Malaysia, where a sizable community of Javanese and Sumatran immigrants reside.

"Batik" translates to "wax drawing," and the vibrant, patterned fabric has gained popularity worldwide. Geometry, geography, natural flora, and animals are often included in the designs of this fabric. Terengganu Batik is renowned for its eye-catching designs, brilliant hues, and adaptability. It comes into two categories: hand-drawn batik and block print. Hand-drawn works are inspired by the artist's ideas and creativity, while block print batik uses a copper or hardwood block that resembles a home iron and is exquisitely decorated. Contemporary designers often use aspects of this outdated method into their vibrant designs.

The Malaysian government has officially endorsed Malaysian batik as a national garment for all public sectors by acquiring new batik patterns that represent the Malaysian



concept. Malaysian batik is distinct from other nations in terms of style and final product, with artists hand-drawing motifs and using chanting to create paintings on white fabric. Geometric and organic elements are prevalent in Malaysian batik design, and Islamic traditions, which forbid the use of animals in art, encourage geometric and floral patterns.

However, the recent rise in popularity of Malaysian batik has hurt the country's indigenous batik sector. Approximately 320 batik businesses in Malaysia are registered with Malaysian Handicraft, having been in operation since 1910 in the states of Kelantan and Terengganu. The importation of batik fabric, often made of polyester, from China costs 200 batik businesses an estimated RM3 million per year. Malaysia's batik industry is dwindling due to imported batik being less expensive than Malaysian batik, and the design is imprinted on the cloth by overseas batik makers using printing presses, leading to massive amounts of false Malaysian batik being produced in a fraction of the time required for hand-painted batik.

To maintain the viability of the domestic batik industry and preserve its traditions and manufacturing techniques, local businesses should utilize Malaysian intellectual property laws to protect their investments and the country's historic batik sector [6].

## 2. Literature Review

The interplay between culture and sustainability becomes increasingly vital in our globalized world, particularly concerning traditional textiles. The art of Ryukyu Bingata and Ryukyu Kasuri, originating from the Okinawa Islands in Japan, exemplifies how cultural heritage can both inform and enhance contemporary sustainability practices. By integrating traditional production methods with modern ecological awareness, artisans are not only preserving their craft but also promoting environmentally responsible practices. This research will explore how these practices offer valuable lessons for the traditional textiles of Terengganu Batik and Songket in Malaysia. Through a comparative analysis, key themes of sustainable development, community engagement, and economic viability will emerge, demonstrating the relevance of cultural heritage in contemporary environmental discourses. Understanding the connections between these textile traditions allows for a deeper appreciation of their roles in sustainable practices, facilitating cultural exchange and highlighting the importance of preserving these art forms for future generations [7].

Preserving cultural heritage while ensuring its sustainability involves a delicate balance between maintaining traditional practices and adapting to contemporary challenges. Sustainability in this context refers not only to environmental considerations but also to the social and economic viability of art forms such as Ryukyu Bingata and Kasuri, which hold significant cultural value in Japan. The approach taken in Japan emphasizes the necessity of integrating modern sustainability practices into the production processes of these textiles. This integration can ensure that traditional artisans can thrive economically while fostering a community that values cultural heritage. Furthermore, lessons learned from these practices can inform the conservation efforts of other textile traditions, such as Terengganu Batik and Songket. By understanding and applying these principles, stakeholders can work towards a more sustainable future that honors the legacy of these crafts while adapting to modern societal needs [8].

### Overview of Ryukyu Bingata, Kasuri, Terengganu Batik, and Songket

The vibrant textile traditions of Ryukyu Bingata and Ryukyu Kasuri reflect the deep cultural heritage of Okinawa, Japan, blending artistry with environmental consciousness.

Ryukyu Bingata is characterized by its bright colors and intricate designs created through a resist-dyeing technique, emphasizing motifs inspired by nature and local culture. On the other hand, Ryukyu Kasuri employs a unique weaving technique that creates blurred patterns, achieved by pre-dyeing threads before weaving. Both practices not only encapsulate traditional craftsmanship but also highlight Japan's evolving approach toward sustainability, seeking to balance cultural preservation with ecological responsibility. Meanwhile, Terengganu Batik and Songket from Malaysia share similarities in their intricate artistry, yet they each present unique narratives tied to their regions. By examining Japan's sustainable practices in textile production, valuable lessons can be drawn to enhance the sustainability of Terengganu's textile heritage, fostering a more environmentally and culturally resilient future [9].

### **Importance of comparative study in understanding sustainability practices**

Drawing connections between diverse cultural practices is essential for enriching our understanding of sustainability. Comparative studies provide valuable insights by allowing researchers to examine how different communities approach sustainable practices within their unique cultural contexts. For instance, analyzing the production methods of Ryukyu Bingata and Ryukyu Kasuri fabrics alongside Terengganu Batik and Songket can reveal contrasting yet complementary techniques that contribute to environmental sustainability. These parallels offer lessons in resource management, social responsibility, and cultural preservation, thereby fostering a holistic view of sustainability practices. Moreover, understanding the economic implications of these artisanal craft techniques enhances the dialogue about sustaining traditional methods in contemporary markets. Ultimately, such comparative analyses not only highlight the shared challenges faced by different communities but also underscore the potential for collective growth through sustainable practices, fostering a deeper appreciation for cultural heritage while addressing urgent environmental concerns [10].

### **Historical Context of Textile Traditions**

The intricate practices surrounding textile production in cultures like the Ryukyu Islands can be traced back to centuries of historical development influenced by trade, colonization, and cultural exchange. Ryukyu Bingata and Ryukyu Kasuri, with their vivid hues and complex patterns, reflect not just artistic expression but also the socio-economic dynamics of their time. Historically, these textiles served multiple purposes, from functional clothing to ceremonial attire, highlighting the intertwined relationship between art and daily life. Similarly, the textile traditions of Terengganu Batik and Songket have evolved through interactions between local artisans and external influences, adapting techniques and motifs while striving to preserve their unique identities. As modern sustainability initiatives gain momentum, it is essential to recognize how these historical contexts inform contemporary approaches, offering valuable lessons in balancing tradition with innovation. Understanding this background lays the groundwork for exploring sustainable practices across different cultures [11].

### **Origins and cultural significance of Ryukyu Bingata and Kasuri**

Deeply rooted in the history of the Ryukyu Islands, Ryukyu Bingata and Kasuri exhibit a rich cultural tapestry that reflects the islands' unique identity and artistic heritage. Originating during the 15th century, Ryukyu Bingata employs intricate dyeing techniques to

produce vibrant fabrics often adorned with motifs inspired by nature and mythology, signifying harmony with the environment. Meanwhile, Kasuri, developed later, utilizes ikat weaving methods to create patterns that echo the textures of nature, demonstrating both aesthetic beauty and practical utility. The cultural significance of these textiles transcends mere craftsmanship; they embody traditional values and communal identity, sustaining economic viability in contemporary society. As Japan adopts new approaches towards sustainability in the production of these fabrics, it highlights the potential for cultural heritage to inform and inspire sustainable development practices, offering valuable lessons for other textile traditions such as Terengganu Batik and Songket [12].

### **Historical development of Terengganu Batik and Songket**

Emerging from a rich tapestry of traditions, the art of Terengganu Batik and Songket has evolved significantly since its inception. Initially influenced by early Malay textile techniques, the distinct motifs and vibrant colors of Terengganu Batik reflect both nature and cultural narratives, often employing natural dyes sourced locally and with sustainable practices in mind. By the late 19th and early 20th centuries, the introduction of new methods and synthetic dyes allowed artisans to expand their palettes, but it also posed challenges to environmental sustainability. Songket, a luxurious fabric traditionally woven with gold or silver threads, further exemplifies the region's artistic heritage [13]. Today, both Batik and Songket face the dual challenge of honoring their historical roots while adapting to modern sustainability standards, making them prominent subjects of study in the intersection of cultural preservation and sustainable development efforts. Through this continuous evolution, these textiles not only symbolize the region's identity but also reflect broader global trends towards sustainability.

### **Influence of historical practices on contemporary sustainability efforts**

Historical practices in fabric production, such as those seen in Ryukyu Bingata and Ryukyu Kasuri, provide a valuable lens through which contemporary sustainability efforts can be understood. These traditional techniques, steeped in cultural significance, showcase a harmonious relationship between artistry and environmental stewardship by utilizing natural dyes and local materials. This historical context serves not only as a source of inspiration for sustainable methods in manufacturing but also fosters a sense of identity and community among practitioners. Contemporary Japan has begun to incorporate these principles into modern strategies aimed at preserving cultural heritage while promoting environmentally friendly practices, thus offering important lessons for other fabric traditions like Terengganu Batik and Songket. By acknowledging and revitalizing these time-honored techniques, societies can nurture sustainable production models that respect tradition and address pressing environmental concerns, ultimately leading to a more resilient cultural fabric [14].

### **Contemporary Approaches to Sustainability**

Modern strategies for achieving sustainability often draw from the lessons of cultural heritage practices, especially in the context of traditional fabric production. In Japan, the crafting of Ryukyu Bingata and Ryukyu Kasuri fabrics has increasingly embraced sustainable methods, incorporating eco-friendly materials and traditional dyeing techniques that minimize environmental impact. This shift not only preserves the unique artistry of these fabrics but also aligns with global trends in sustainable development, advocating for

the importance of cultural heritage in this discourse . Engaging local artisans and communities in these practices fosters a greater awareness of social sustainability, ensuring that traditional crafts remain viable while adapting to contemporary market demands [15]. The economic challenges faced by practitioners also necessitate a balanced approach, blending innovation with tradition to develop viable strategies for the long-term conservation of these cultural treasures . Ultimately, these approaches create a thoughtful framework for promoting sustainability in similar textile traditions, such as Terengganu Batik and Songket fabrics.

### **Japan's strategies for sustainable production of Ryukyu Bingata and Kasuri**

In recent years, Japan has adopted innovative strategies to ensure the sustainable production of Ryukyu Bingata and Kasuri, recognizing the importance of cultural heritage while addressing environmental concerns. This approach emphasizes traditional techniques, such as natural dyeing processes and manual craftsmanship, which not only preserve the art form but also minimize ecological impact. Social sustainability is paramount, as local artisans are engaged in the process, fostering a community-oriented mindset that promotes heritage preservation and skill-sharing among younger generations. Additionally, collaboration with environmental organizations has encouraged the implementation of sustainable practices in sourcing materials, making use of local resources to reduce carbon footprints [16]. The economic implications of these strategies indicate a delicate balance; while sustainability may involve upfront costs, the long-term benefits include increased market value and consumer interest in ethically produced textiles . This multifaceted approach serves as a valuable lesson for similar cultural practices, like Terengganu Batik and Songket, highlighting the potential for integrating sustainability into traditional fabric production globally [17].

### **Lessons learned from Japan's practices for Terengganu Batik and Songket**

Sustainable practices in Japan's textile production, particularly with Ryukyu Bingata and Kasuri fabrics, offer valuable insights for Terengganu Batik and Songket artisans. By emphasizing the integration of traditional techniques with modern sustainability principles, Japanese practitioners have created a model that harmonizes cultural heritage with ecological responsibility. For instance, the use of natural dyes and organic materials not only preserves aesthetic qualities but also reduces environmental impact, a lesson that Terengganu craftsmen could adopt to enhance their practices. Furthermore, Japan's focus on community involvement in crafting processes fosters social sustainability, encouraging local engagement and shared knowledge. This collective approach could inspire similar initiatives in Terengganu, promoting collaboration among artisans and stakeholders . As the region faces environmental challenges, adopting Japanese strategies may not only bolster the economic viability of Batik and Songket but also ensure the longevity of these cultural artifacts in a global market [18].

### **Role of community engagement in promoting sustainable practices**

Community engagement serves as a vital catalyst in advancing sustainable practices, particularly within cultural heritage projects. By fostering collaboration between local artisans, environmental organizations, and consumers, communities can create a shared understanding of sustainability that resonates deeply. For instance, in the realms of Ryukyu Bingata and Kasuri fabric production, community workshops and collaborative initiatives can elevate awareness of eco-friendly techniques and resources, encouraging artisans to

adopt sustainable practices that honor traditional methods while ensuring ecological viability. This interconnectedness not only strengthens local identity but also promotes economic resilience through the development of markets that favor sustainable products. Furthermore, engaged communities are better equipped to tackle environmental challenges by collectively assessing the impact of their practices on local ecosystems. This holistic approach is essential for preserving cultural heritage while simultaneously addressing the pressing demands of modern sustainability efforts, ultimately contributing to a more sustainable future for all stakeholders involved [19].

### **Economic and Environmental Implications**

Balancing economic growth with environmental sustainability presents significant challenges for practitioners of traditional textile arts, such as Ryukyu Bingata and Kasuri. These crafts, integral to the cultural heritage of Okinawa, face increasing pressure to adapt to modern sustainability practices while retaining their historical significance. Contemporary initiatives in Japan emphasize eco-friendly materials and production methods, fostering a framework that respects both the artisans and the environment. This shift not only enhances the market value of these textiles but also ensures that natural resources are preserved for future generations. Meanwhile, lessons learned from Japan's embrace of sustainable practices can be vital to other traditional fabric producers, such as those engaged in Terengganu Batik and Songket. By integrating these approaches, we can create a more resilient economy while safeguarding cultural heritage, ultimately promoting a symbiotic relationship between economic vitality and environmental stewardship [20].

### **Economic challenges faced by practitioners of Ryukyu Bingata and Kasuri**

The revival and preservation of Ryukyu Bingata and Kasuri fabrics face significant economic hurdles that impact practitioners alike. Many artisans struggle to find a market for their products, as modern consumers often prioritize mass-produced goods over traditional craftsmanship. This trend, coupled with rising costs of raw materials and production, places immense financial pressure on those who create these cultural textiles. Furthermore, the time-consuming techniques involved in crafting Bingata and Kasuri often do not yield prices sufficient to sustain a living, resulting in a decline in skilled artisans. New approaches to sustainability may present opportunities for artisans to differentiate their offerings, yet implementing these strategies often requires upfront investment and training, creating an additional barrier for those already facing economic challenges. Balancing tradition with contemporary demands is crucial for the survival of these art forms, necessitating support systems that foster economic viability and cultural heritage preservation [21].

### **Environmental impacts of traditional textile production methods**

Traditional textile production methods, while rich in cultural heritage, often lead to significant environmental degradation. The processes involved, such as dyeing and finishing, frequently rely on toxic chemicals that contaminate water systems and harm local ecosystems. Moreover, practices like water-intensive weaving and the use of synthetic fibers contribute to excessive water consumption and pollution. For instance, the synthetic dyes commonly employed can release harmful substances into waterways, negatively affecting aquatic life and human communities that depend on these resources. Additionally, the growing demand for textiles can lead to over-extraction of natural materials, further straining ecosystems. Balancing cultural preservation with ecological responsibility requires

innovative approaches that prioritize sustainable practices, such as using organic dyes, recycling fibers, and employing energy-efficient technologies. By addressing these environmental impacts, traditional textile practitioners can move towards a future that honors heritage while protecting the planet [22].

### **Strategies for balancing tradition with modern sustainability needs**

Incorporating traditional practices within the framework of modern sustainability poses unique challenges that require thoughtful strategies. To effectively balance these two domains, communities producing textiles like Ryukyu Bingata and Ryukyu Kasuri can adopt eco-friendly materials and techniques while honoring historical methods. For instance, integrating natural dyes and organic fibers not only preserves cultural heritage but also aligns with contemporary environmental goals. It is crucial for practitioners to collaborate with local stakeholders to foster social sustainability through workshops and educational initiatives that emphasize the importance of traditional techniques. This collaboration can help bridge generational gaps, ensuring that artisanal skills are passed down while adapting to modern market demands. Ultimately, a harmonious coexistence of tradition and sustainability can drive economic growth, encouraging new consumers to appreciate and support these cultural practices, while also addressing the ecological concerns prevalent in today's world [23].

### **3. Theoretical Frameworks**

While sustainability is the project's primary theme, sustainability is a broad term, and the caption alone does not define its scope. Sustainability is a multidisciplinary academic, political, and sociological topic, and the phrase is extremely normative in some contexts. In 1987, the United Nations Brundtland Commission defined sustainability as "filling current demands without jeopardizing future generations' ability to satisfy their own." In other words, 'sustainability' is a phrase that refers to a strategy for meeting development requirements, frequently with a focus on ensuring that our current way of life does not have a detrimental impact on future generations. This is also the dominant term within the context of this project, whose objective is derived from the United Nations Sustainable Development Goals 2030 Agenda. This is the most fundamental definition and should be used appropriately. Comparative studies are conducted holistically, examining the manifestations of approaches to sustainability in contemporary society in general (as embodied by SDG 2030) and in the cultural heritage sector in particular. Exemplary practices contribute to a more seamless integration of theory and practice [24]. It appears to be an effective technique for investigating and conveying a complex subject like sustainability, which is both concrete and abstract. Exhibiting approaches to sustainability in the cultural heritage sector demonstrates how sustainability is made socially and culturally significant via cultural heritage management. In this thesis, exemplarity serves as a demonstration of how approaches to sustainability present themselves in the cultural heritage sector. It is a method of extending the discussion on the importance of sustainability in cultural asset management.

### **Methodology and Material**

This research is divided into two sections: the first examines modern approaches to sustainability in the cultural heritage sector, while the second examines sustainability in the field of cultural heritage conservation [25]. The first phase of this endeavor will begin with the United Nations' 2030 Sustainable Development Goals. Further study will be qualitative in

nature and will focus on practical examples of how the growing emphasis on sustainability is manifesting itself in the cultural heritage sector. The study will use published material from ongoing research initiatives, as well as scholarly publications, international norms and charters, and material collected from Japanese Ryukyu Bingata and Ryukyu Kasuri organizations/institutions. The research material was chosen based on its relevance, trustworthiness, and capacity to demonstrate approaches to sustainability in the cultural heritage sector. It is chosen to represent a cross-section of the cultural heritage industry through the presentation of both national and international initiatives. The sources include a variety of institutions, reputable international organizations, peer-reviewed scientific publications, and reputable worldwide conservation networks. The second section of this project will examine how the increased emphasis on sustainability affects the profession of cultural heritage conservation in Japan's Ryukyu Bingata and Ryukyu Kasuri organizations/institutions, primarily through the lens of scientific publications from conservation associations and personal reflections. The discussion of Ryukyu Bingata and Ryukyu Kasuri fabric development will be guided by observation and case studies of Ryukyu Bingata and Ryukyu Kasuri arts and heritage industries.

#### 4. Ryukyu Bingata, A Textile-Dyeing Practice

Sumiko Sarashima discusses public experiences and the social potential of intangible cultural property in Japan: Ryukyu Bingata, an Okinawan textile dyeing process. The origin is unknown, although it is believed to be from the 15th century. *Ryukyu Bingata*, produced in Naha City, *Tamagusukumura*, and *Tomigusukumura Shimajirigun* (Okinawan: 紅型, meaning "red style") is an Okinawan traditional resist dyeing method. *Ryukyu Bingata* is characterized by a complex pattern of recurring natural themes such as fish, flowers, and animals in a variety of vibrant descriptions. *Ryukyu Bingata* is worn at traditional Ryukyuan festivals and performances of traditional arts. *Ryukyu Bingata* originated during the *Ryūkyū* Kingdom era (14th century), when the island of Okinawa was flooded with imported products and industrial skills. It is thought to have evolved as a combination of Indian, Chinese, and Javanese dyeing techniques. The dyeing method is probably influenced by "*urashi gata*," a stencil dyeing technique transmitted from China, as well as by mainland Japan's dyeing techniques and patterns. Due to the fact that "*Ryukyu Bingata*" was used to create clothes for the ruling class and as a trade commodity during the *Ryūkyū* Dynasty, three families have kept the *Ryukyu Bingata* method to the present day. During the *Ryūkyū* Dynasty, the color of the fabric used for the background and the patterns varied according to status. The aristocracy wore silk crepe or figured satin ("*Rinzu*") with beautiful and multi-coloured big patterns on a white or light yellowish background. There are two distinct varieties of *Ryukyu Bingata*. The first employs simply indigo blue, whereas the second incorporates a range of descriptions. Additionally, there are two distinct dyeing techniques in *Ryukyu Bingata*. One makes use of patterns, while the other makes use of hand-drawn patterns. It incorporates women's clothing, "*Haori*" (half coats), sashes, "*Noren*" (shop curtains), wall hangings, table cloths, wrapping cloths, and pouches, among other materials. The common folks wore cotton material with basic patterns that were colored in five or two colors (indigo and black). "*Ryukyu Bingata*" was introduced to mainland Japan between 1688 and 1704 and quickly became popular. After the *Ryukyu* Dynasty was dissolved in 1879 and then completely dismantled during WWII, output fell dramatically before being recovered during the war [26].

## Dyeing Method

"*Ryukyu Ai*" (indigo), "*Fukugi*" (a tall tree in the *Hypericum erectum* family), "*Suo*" (*Caesalpinia sappan*), and "*Yamamomo*" (*Myrica rubra*) were used as dyes, and "*Shoenji*" (cochneal), "*Shu*" (cinnabar), "*Sekio*" (orpiment), "*Sumi*" (aleurone). To bind the color to the textile, "*Gojiru*" liquid made from powdered soy beans is combined with pigment and alum is combined with plant dyes. Over the pigment, plant dyes are painted.

## Types of techniques

1. "*Shiruji* (white background) *gata*" Only the patterns are dyed, leaving the background white.
2. "*Sumiji* (dyed background) *gata*" The patterns and the backdrop are both dyed concurrently. The resistive is applied to the white portions of the patterns.
3. "*Keshi gata*" This is the next phase after "*Shiruji gata*" (1), which involves dyeing patterns. After the resistance is put to the patterns, the background is colored.
4. "*Uburu* (darkness) *gata*" A method that utilizes procedures (1) and (2) to add patterns to an already colored background (2).
5. "*Dan Zome Ji gata*" The dyed background color is primarily split into two halves by a horizontal line.
6. "*Shinobu gata*" After the dyeing process is complete, gradation and hand-dyeing are performed.
7. "*Tetsuke Ryukyu Bingata*" The white sections are dyed after being washed in water.

## Varieties of "E gata"

1. "*Shiroji E gata*": Designs are all in one tone of indigo on white background.
2. "*Asaji Hanatori*": Designs with different shades of indigo.
3. "*Kurohana* (black flower) *dashi*": White designs on indigo background.
4. "*Shirohana* (white flower) *dashi*": White designs on indigo background.
5. "*E Uburu*": Double dyeing in indigo with techniques (1) and (2).
6. "*Sumiji E gata*": Gradation is given to designs with Indian ink.
7. "*Bin Iri E gata*": Such colors as red, yellow or blue, are added to the indigo part.

## Ryukyu Kasuri Weaving Fabric

*Ryukyu Kasuri* is a form of hand weaving that emphasizes and values originality and individual expression. There are no restrictions, no fear - only total immersion in weaving and working with yarn and threads. This 'non-technique' is contemplative in nature and seeks to help you express your human being more clearly via the procedure and the finished handwoven textile. This free-style weaving technique developed in Japan and is all about expressing oneself via expressive, no-rules weaving. *Ryukyu Kasuri*, which translates as a technique for unearthing the latent power of creation, was established by Misao Jo, who realized through a missing warp thread that a non-machine-like fabric had distinct human worth. *Ryukyu Kasuri* is inspired by Japan's *Wabi-Sabi* aesthetic, or acceptance of imperfection. Whatever is weaved is flawless in its current state: broken and mended warp threads, lumpy selvages, etc. These imperfections demonstrate the distinction between human-made woven cloth and a "perfectly" woven cloth. On all levels, imperfections are to be welcomed. Most importantly, *Ryukyu Kasuri* promotes the integration of everybody interested in weaving. As a beginner weaver, experimenting with free-style weaving on a 15-



inch Cricket rigid heddle loom has allowed me to learn by doing, without worry of producing "bad" results.

Who weaves Ryukyu Kasuri? Ryukyu Kasuri is widely performed across the world by individuals with disabilities, art therapists, hospitals, for meditation sessions, in schools, for corporate team building, by textile and fashion designers, handweavers, artists, and craftsmen, and by anybody interested in experiencing it. Ryukyu Kasuri weaving is a liberating approach to handweaving. It is founded on the belief that all humans are creative and that we are all encouraged to weave according to our own rhythm, which is determined by our style, personalities, and life experiences. Rather than approaching weaving with preconceived notions of structure and set up, we begin with the creation stage and work with simple weave structure to include texture, color, and irregularity into the fabric. While Ryukyu Kasuri weaving, its method, and basic processes may be used to any weaving on any loom, the Ryukyu Kasuri floor looms are specifically built to maximize the capacity to weave lengths of cloth in the Ryukyu Kasuri manner. Additionally, the Ryukyu Kasuri loom is critical for a variety of innovative methods that are not readily available on other looms.

The rich tradition of fabric weaving in the Ryukyu Islands has evolved significantly, showcasing a blend of artistry and cultural significance. This essay explores the unique characteristics of Ryukyu Kasuri weaving fabric, highlighting its historical importance and contemporary relevance. By examining the sustainable practices surrounding the production of this fabric, we can uncover valuable lessons that extend beyond Japan to regions like Terengganu, which is renowned for its Batik and Songket fabrics. The approach to cultural heritage management in Japan emphasizes the need for sustainability, encouraging artisans to adapt traditional techniques to modern ecological challenges. This not only preserves the artistry of Ryukyu Kasuri but also serves as a model for other regions to follow. Ultimately, by understanding these dynamics, we can foster a broader appreciation for cultural heritage weaving practices worldwide and promote sustainability that celebrates both tradition and innovation.

Originating from the Okinawa Islands, Ryukyu Kasuri weaving is a unique textile art that exemplifies the intricate relationship between culture and craftsmanship. This traditional technique involves a labor-intensive process of resist-dyeing, where patterns are created through meticulous knotting of threads before dyeing, resulting in stunning designs that depict natural elements and local symbolism. Cultural significance is deeply embedded in Kasuri, as its patterns often communicate historical narratives and the identity of the Okinawan people, linking the fabric to their shared heritage and communal life. Furthermore, the resurgence of interest in sustainable production methods is promoting renewed appreciation for this craft, encouraging artisans to pass down their skills and tradition. As Okinawa continues to blend modernity with tradition, Ryukyu Kasuri serves not only as a functional fabric but also as a vital thread in the tapestry of Okinawan culture, fostering a sense of belonging and pride among its people.

The story of Ryukyu Kasuri weaving is deeply intertwined with the historical context of the Ryukyu Kingdom, a unique cultural sphere that flourished from the 15th to the 19th centuries. This period was marked by significant trade with neighboring countries, leading to the exchange of ideas, techniques, and materials essential for the development of distinctive textiles. Ryukyu Kasuri, characterized by its ikat dyeing technique, evolved during this time, integrating influences from both indigenous practices and foreign elements, especially from China and Southeast Asia. The exchange of goods and cultural practices was crucial in establishing a vibrant textile industry that not only provided for local needs but also positioned Ryukyu as a significant cultural hub. Furthermore, as historical shifts transformed Ryukyu into a part of Japan in the late 19th century, the preservation and

adaptation of Kasuri fabric became emblematic of the region's resilience and its commitment to cultural heritage, making it a vital area of study for contemporary sustainability efforts in textile practices.

The intricate art of Ryukyu Kasuri weaving reflects a rich history that has evolved significantly over the centuries. Originating in the Ryukyu Islands, this unique textile tradition blends influences from both Japanese and Southeast Asian cultures, underscoring its complex heritage. Historical studies reveal that early weavers utilized natural dyes and simple patterns, gradually advancing their techniques through interaction with various cultures, including trade with China and the introduction of new materials and methods from Southeast Asia. These exchanges not only enhanced the aesthetic qualities of Ryukyu Kasuri but also led to innovative processes, such as the application of ikat techniques, which involve pre-dyeing threads before weaving. Today, contemporary Japan is pivoting towards sustainability in textile production, showcasing a commitment to preserving these traditional methods while incorporating eco-friendly practices, offering valuable lessons for the development of similar crafts like Terengganu Batik and Songket fabrics [27].

In approaching the intricate balance between tradition and modern sustainability, Japan's integration of contemporary practices within the Ryukyu Bingata and Ryukyu Kasuri fabric production provides valuable insights. For instance, the revival of traditional weaving techniques is not just about preserving art but also about fostering economic stability within local communities. Innovations emphasize recyclable and sustainable materials while promoting slow fashion principles, aligning with an increasing global emphasis on environmentally responsible practices – similar to the approach discussed in the integration of Gazenne fabric into modern attire with an eye toward sustainability. Furthermore, as seen with the Bhujodi fabric production, immersive experiences with artisans can enhance the understanding of these crafts, ultimately leading to longer-lasting cultural appreciation and economic health. By engaging with artisans and promoting these practices, contemporary Japan offers a model for sustainable cultural heritage that other regions, including Terengganu Batik and Songket, can aspire to emulate.

Recent advancements in sustainability practices have significantly influenced the production of Ryukyu Kasuri, showcasing a delicate balance between tradition and modernity. Craft practitioners are incorporating eco-friendly materials and processes, such as using natural dyes derived from local plants, which not only reduce environmental impact but also strengthen cultural identity within the community. This movement toward sustainable practices reflects a broader acknowledgment of the importance of cultural heritage conservation, serving as a model for similar traditional crafts, such as Terengganu Batik and Songket fabrics. Additionally, the integration of modern technology, like digital design tools, enhances the accessibility and appeal of Ryukyu Kasuri while maintaining its artistic integrity. Consequently, by prioritizing sustainability, the production of Ryukyu Kasuri not only preserves traditional techniques but also promotes economic resilience and environmental health, suggesting a promising pathway for cultural heritage conservation globally.

The significance of Ryukyu Kasuri weaving fabric extends beyond its aesthetic value, encapsulating lessons in sustainability that can be pivotal for other textile traditions such as Terengganu Batik and Songket. Japan's contemporary approaches to sustainability emphasize a respectful integration of cultural heritage with modern practices, as seen in the continued production of Ryukyu Bingata and Kasuri fabrics. Historic methods, which often involved recycling materials and embracing simplicity due to socioeconomic conditions, are increasingly relevant today as artisans look to create textiles that honor tradition while addressing environmental challenges. The balance between preserving techniques and

adapting to new sustainable practices not only benefits craftspeople but also enriches cultural identity and fosters community engagement. As the global dialogue on sustainable development continues to evolve, the Ryukyu tradition underscores the vital connection between cultural heritage and sustainable practices that can inspire similar movements in other regions.

### **Ryukyu Kasuri weaving fabric in cultural heritage and its future in sustainable practices**

The distinct artistry of Ryukyu Kasuri weaving fabric not only reflects the rich cultural heritage of Okinawa but also embodies a significant aspect of sustainable practices within traditional craftsmanship. This traditional textile art utilizes natural dyes and local materials, showcasing a commitment to eco-friendly methods that have been passed down through generations. Contemporary approaches in Japan emphasize the integration of sustainability into preservation efforts, offering invaluable lessons for other regions, such as Terengganu's Batik and Songket fabrics. By prioritizing techniques that minimize environmental impact, practitioners can engage in social sustainability, fostering a community that values both tradition and ecological responsibility. Furthermore, the economic implications of these sustainable practices highlight the necessity for practitioners to balance innovation with preserving cultural authenticity. As society increasingly values sustainable traditions, Ryukyu Kasuri weaving stands as a testament to how cultural heritage can thrive alongside environmental stewardship, paving the way for future artisans worldwide [28].

### **5. Terengganu Batik Fabric**

Malaysian batik is a form of batik cloth art that originated in Malaysia, particularly on the east coast states in Malaysia (Kelantan, Terengganu and Pahang). Flowers and leaves are the most often used themes. Malaysian batik with human or animal motifs is uncommon, as Islam prohibits the use of animal imagery as ornamentation. The butterfly motif, on the other hand, is a frequent exception. Malaysian batik is especially well-known for its geometric patterns, particularly spirals. Malaysian batik is also extremely distinct from Indonesian Javanese batik in that the design is bigger and simpler; it seldom, if ever, employs canting to produce complicated patterns and mainly relies on brush painting to apply colors to fabrics. Additionally, the colors are brighter and more vivid than those seen in deep-colored Javanese batik.

The origins of Malaysian batik manufacturing Since the 13th century, trade links between the Melayu Kingdom in Jambi and Javanese coastal cities have flourished; northern coastal batik producing areas of Java (Cirebon, Lasem, Tuban, and Madura) have impacted Jambi batik. Jambi (Sumatran) batik, as well as Javanese batik, have impacted the Malay peninsula's batik craft.

According to the Oslo Museum of Cultural History, it is evident that the Javanese impacted Malay batik-making both technically and in terms of design development. Malaysians originally utilized wooden blocks to create batik-style fabrics. Javanese batik artisans popularized the use of wax and copper blocks on Malaysia's east coast as late as the 1920s. Hand drawn batik production began in Malaysia relatively recently and is connected to Javanese batik tulis [29].

The 1960s saw the commencement of commercial manufacturing. This craft has evolved a distinct look and design that is unique to Malaysia. Malaysian batik has a distinct

identity distinct from the Javanese heritage of hand-painted batiks. Malaysian batik is found on the east coast of Malaysia in states such as Kelantan, Terengganu, and Pahang, but batik in Johor obviously reflects Javanese and Sumatran influences, as southern Malaysia is home to a high number of Javanese and Sumatran immigrants.

The term "Batik" translates as "wax drawing." Not just in Malaysia, but also in worldwide fashion scenes, the vibrant and patterned fabric has acquired appeal. Typically, this fabric features themes inspired by nature's flora and fauna, geometry, and scenery. Terengganu Batik is famous for its vivid hues, dramatic patterns, and adaptability. Its fabric is soft, light, and airy, making it ideal for summer and tropical climates, and it is used to make shirts, dresses, crepe de chine, scarves, kaftans, sarongs, pillow covers, purses, and tablecloths, among other products. Batik is classified into two types: hand drawn and block print. The artist's hand drawn work is inspired by his or her ideas and ingenuity. To begin, the artist uses a tiny pen-shaped container filled with hot-melted wax. It is then hand-drawn with hot liquid wax onto a white cloth to create a pattern. Brushes are then used to paint dyes inside the outlines, resulting in shaded and multicolored patterns. Their grace and dexterity with their freehand never cease to astound. It is the pinnacle of traditional batik beauty, with each hand-drawn piece of apparel being unique. The block print batik technique uses either a copper or a hardwood block that resembles a home iron and is intricately decorated aesthetically. The block is dipped in melted wax and then pressed onto white fabric, which is subsequently dyed in the desired colors, washed, and dried. Numerous current designers use parts of this old skill into their vibrant works of art as well. Today, batik is not only utilized to create clothes; it is also employed in creative commercial applications such as bags, pillow covers, curtains, and slippers.

In keeping with the Malaysia concept, the Malaysian government has officially endorsed Malaysian batik as a national clothing for all segments of the general public, by commissioning new batik patterns that represent the Malaysia concept. Malaysia has a lengthy history with batik. Batik manufacturing began as a small-scale activity and has grown into a wealthy cottage industry and national enterprise. Batik is a term that refers to beautiful fabrics that have a variety of colors and patterns. The name 'batik' originates in the Javanese word 'tick,' which means to drip or write points. The term 'Ambatik' refers to the act of drawing, writing, painting, or dripping. Batik designs can be created with a carved block, a screen, or a single hand stroke. While Malaysia is not the only country in the area that produces batik, the style and final result of Malaysian batik are distinct from those of other countries in the region. To begin, Malaysian batik artists employ hand sketching techniques to produce paintings on white fabric with the use of chanting. The artist draws designs on the cloth with hot wax and then colors it to match the pattern. Second, the design, which refers to the batik's painted or inlaid ornamental patterns, is distinctive from those of other international batik manufacturers. Malaysian batik design is dominated by two motifs: the organic and the geometric. Malaysian batik is largely inspired by religious beliefs that forbid the use of animals in design work and instead favor floral and geometric patterns. Malaysian batik has acquired prominence for its particular character and look as a consequence of the subtleties in both manufacturing and design. Malaysian batik is well-known both domestically and internationally. Batik is the most popular handcraft product in Malaysia, both among locals and visitors. Batik is third in popularity among corporate purchasers, after pewter and wood craft goods. The Malaysian Handicraft Development Company (Malaysian Handicraft), a statutory corporation created in 1979 to promote the marketing and export of handicraft items, leads continuous government initiatives to boost batik manufacturing (Acts 222, S.7). The initiative has resulted in international retailers such as Harrods of London showcasing and selling Malaysian batik, which is viewed as both visually pleasing and luxury when worn by international consumers. However, the rising

popularity of Malaysian batik in recent years has had repercussions for Malaysia's local batik sector. There are about 320 batik businesses registered with Malaysian Handicraft in Malaysia, with the largest concentrations of batik manufacturers in the states of Kelantan and Terengganu, where batik was introduced in 1910. Due of the distinctive characteristics of Malaysian batik, its effective marketing has resulted in international manufacturing of batik that imitates Malaysian batik. Foreign batik manufacturers' infringements on the designs and manufacturing methods of Malaysian batik have an influence on the earnings of local batik producers and the national economy (Malaysian Handicraft, 2009). Foreign manufacturers, such as batik companies in China, began producing batik prints with a design like that of Kelantan's batik. Batik fabric from China, which is often composed of polyester, allegedly results in annual losses of around RM3 million to 200 batik businesses (Malaysian Handicraft). Malaysia's batik business is dwindling as imported batik is sold at a lower price than Malaysian batik. The primary reason for the pricing difference is because overseas batik makers create the design on the cloth using printing presses. This enables the manufacture of huge numbers of imitation Malaysian batik in a fraction of the time required for hand-painted batik. As a result, Malaysia's batik sector is currently confronted with two unique difficulties. To begin, domestic batik manufacturers must compete with international batik producers to secure the domestic industry's survival. Second, and most importantly, Malaysian batik producers confront a new struggle in defending their traditional patterns and manufacturing processes. The current study examines how Malaysian intellectual property law may be utilized to assist local businesses in protecting both their traditional Malaysian batik sector and their investments.

### **Terengganu Songket Fabric**

Songket is a brocade made of woven silk or cotton with silver or gold threads. Songket weaving is another ancient technique for creating complex cloth that is still utilized for weddings and ceremonial occasions. As with batik, there are still numerous songket weavers making high-quality songket for usage on special ceremonial occasions by royalty, nobles, ministers, and state officials. Songket weavers continue to broaden the horizons of songket possibilities. Exclusive Malaysian Resorts use songket to create a crystal-clear Malaysian identity by fusing the modern and traditional. State Houses and government buildings use songket paneling into their foyers and amphitheatres to highlight Malaysia's history. The genuine Malay Songket is beautiful nowadays. It has culminated in a love tale that is infused with art, emotion, tradition, and identity [30].

Malay songket textures are an enduring emblem of rank, elegance, and distinction, with complex patterns and regal motifs. For generations, rulers and aristocrats used songket cloth.

The songket was entirely handmade and painstakingly produced by the finest artisans. Now, songket fabric is used by members of all strata of society, including weddings, traditional dancers, and people who require formal dress for events like as university commencements. It is, nevertheless, closely connected with conventional ideas of palace, valor, and majesty, and its use implies the rank and position of a person or an event of social and cultural significance. This is demonstrated via its inclusion in a number of Malay rituals and public events. Simultaneously with its cultural modernization, songket cloth has evolved tremendously, becoming even more gorgeous and mystical when treated and tailored to the wearer's specifications.

Terengganu songket is perhaps the finest for those seeking something beautiful, traditional, and distinctive, and it is precisely because of these distinguishing characteristics that it is the rarest songket.

Songket Terengganu is said to be made of the finest materials and crafted by the most skilled artisans, based on its own distinct identity and symbolism. It has a long history of cultivation. The materials used in the manufacture of songket are chosen for their aesthetic, olfactory, and tactile qualities. These characteristics, coupled with Terengganu's traditional weaving techniques and production procedures, clearly identify Terengganu songket from fake songket produced in other states.

In Terengganu, traditional weaving techniques are still used, with songket created on looms operated by hand and foot. Each sheet of yarn is inspected during the weaving process, ensuring that the Terengganu songket maintains its excellent quality with a traditional and distinctive design that must be viewed up close to appreciate its splendour and richness. It is woven with silk or cotton yarns, and the songket design is created with gold or colored metallic threads via the use of extra weaving techniques by highly trained weavers. The intricacy of the process of adjusting flowers may be used to determine the quality of woven cloth. The type of yarn used in this technique, whether silk, cotton, or polyester, also has an effect on the softness and quality of songket Terengganu fabric.

Choosing songket Terengganu indicates that the consumer values beauty, perfection, neatness, and accuracy in their fabric selection. Precision and care are required for the manufacture of the finest and highest quality songket weaving.

Terengganu songket weavers exemplify modesty, taking delight in the understanding that good work comes from a true heart, as well as the pleasure the songket provides people who have the chance to wear it.

The songket weaver requires exceptional ability and inventiveness. A pair of lengthy songket textiles measures between 2 and 4 metres in length and takes between six and twelve weeks to produce, although the woven design is entirely unique and created by the weaver's creativity. The songket cloth is made from silk or cotton yarns and gold or silver threads. Generally, the weaver creates the woven cloth headscarf according to his or her personal tastes. The most often utilized designs are referred to as 'mangosteen characteristics', 'bambo shoots', 'lawi ayam', and 'fruit'. While songket designs are composed of complete flower arrangements, tabor flowers, and patterned masks.

While songket manufacturing has grown more modernized, songket weavers, particularly in the state of Terengganu, continue to practice their traditional techniques. Notably, the weavers in Terengganu also employ the finest Japanese threads.

Songket is made in modest quantities in the majority of Terengganu households, ensuring that it is an integral component of the region's social and cultural character.

Additionally, the songket weaving sector is dominated by women who live at home with their families. Indeed, virtually every family in Terengganu formerly possessed equipment for weaving songket, indicating that every woman in Terengganu was definitely proficient in songket weaving. Not only that, these ladies were trained in songket weaving from an early age, as young as seven years old, to guarantee that the skills and knowledge associated with this priceless craft were ingrained in their hearts. The Terengganu State weavers also gained the greatest ideas and talents for creating their natural patterns by just gazing at the natural beauty that surrounds them in such a lovely location with a diverse ecosystem. This unique combination of knowledge, experience, and abilities endows Terengganu's weavers with the ability to create the best specimens of songket.

Terengganu songket's extraordinary aesthetic worth and distinctiveness are cherished not only in Terengganu Malay society, but also across Malaysia, South East Asia, and internationally by people interested in the finest garment manufacturing and textile traditions.

## **6. Conclusion**

Increased emphasis on sustainability is both a source of stress and an opportunity in the field of cultural asset management. Although it is hard to anticipate precisely what impact new methods to sustainable development will have on the management of Japan's Ryukyu Bingata and Ryukyu Kasuri textiles' cultural heritage, changes are inescapable. These developments will have an effect on our approach to material cultural heritage, particularly its protection.

The ongoing emphasis on sustainability has an impact on the preconditions for cultural heritage management and the way we operate as cultural heritage professionals; it impacts available resources, work processes, and ethical approaches to the use and treatment of cultural artifacts.

Certain artifacts are regarded as one-of-a-kind, irreplaceable, and intrinsically important cultural heritage, and it is our job to manage and maintain them optimally. Professional guidelines provide ethical ideas of conservation that are occasionally conflicting with sustainable practice standards. While it is impossible to create uniform rules of ethics that apply everywhere, the consensus among professional groups is that conservators must encourage preventative conservation and ethical collection usage.

Despite the difficulties and concerns associated with development demands, boosting motivation appears to be the field's present trend. Rather of viewing the future as an abstract and distant thing, the cultural heritage sector advocates for an approach that emphasizes how the future is always being affected by our current activities. The overall trend is for professionals in the cultural heritage sector to be committed to the industry's and society's long-term growth. The cultural heritage industry and conservation networks are increasingly engaged in sustainability efforts. It paints an image of cultural heritage institutions that are conscientious and actively promote sustainable development among their workers and communities.

Professionals working in the cultural heritage sector contribute to the possibility of sustainable growth. Each conservator contributes to sustainable development through participating in sustainability networks and incorporating sustainability practices into daily practice. The view is that cultural heritage management may contribute to the creation of a more sustainable world, and that cultural heritage institutions can play a critical role in facilitating the development of sustainable societies.

Cultural heritage is a tiny sector that is frequently adversely affected by global phenomena – whether a viral epidemic, a financial crisis, or climate change – and working methods within the field must adapt appropriately, in close collaboration with other sectors of society and across borders.

The general participation of the cultural heritage conservation profession results in the formation of new groups and organizations dedicated to the long-term protection and correct use of tangible cultural property. Collaboration and communication among conservation experts help to make the notion of sustainability less abstract and sustainable development more attainable.

In examining the intricate relationships among Ryukyu Bingata, Kasuri, Terengganu Batik, and Songket, a greater appreciation for sustainable practices emerges as essential for cultural preservation. These textiles not only exemplify artistic expression but also embody the cultural legacies of their regions. Contemporary Japan's sustainability approaches within the production of Ryukyu Bingata and Kasuri provide invaluable lessons that can be adapted by other cultures, particularly in maintaining traditional crafts while responding to environmental challenges. By fostering community engagement and integrating sustainable techniques, practitioners can enhance both ecological stewardship and economic resilience. As cultural heritage increasingly overlaps with sustainable development goals, it is critical to assess the existing challenges and develop strategies that promote the longevity of these art forms. This holistic perspective ensures that the rich heritage of textiles like Terengganu Batik and Songket continues to thrive and adapt in an ever-changing world [31].

The intricate relationship between cultural heritage and sustainability emerges as a critical area for exploration, particularly in the context of traditional textile arts like Ryukyu Bingata, Kasuri, Terengganu Batik, and Songket. These practices not only preserve age-old craftsmanship but also embody sustainable production methods that align with the ethos of environmental stewardship. As artisans confront the challenges posed by globalization and mass production, their commitment to sustainability reflects a deeper understanding of the need to safeguard cultural identity while minimizing ecological footprints. By prioritizing community engagement and educational initiatives, these traditional crafts can adapt to modern sustainable practices, fostering resilience against economic pressures. Ultimately, the synergy between cultural heritage and sustainability signifies a promising pathway for revitalizing local economies, inspiring innovative approaches that honor heritage while addressing pressing environmental concerns. This interconnectedness underscores the value of traditional crafts as vital contributors to global sustainability narratives.

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# An AI Chatbot Communication for Micro-Learning in Higher Education

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## **ABSTRACT**

Large language Models (LLMs) show promise in artificial intelligence, especially in education. This study examines micro-learning with AI-enhanced 'Student's Assistant' and 'Study Companion' chatbot communication in higher education in Malaysia. The research emphasizes the growing reliance of educational institutions on AI-driven solutions to provide adaptive learning experiences and personalized guidance. A systematic and multifaceted approach examines the relationship between prompt construction, engineering methods, and LLM outputs. Two methods determine how prompt structuring techniques, such as persona and template applications, affect LLM outputs. Second, the effects of advanced prompt engineering methods like the few-shot and chain-of-thought prompt on LLM responses are examined. The 'Study Companion' approach also uses applied sciences curricula for experimentation. The findings have significant implications for AI in education. This study lays the groundwork for better AI-driven educational tools by revealing the variables that affect LLM performance. The research addresses the challenges of modern education, particularly the need for accurate, relevant, and diverse educational content, and provides academic and practical insights. As education evolves, the study emphasizes the need for ongoing exploration and refinement to leverage AI in education fully.

**Keywords:** AI-enhanced chatbots, Large language models (LLMs), Micro-learning, Adaptive learning experiences, Educational content optimization.

## **1. Introduction**

Artificial Intelligence (AI) has significantly advanced in several fields, including education. Large Language Models (LLMs) have emerged as key instruments in artificial intelligence and have shown considerable potential in educational settings [1], [2]. This research uses AI-driven chatbots, namely the 'Student's Assistant' and 'Study Companion' chatbots, to enhance micro-learning. The essay explores the growing reliance on AI-driven solutions in educational institutions to provide adaptive learning experiences and individualized support. This project examines the relationship between rapid formulation, engineering techniques, and LLM outputs to determine the elements affecting LLM performance and improving AI-based instructional aids. The research underscores the need

for ongoing exploration and enhancement to fully harness the capabilities of AI in education [3].

AI chatbot communications have emerged as valuable educational resources due to their ability to provide personalized assistance and adaptable learning experiences. Using extensive language models (LLMs), these chatbots are mainly designed to aid students in their academic pursuits by delivering accurate and relevant instructional content. Educational institutions increasingly use AI-driven solutions, recognizing the benefits of technology in enhancing student engagement and performance. Understanding the historical background and evolution of AI Chatbot Communications in education allows for identifying their capabilities and addressing challenges faced in improving educational content for practical micro-learning applications.

This project seeks to accomplish two primary objectives: developing an AI Chatbot Communication for a micro-learning application named 'Student's Assistant' and 'Project Companion.' The main aim is to investigate the impact of quick creation methods, including persona and template use, on the outputs produced by large language models (LLMs) [4]. This study seeks to elucidate the influence of different prompt formats on the replies generated by LLMs to improve the effectiveness of AI-driven instructional systems. Furthermore, it aims to examine the impact of advanced prompt engineering methods, including few-shot prompting and chain-of-thought prompting, on the replies produced by Language Models (LLMs). This study seeks to enhance chatbots' adaptability and individualized support [5].

## 2. Significance of AI in Education

The significance of AI in education is substantial. The ongoing progression of technology indicates that AI-driven solutions may radically alter educational practices. The research examines AI-enhanced chatbots, like 'Student's Assistant' and 'Research Companion,' which provide individualized coaching and adaptive learning experiences. The use of large language models (LLMs) in these chatbots facilitates the delivery of accurate and diverse instructional content, successfully addressing the challenges faced in modern education. Through artificial intelligence, instructors and institutions may augment instructional material and provide tailored student support, fostering a more effective and engaging learning environment [6].

Despite integrating computer technology into educational institutions, several challenges must be addressed before a transformation in education can occur. Here are many of these concerns:

1. Homogeneity in education: Numerous educational institutions use a uniform approach that disregards each student's individual strengths and limitations. This may hinder children's ability to achieve their full potential and get the specialized assistance necessary for success.

2. Protracted feedback: Educators often provide comments at an exceedingly slow rate, perhaps resulting in pupils requiring more study time and receiving notifications later than anticipated. This may result in missed development opportunities and insufficient timely support for those struggling with specific topics.

3. Overburdened Educators: Teachers must allocate more time to manage extensive class sizes and substantial caseloads. This may hinder their ability to provide individualized assistance and attention to each child.

### 3. Literature Review

This research investigates the advancement of artificial intelligence (AI) in education and using chatbots in learning environments. This report examines previous research on AI-enhanced educational technologies to understand the current situation comprehensively. The literature review highlights the capabilities of large language models (LLMs) in academic environments, particularly in developing adaptive learning experiences and individualized support [7], [8], [9]. This study provides a foundation for investigating the impact of rapid formulation and engineering techniques on LLM outcomes via the analysis of current literature. Consequently, it offers significant insights into artificial intelligence in education.

Artificial intelligence has enhanced education by introducing innovative methods for teaching and learning. This section examines contemporary research that illustrates these advancements. Research indicates that AI chatbot communications exhibit potential as an astute academic assistant. Pereira's 2016 study, 'Leveraging Chatbots to Improve Self-guided Learning via Conversational Quizzes,' investigated the possibility of chatbots to enhance self-directed learning. The study developed Dawebot, a Telegram chatbot that facilitated interactive quizzes and gave students prompt feedback. The chatbot monitored the quiz attempts and progress of 20 participants. The majority of students like the chatbot experience and considered the use of bots for test preparation to be beneficial. The chatbot offered immediate responses, user-friendliness, and progress tracking. The findings suggest that chatbots might enhance self-directed learning by tailoring educational experiences and actively involving students.

In his essay 'TA-bot: An AI Agent as a Teaching Assistant,' Ho (2018) developed and implemented a virtual teaching assistant using artificial intelligence. TA-bot was created with conversational technology and proprietary software. The research promotes using AI teaching assistants to rectify current inadequacies in personnel and resources within the educational sector. The research demonstrates that TA-bot effectively serves as a specialist assistant in a Digital Marketing course at George Mason University, addressing student questions on the curriculum. The study suggested that publicly accessible technologies might facilitate the development of virtual teaching assistants, including TA bots. The findings demonstrate that contemporary natural language processing technologies provide fast training and deployment of these assistants, improving student learning.

Benedetto and Cremonesi presented Remy, a novel architecture for virtual teaching assistants (VTAs). Remy is a novel design for a virtual teaching assistant, as shown by the research. IBM Watson Assistant enables natural language processing and comprehension. Remy is used in an on-site training program at Politecnico di Milano and evaluated using a qualitative user survey. Students offered favorable assessments of the VTA, emphasizing its capacity to address concerns and reduce the professor's burden promptly. The research underscores the need to increase the training set to improve intent detection and refine the confidence level for replies. The study shows that Remy is an efficient technique for VTA installation. It suggests improving its performance and capabilities, especially for one-to-many interactions.

Dokukina and Gumanova's article, 'The Rise of Chatbots – New Personal Assistants in Foreign Language Learning,' analyzed chatbots as interactive tools for language instruction. The authors examine chatbot technology from its inception in the 1960s to contemporary iterations such as Microsoft's Xiaoice and other advanced chatbots. Research indicates that chatbots provide regulated interactions, guidance, and practice for specific language competencies. Practical chatbot-based language instruction encompasses Vasya and Duolingo. Research suggests that in the contemporary fast-paced environment, chatbots

provide language learners with convenient, accessible, and engaging educational experiences. Chatbots may assist language learners in fulfilling their needs and preferences, but they cannot substitute for teachers.

Dimitriadis conducted a study titled 'Evolution in Education: Chatbots' to investigate the potential use of chatbots in educational settings. The paper illustrates the global phenomenon of chatbots, AI systems replicating human communication. It examines the advantages and disadvantages of chatbots across several domains and their capacity for personalized and adaptive learning in education.

The study also regards chatbots as virtual teaching assistants that alleviate teachers from tedious tasks, allowing them to focus on delivering high-quality training. The psychological factors influencing the tendency to anthropomorphize chatbots are analyzed. The study concluded that chatbots provide several benefits; nevertheless, further research is necessary to fully harness their potential for enhancing learning.

Chen investigated chatbots in higher education in a work titled 'Artificial Intelligence (AI) Student Assistants in the Classroom: Designing Chatbots to Support Student Success.' Chatbots were evaluated for their ability to impart basic AI concepts, engage pupils, and alleviate the workload of educators. The study revealed that students appreciated the engagement and responsiveness of chatbots in the classroom. The results indicated that chatbots cannot effectively replicate human conversation or emotions. The study advocated for enhancing chatbots' intelligence and emotional awareness while addressing their ethical implications in education. This study enhances the literature on AI Chatbot Communication in education by presenting these findings.

Haderer and Ciolacu examined 'Education 4.0: Artificial Intelligence Assisted Task- and Time Planning System' and the use of AI in education. Our research aims to improve students' self-regulated learning. The article introduces an AI-based work and time management system aimed at helping students optimize their daily activities and enhance productivity. Education 4.0 necessitates the integration of digital technologies and artificial intelligence, including adaptivity, mobile connection, customization, AI assistance, gamification, learning analytics, e-assessments, and the Internet of Things. The suggested methodology offers tailored suggestions and adaptive learning using AI systems that monitor student activities and timetables. The system comprises an information repository, artificial intelligence engines, an open application programming interface, a user interface, and an AI dashboard. The research underscores data integrity, protection, security, user-friendliness, and usability. The results suggest that AI and digital technology may enhance teaching and learning in Education 4.0, improving efficiency and effectiveness.

Boateng ultimately analyzed 'Kwame for Science: An AI Teaching Assistant for Science Education in West Africa' to tackle African pupils' educational obstacles, such as restricted access to educators and issues in receiving answers to questions. The researchers used Kwame, an AI coding teaching tool, for scientific education. Kwame for Science used sentence-BERT for question-answering. He was created to address challenges associated with the West African Senior Secondary Certificate Examination Integrated Science. The solution demonstrated robust performance in a real-world web application deployment, with 87.5% top-3 accuracy across 190 users from 11 countries. The research showed that Kwame for Science could provide scalable, cost-effective, and high-quality remote instruction to millions of African students, with plans to improve accuracy and extend into local languages and offline formats. This research suggests that chatbots and AI-driven systems may improve learning, provide individualized support, and tackle educational difficulties.

### 3.1 Evolution of AI in Education

In recent years, significant improvements have been seen in the growth of AI in education. The use of AI-driven technology into educational settings is becoming common to enhance and personalize learning experiences. The advent of extended language models (LLMs), such as chatbots, enables students to access AI-driven resources that provide customized learning experiences and personalized assistance. These AI chatbot communications, student helpers, and study companions can understand prompt structures and provide relevant and accurate replies. This progression may revolutionize education by delivering precise, diverse, and tailored instructional information to learners, improving overall learning results [10].

### 3.2 Role of chatbots in learning environments

Chatbots are vital in educational environments since they provide personalized and flexible support to learners. As artificial intelligence advances, chatbots have grown more intelligent, offering students a responsive and engaging learning experience. The AI-driven chatbots, 'Student's Assistant' and 'Study Companion', serve as virtual instructors, offering immediate support to students in mastering complex topics. Employing natural language processing and machine learning algorithms, chatbots can understand students' questions and provide accurate and relevant responses, enhancing their understanding and memory of educational content. Chatbots are essential in educational settings because they promote self-directed learning and cater to individual learning needs. We implemented five stages to conduct the Student Assistant examples (Figure 2).

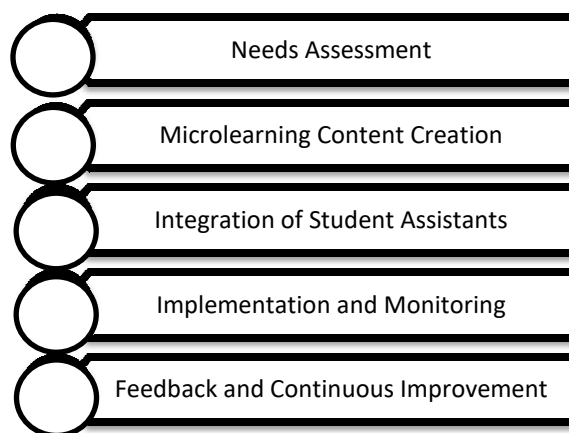


Figure 2. Student's Assistant Methodology Steps

## 4. Previous Studies on AI-enhanced Educational Tools

Previous studies have examined the use of artificial intelligence (AI)-augmented educational aids, especially in the context of chatbots. These studies have shown the ability of chatbots to enhance learning experiences and provide personalized assistance [12]. Researchers have investigated the use of chatbots in language learning. AI-driven chatbots have shown the ability to engage learners actively, provide immediate feedback, and adapt to personalized learning needs. Further study has focused on the use of chatbots in science and mathematics education, showing the ability of these artificial intelligence tools to assist students in solving complex issues and improving their understanding of difficult subjects. Previous studies highlight the effectiveness of AI-augmented educational aids and provide a

foundation for continued research and development in this field.

## 5. Research Methodology

A comprehensive and varied study approach was used to investigate the relationship between rapid construction, engineering techniques, and Large Language Models (LLMs) outputs. The system architecture was designed, and data collecting was performed, identifying relevant domains and curricula in applied sciences. The training data was collected to develop the AI-driven chatbots, namely the 'Student's Assistant' and 'Study Companion.' Techniques for prompt building, including persona and template applications, were used to examine their impact on LLM results. Moreover, advanced methodologies, including few-shot and chain-of-thought prompts, were used to assess their influence on the language model's replies.

### 5.1 Student's Assistant and Study Companion

We adhered to a systematic strategy to pursue our research objective carefully. The Study Companion and the Student's Assistant were both implemented in four phases. Methods Employed by the Student Assistance and Study Companion (Figure 2) Procedures Below are the comprehensive steps:

1. Curriculum Selection: We identified the appropriate applied sciences curriculum to serve as the foundation for our investigations. We obtained these courses and sent them to our trial application in PDF format.

The selected curriculum was on the website STEM.org.my, which provides STEM (science, technology, engineering, and mathematics) educational resources for learners of all ages. Each chapter in the selected books has corresponding questions and answers. The assigned texts for our class are as follows: Science: derived from 'STEM-12 Biology for High School,' a textbook used in ninth and tenth grades. This is a mathematical excerpt from the seventh-grade textbook 'STEM-12 Basic Algebra Concepts.' Physics lessons for grades 10, 11, and 12, based on 'People's Physics Book Version 3 (with Videos)'

2. Identifying the Suitable Questionnaire: Upon examining the selected chapters of the books, we discovered a compilation of questions and their corresponding answers.

The subsequent phase is evaluation. We used questions from the selected chapter surveys to evaluate the application rigorously.

4. Establishing Assessment Criteria: To evaluate the efficacy of our application, we established explicit benchmarks for comparison, supposing that the replies provided by educators are accurate and comprehensive. These criteria are tailored to accommodate the distinct characteristics of theoretical disciplines such as biology and technological domains like mathematics and physics.

### 5.2 System architecture of the chatbot application

The system architecture of the chatbot application is essential for developing and operating AI-driven educational aids. The framework enables seamless interaction between the chatbot and the user, offering an efficient and effective user experience. The architecture consists of multiple components, including the natural language processing (NLP) module,

enabling the chatbot to understand and respond to user inquiries, and the machine learning module, which incorporates large language models (LLMs) to enhance the chatbot's responses. Furthermore, the design includes the database module, which is tasked with storing and retrieving relevant information, and the user interface module, which provides an intuitive platform for interaction. The system design is essential for adequately integrating AI Chatbot Communications into micro-learning applications, facilitating personalized and flexible learning experiences for students [13].

### 5.3 Data collection process

The data-gathering procedure for this research included many successive steps. The first phase was the meticulous selection of subjects and curricula, especially in applied sciences, to provide diverse teaching resources [14]. Subsequently, training data was gathered, including a thorough collection of prompt-response pairings from which the chatbots might learn. The data was acquired from several educational sources and assessed for accuracy and relevance. The meticulous data collecting method guaranteed that the chatbots had extensive access to varied information, allowing them to provide accurate and useful replies to user queries (see Figure 2).

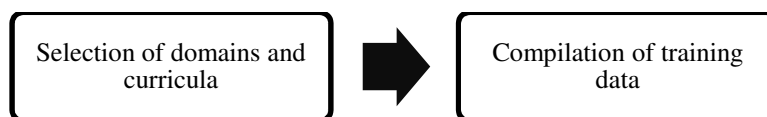


Figure 2. Study Companion Methodology steps

#### 1. Selection of areas and curricula

The research started with prioritizing topics and curricula for AI Chatbot Communications, explicitly focusing on applied sciences and essential educational areas. These categories were selected to ensure various issues and assess the AI Chatbot Communications' capacity to provide accurate and relevant information across diverse disciplines. The curricula in each subject were carefully chosen to offer a wide range of educational content, enabling comprehensive evaluation of the chatbots' capabilities. The selection procedure was crucial in building a robust and comprehensive experimental framework for the research [15].

#### 2. Compilation of training data

An extensive compilation of training data was performed to train the AI-driven chatbots. Selecting domains and curricula was essential for equipping the chatbots with relevant knowledge across many areas. A thorough examination was performed to identify the vital topics and ideas in applied sciences that required incorporation into the training data [16]. Following establishing the domains and curricula, a significant volume of educational information, including textbooks, study materials, and internet resources, was gathered and processed to create a complete dataset. The dataset provided the foundation for training the chatbots, enabling them to provide accurate and reliable information to pupils [17].

## 6. Prompt Construction Techniques



The building approaches used in prompts are crucial in influencing the outputs produced by large language models (LLMs) in educational chatbots. This research examines the impact of quick structuring strategies on the performance of LLM students [18]. Two principal strategies are utilized: persona and template applications. Persona-based prompts need the LLM to adopt a specific persona or role for engagement, while template apps use predefined language patterns to guide the LLM's replies successfully. This study provides significant insights into optimizing educational chatbots and enhancing the micro-learning experience for students by examining the relationship between fast formulation and LLM outcomes [19].

### **6.1 Persona and Template Applications**

The research study examines the impact of prompt structuring strategies, including persona and template applications, on the performance of Large Language Models (LLMs) in AI Chatbot Communications tailored for micro-learning. Persona applications include creating a unique persona or identity for the chatbot to enhance engagement with learners [20]. Conversely, template applications depend on pre-established templates to guide the chatbot's replies. The research investigates the influence of various quick formulations on the efficacy of LLMs and their capacity to provide accurate and meaningful answers to learners' questions. The findings of this investigation promote the development of more effective AI-driven instructional tools.

### **6.2 Advanced prompt engineering methods**

Advanced quick engineering approaches are applied to optimize the performance of large language models (LLMs) in response generation. This research examines the effects of two particular strategies, the few-shot prompt, and chain-of-thought prompt, on the responses of AI-enhanced chatbots in micro-learning applications. The few-shot prompt involves providing the Language Model with limited information to generate a response, mimicking a scenario where the model has little previous knowledge [21]. The chain-of-thought prompt necessitates that the LLM deconstruct the prompt into smaller components for analysis. This enables the LLM to provide coherent and contextually appropriate replies. This work aims to enhance the accuracy and relevance of AI-driven instructional aids by analyzing advanced prompt engineering approaches [22].

## **7. Experimental setup**

The research used an experimental framework in which AI-enhanced chatbots, designated as 'Student's Assistants' and 'Study Companions,' were integrated into a regulated educational setting. The chatbots were integrated into the current learning management system used by the participants. The participants were assigned various tasks and situations to interact with the chatbots, ranging from answering subject-specific questions to requesting personalized assistance for their academic endeavors [23]. The data from these encounters were collected and analyzed to evaluate the impact of prompt-building approaches and sophisticated prompt engineering methods on the answers of the large language models (LLMs) that power the chatbots.

### **7.1 Study design**

The investigation into AI Chatbot Communication for Micro-Learning Applications:

Student Assistant and Study Companion used a systematic and thorough research strategy. Two basic strategies were used to investigate the relationship between rapid construction, engineering procedures, and the outputs of Large Language Models (LLMs) [24], [25]. The research examined the effects of rapid structuring methods, particularly persona and template applications, on the outputs of LLM models. The investigation examined the impact of advanced approaches in prompt engineering, including few-shot and chain-of-thought prompts, on the replies of the Language Model. Furthermore, the 'Study Companion' methodology used an applied sciences curriculum for experimentation, producing significant insights into artificial intelligence in education [26].

## 7.2 Data preprocessing

Data preparation is a crucial and fundamental phase in any research study, including evaluating AI Chatbot Communications for micro-learning applications. This project involves transforming raw chatbot discussion data into a suitable format for analysis. This consists of deleting superfluous material, cleansing the text of punctuation and stopwords, and segmenting the text into distinct words or phrases. Furthermore, data preparation includes identifying and managing missing or incomplete data. By executing these preprocessing protocols, researchers may ensure the integrity and accuracy of the data used for analysis, yielding more reliable and meaningful results.

## 7.3 Metrics for evaluation

This research utilizes many measures to evaluate the efficacy of AI-augmented chatbots in the micro-learning application. These metrics are designed to assess the effectiveness and accuracy of chatbots in providing educational assistance and support. Response time is an essential parameter that measures the efficiency of chatbots in delivering responses and assistance to student requests. Response accuracy is a crucial metric that assesses the precision of the information provided by chatbots. The research evaluates user satisfaction by analyzing the whole user experience and interactions with the chatbot. These measurements provide critical insights into the performance and appropriateness of chatbots for micro-learning applications [27].

## 8. Results and Discussion

This section delineates and analyzes the outcomes of research investigating the impact of prompt structuring approaches and advanced prompt engineering methods on the efficacy of Large Language Models (LLMs) in the 'Student's Assistant' and 'research Companion' chatbots. The findings indicate that using prompt structuring strategies, including personas and templates, significantly influences the output of Language Models (LLMs) [28]. The use of advanced prompt engineering approaches, including few-shot and chain-of-thought prompts, substantially influences the replies generated by LLMs. Furthermore, using applied sciences courses inside the 'Study Companion' framework provides significant insights into the practical use of AI in specific disciplines [29]. The results and analysis include considerable significance for advancing artificial intelligence in education, underscoring the need for continuous investigation and enhancement of AI-driven educational resources. Further analysis and elucidation of the results are offered to improve understanding of the study's findings.

### **8.1 Impact of prompt structuring techniques on LLM outputs**

In developing AI Chatbot Communications for micro-learning applications, evaluating the impact of prompt structuring strategies on the outputs of Large Language Models (LLMs) is crucial. The research investigates the influence of several prompt creation methods, including persona and template use, on the outputs generated by the LLM. The study examines the impact of quick formulation, engineering techniques, and LLM outputs on the efficacy of AI-based instructional aids, offering insights into the factors that affect their success. These results give significant insights for improving LLM performance and advancing the use of AI in education to provide accurate and customized learning experiences [30].

### **8.2 Influence of advanced prompt engineering methods on LLM responses**

A crucial aspect to consider in developing AI Chatbot Communications for micro-learning applications is the influence of advanced prompt engineering approaches on responses to large language models (LLMs). This research examined several quick construction approaches to evaluate their impact on LLM results. The study investigated the effectiveness of sophisticated prompt engineering methods, such as few-shot and chain-of-thought prompts. The findings demonstrated the significant effect of these strategies on enhancing the quality and accuracy of LLM replies. This underscores the need to adequately formulate prompts to optimize the efficacy of AI-powered chatbots in educational settings.

## **9. Findings from the 'Study Companion' approach**

The 'Study Companion' methodology provided significant insights into the effectiveness of AI-enhanced chatbots in applied sciences education. The research examined the effects of prompt structuring approaches and sophisticated prompt engineering methods on the outputs generated by Large Language Models (LLMs). The influence of persona and template applications on the precision and pertinence of LLM outcomes was substantial. Moreover, the use of few-shot and chain-of-thought prompts showed significant potential in enhancing the quality of the chatbot's answers. These results substantially influence integrating AI-driven educational systems to improve learning experiences [31].

## **10. Comparative Analysis and Interpretation of Results**

In micro-learning using AI-enhanced chatbots, it is crucial to undertake comparison analyses and interpret data to understand these educational instruments' efficacy and performance fully. This research aims to identify the most effective strategies for improving the performance of large language models (LLMs) by evaluating various prompt structure techniques and sophisticated prompt engineering methodologies. This comparative study evaluates the data obtained from tests using the 'Student's Assistant' and 'Study Companion' chatbots. It offers significant insights into the impact of various rapid building and engineering techniques on LLM replies. This study facilitates future progress in AI-based educational instruments [32].

## **11. Implications for AI in Education**

The research has considerable ramifications for the incorporation of AI in education. This study identifies the key elements affecting the performance of large language models

(LLMs), laying the foundation for developing more efficient AI-based educational aids. The findings underscore the increasing reliance of educational institutions on AI-driven technologies to provide tailored learning experiences and personalized support. The research examines the challenges encountered in modern education, particularly the need for accurate, relevant, and diverse instructional resources. The empirical insights gained from this study may aid educators and institutions in optimizing their use of AI in the classroom, thereby promoting the progress of educational technology [33].

### **11.1 Contribution to educational technology**

The investigation of artificial intelligence chatbots tailored for micro-learning applications, namely the Student's Assistant and Study Companion, represents a significant progression in educational technology. This study lays the groundwork for enhancing AI-based educational aids by examining the relationship between prompt design, engineering techniques, and large language models (LLMs) results. The results clarify the elements influencing LLM success and provide academic and practical insights for improving adaptive learning experiences and individualized instruction. This research emphasizes the need for accurate, relevant, and diverse optimization of educational material to successfully use the capabilities of AI in education, as academic institutions increasingly rely on AI-driven solutions [34].

### **11.2 Practical insights for educators and institutions**

This study's results on AI Chatbot Communications for micro-learning provide significant and practical insights for educators and institutions [35]. The research examines the impact of prompt structuring approaches and sophisticated prompt engineering methods on the effectiveness of large language models (LLMs). Educators may use these data to optimize the deployment of AI-powered chatbots in educational settings, providing students with customized learning experiences and personalized assistance. Educators may enhance the correctness, relevance, and variety of instructional material by understanding the influence of different prompt formulations and engineering techniques on LLM outputs. Gaining this information may enhance the efficacy of AI-driven instructional technologies and foster ongoing research and advancement in AI within the educational sector [36].

## **12. Addressing Challenges in Modern Education**

This research seeks to make a substantial contribution to tackling the issues in contemporary education [37]. The rising desire for adaptive learning experiences and individualized advice in educational institutions is seen via AI-driven solutions such as chatbots. This study examines the impact of prompt structure approaches and sophisticated prompt engineering methods on large language models (LLMs) performance. It explains how artificial intelligence (AI) might improve instructional material [38]. This study's findings have substantial implications for using AI in education, underscoring the need for ongoing research and enhancement to leverage the potential of AI-driven educational technologies fully.

## **13. Conclusion**

This research has shown the potential of AI-enhanced chatbots, particularly Large Language Models (LLMs), in education. This study has provided significant insights into

improving AI-driven teaching aids by examining the impact of prompt-building approaches and sophisticated prompt engineering methodologies on LLM results. The findings indicate that using persona and template applications may enhance the efficacy of LLMs. Furthermore, sophisticated prompt engineering methods, such as few-shot and chain-of-thought prompts, may significantly improve the quality of LLM replies. These results have substantial implications for enhancing adaptive learning experiences and individualized educational assistance, underscoring the need for ongoing research and refinement to harness AI's potential fully in the education sector.

The research results about AI Chatbot Communications for micro-learning applications, particularly with the 'Student's Assistant' and 'Study Companion' chatbots, provide substantial insights into the role of AI in education. The research examined the impact of prompt creation strategies, including persona and template applications, and advanced prompt engineering methods, such as few-shot prompts and chain-of-thought prompts, on the outputs and replies of large language models (LLMs). The research used a curriculum in applied sciences for experimental objectives. These results have substantial implications for developing AI-driven educational technologies and underscore the need for ongoing research and enhancement to use AI in education fully.

Nonetheless, it is essential to acknowledge the limitations of this study. The study mainly investigates the impact of prompt formulation approaches and sophisticated prompt engineering procedures on LLM results. While the significance of these characteristics in understanding the efficacy of AI-enhanced chatbots is considerable, there is a paucity of investigation into other variables, including user engagement, contentment, and long-term knowledge retention. Furthermore, the research mainly relies on the curriculum of practical sciences, hence limiting the application of the findings to other disciplines. Moreover, the sample size and duration of the experiment might influence the statistical power and dependability of the results. These constraints need more investigation to include a broader spectrum of participants, include user perspectives, and conduct long-term studies to validate the sustained efficacy of AI-driven instructional aids.

In light of the findings and limitations of this study, some recommendations for future research in the field of AI-enhanced instructional tools are proposed. More studies are needed to explore the potential for incorporating new courses and disciplines into the 'Study Companion' framework beyond applied sciences. This would provide a more comprehensive understanding of the effectiveness and adaptability of chatbots in meeting a more extensive range of academic needs. Moreover, it is essential to explore other techniques for formulating prompts to identify the most effective tactics for enhancing the performance of large language models in educational settings. Moreover, subsequent research must evaluate AI-driven teaching technologies' long-term impacts and sustainability. Furthermore, it is essential to enhance the integration of these technologies into traditional educational environments to provide a seamless and practical learning experience for students. By adopting these recommendations, researchers may significantly enhance the ongoing development and refinement of artificial intelligence (AI) in education. This will eventually improve the quality and accessibility of educational resources for persons of various age groups and backgrounds.

### **Acknowledgement**

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# Science and Engineering





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# Synthesis and Characterization of Ibuprofen complex with Cu(II)-ion

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## ABSTRACT

Ibuprofen (isobutylphenyl propionic acid) is one of the most commonly used non-steroidal anti-inflammatory drugs and has been used for many years in the treatment of diseases such as rheumatoid arthritis. Interactions between molecules and metals provide various possibilities of influencing their properties. Metal ions in combination with NSAIDs have an advantage over the drug molecules themselves. The complex of Cu(II) ions with ibuprofen was synthesized and characterized. FTIR, UV-Vis and optical microscopy confirm the positive action of the metal with the isobutylphenyl propionic acid molecule. The  $^1\text{H}$  NMR method confirms the complex between the molecule and the metal.

**Keywords:** complex, Ibuprofen, metal, Cu(II)-ion, FTIR,  $^1\text{H}$  NMR

## INTRODUCTION

**Ibuprofen** is (2*RS*)-1 [4-(2-methylpropyl)phenyl]propionic acid (Bradbury, 2004: 27-32) introduced in 1969 as a better alternative to aspirin. It is an organic compound whose structure is shown in Figure 1. The molecule consists of propanoic acid, which has a benzene ring attached to the second carbon atom with an isobutyl group in the para position, molecular formula  $\text{C}_{13}\text{H}_{18}\text{O}_2$  and a mass of 206.281 g/mol. The compound ( $\alpha$ -methyl-4-(2-methylpropyl)benzeneacetic acid) is a white crystalline powder, which is sometimes found in the form of colourless crystals, almost insoluble in water, and easily soluble in acetone, ether, methanol and methylene chloride. Melting points from 76° C. It dissolves in dilute solutions of alkaline hydroxides and carbonates (Kovač, 2000: p.479., British, Pharmacopoeia, 2000: p.16.)

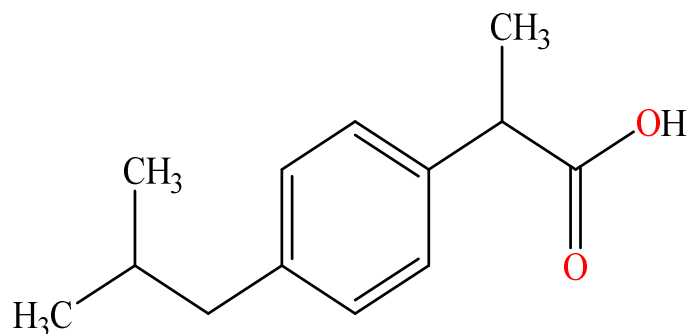


Figure 1. Structure (RS)-2-(4-(2-methylpropyl)phenyl) propionic acid

Furthermore, IBU is one of the primary pharmaceuticals placed in the list of essential drugs of the World Health Organization (WHO) ( Mathias, Fockink, Disner, Prodocimo, Ribas, Ramos, Cestari, Silva de Assis, 2018: 105-113). As one of the most famous non-steroidal anti-inflammatory drugs, it is effective in lowering body temperature, inhibits the normal function of platelets, reduces joint and muscle pain, is used in the treatment of arthritis, etc. The presence of this group makes these molecules possible candidates for the synthesis of metal complexes in coordination chemistry (A.T.M. Fiori et al., 2011: 738-740) . The harmful effect of this drug is probably the result of frequent and widespread use (Gomaa, 2018: 1-9).

Various metal ions, including the Cu(II)-ion, are often used due to the creation of low molecular weight, which has been shown to have positive effects on various diseases. Interactions between different metals and biomolecules provide different possibilities of influencing their properties; reactivity; and finally, their biological impacts (Franz, Nils, 2019:727-729) . Metal complexes with bioactive ligands such as NSAIDs are of great importance in the area of bioinorganic chemistry, leading to enhanced pharmacological profile significantly higher than that of the free ligand (Geary,1971:81-122). For many years, studies of copper(II) complexes with various drugs have been the subject of bioinorganic chemistry research, because Cu is a component of many key proteins (Crisponi, Nurchi, Fanni, Gerosa, Nemolato, Faa, 2010: 876-889) and due to the high activity of copper against bacteria, viruses, yeasts, and fungi (Medici, Peana, Nurchi, Lachowicz, Crisponi, Zoroddu, 2015: 329-350).

## EXPERIMENTAL

### Materials and methods

- Materials  $\text{CuCl}_2 \cdot 2\text{H}_2\text{O}$  was purchased from Superlab, Ibuprofen and sodium hydroxide (NaOH) was purchased from Sigma; distilled water.

### Synthesis of Ibuprofen -metal complexes

- Solutions of the ligand Ibuprofen (1,545 g) and the metal  $\text{CuCl}_2 \cdot 2\text{H}_2\text{O}$  (0,5125g) were separately dissolved in saturated basic solution, mixed and stirred stirring at 60 °C with

reflux for one hour. The suspension was left overnight at  $-4\text{ }^{\circ}\text{C}$  in the refrigerator. The sample was filtered and washed with distilled water.

#### **FTIR spectroscopy:**

- The analysis of the formed metal complexes with Cu(II)-ion was performed on a Thermo Scientific Nicolet I S10 spectrometer in the ratio of  $4000$  to  $450\text{ cm}^{-1}$ , with a resolution of  $2\text{ cm}^{-1}$ . The samples were analysed in the laboratory of the pharmaceutical company Zada.

#### **UV-Vis spectrum**

- UV/Vis spectroscopy: Analysis of the synthesized complex was performed on a UV/Vis spectrometer with a wavelength of  $200\text{-}400\text{ nm}$ .

#### **NMR spectrum**

- Metal complex was analysed by NMR spectroscopy, Ruđer Bošković Institute in Zagreb.
- NMR spectra were recorded on a Bruker 600 spectrometer, at a frequency of  $600.13\text{ MHz}$  ( $^1\text{H}$ ). Spectra were recorded in DMSO- $d_6$  at room temperature. Chemical shifts are expressed in ppm units relative to tetramethylsilane (TMS) as an internal standard. Spectra were assigned based on 1D ( $^1\text{H}$ ) experiments.

#### **Optical spectroscopy**

- Sample analysis was done on microscope Leica, model 2500D, working on the principle of passed polarized light.

## **RESULTS AND DISCUSSION**

### **Synthesis and Characterization**

#### **Infrared absorption spectra**

The complex was prepared by the reaction of the  $\text{CuCl}_2 \cdot 2\text{H}_2\text{O}$  with ibuprofen in NaOH solution. The synthesized complex with  $\text{CuCl}_2 \cdot 2\text{H}_2\text{O}$  was white and black-green in colour. After synthesis, the sample was analysed. The Infrared spectra of the sample synthesized complex and their ligand is presented in Figure 2. The characteristic functional groups bands of the standard ligand was compared to of the synthesized complex. On the spectrum of the complex, a slightly broad-sharp band hydroxyl ( $-\text{OH}$ ) groups is observed, which is shifted to a wavelength of  $3346.49\text{ cm}^{-1}$  compared to the free ligand (Ibuprofen). That is, a shift to longer wavelengths compared to the pure ligand (Ibuprofen). A band at  $1704.95\text{ cm}^{-1}$  is attributed to  $\nu(\text{C}=\text{O})$  vibration in the Ibuprofen and that group disappears in spectra of the complex. Two strong bands are present at  $1435\text{ cm}^{-1}$  and  $1405.61\text{ cm}^{-1}$  assigned to ( $\text{COO}^-$ ) asymmetric and symmetric stretches, indicating bidentate coordination of carboxylate.

The characteristic band at  $1363.55\text{ cm}^{-1}$  in the complex is shifted to shorter wavelengths compared to the spectrum of the pure ligand at a wavelength of  $1379.00\text{ cm}^{-1}$ . It refers to the stretching deformations of the  $-\text{CH}$ ,  $\text{CH}_2$  group. The characteristic band at  $1293.24\text{ cm}^{-1}$  is shifted

to shorter wavelengths by  $27.29\text{ cm}^{-1}$  compared to the spectrum of the pure ligand. The band in the spectrum of the complex at the wavelength of  $864.42\text{ cm}^{-1}$  refers to -CH, the phenyl group band in the structure. It is shifted to shorter wavelengths compared to the spectrum of the free ligand whose wavelength is  $935.82\text{ cm}^{-1}$ . The spectrum of the complex shows a band at  $785.74\text{ cm}^{-1}$ , which is shifted to longer wavelengths and refers to the bending of the carboxylate ligand.

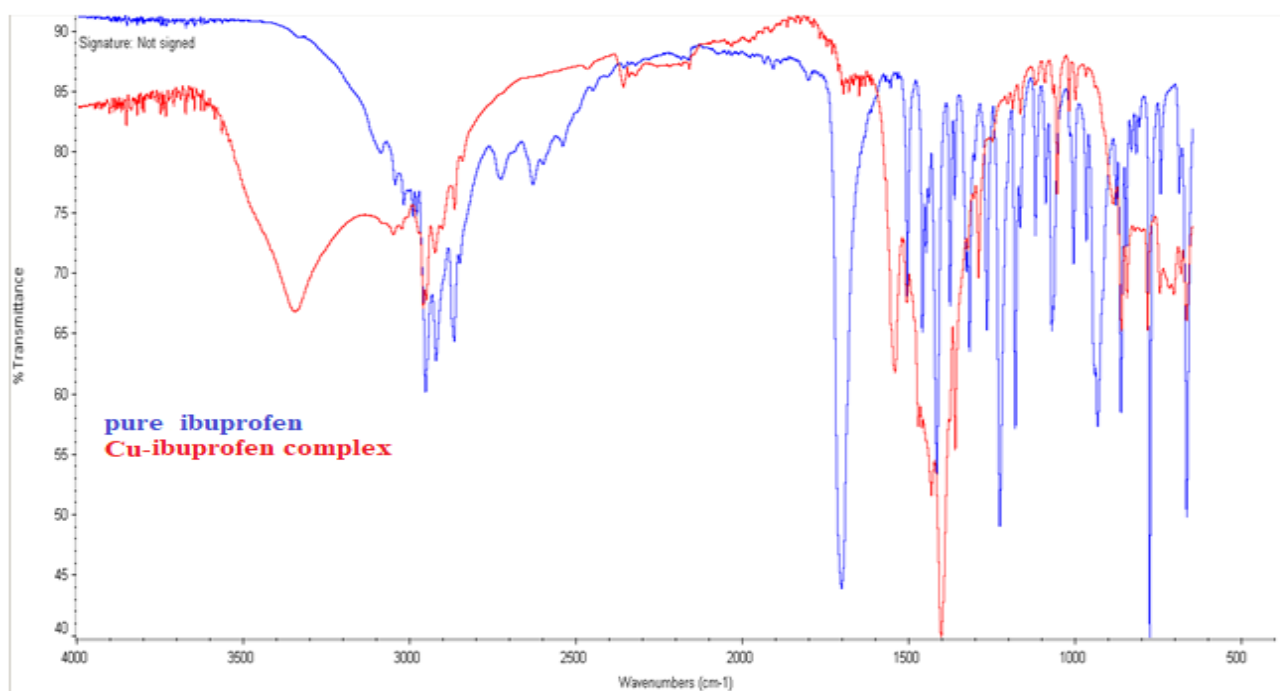


Figure 2. Spectrum of synthesized Cu-ibuprofen complex and spectrum of pure ibuprofen

### UV-Vis spectrum

Figure 3 shows the UV-Vis spectrum of complex and pure ibuprofen. On the spectrum of the complex, absorption maxima are observed at  $202.84\text{ nm}$  and  $219.49\text{ nm}$ , which indicates hypochromic changes. The spectrum of the complex also indicates a bathochromic shift towards higher frequencies at  $264.52\text{ nm}$  compared to the pure ligand (Ibuprofen). The bathochromic shift of the reflection band and the appearance of new bands for the complexes is attributed to the complexation of ibuprofen (Zordok, Sadeek, El-Shwiniy, 2012:353-369). The pure ligand shows an absorption maximum at  $219.49\text{ nm}$ .

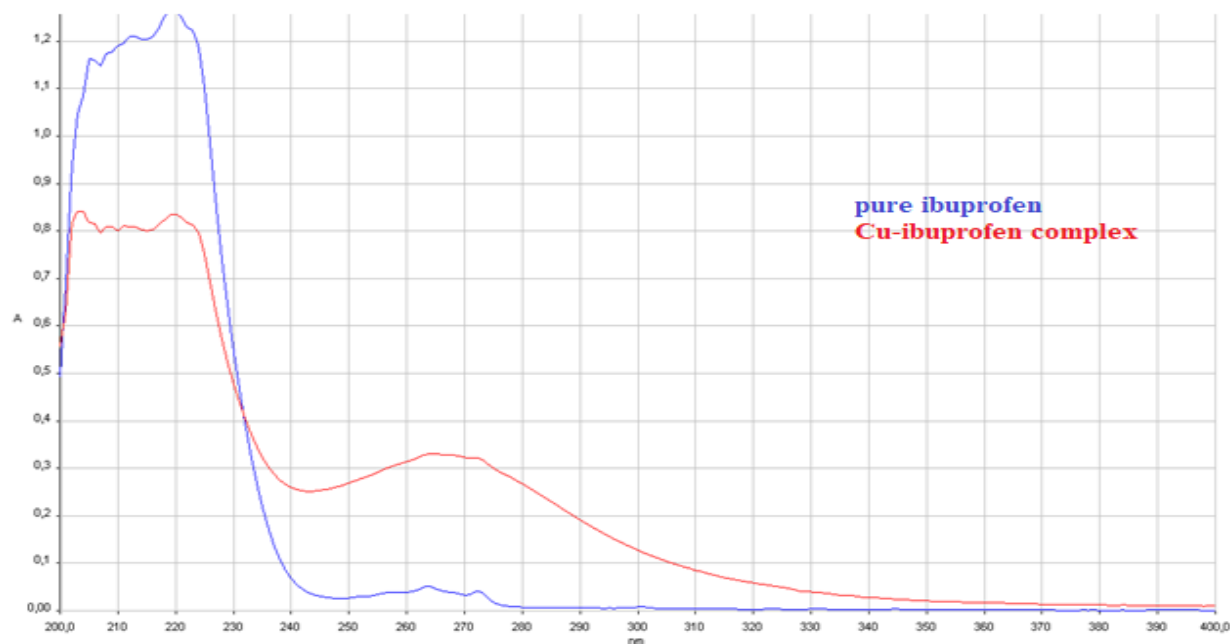


Figure 3. UV spectrum of synthesized Cu-ibuprofen complex and spectrum of pure ibuprofen

### Optical microscopy

Figure 4 shows the microscopic image of the pure ligand and the complex. Comparing the images of the pure ligand (Ibuprofen) and the Ibup-Cu(II) complex, one can see the difference between the size, shape and colour of the crystals. Crystals of pure ligand appear in prismatic-elongated forms, and the development of dendritic forms can be observed on sides. Crystals do not have pronounced pleochroism; they interfere in grey colours; they are irregularly oriented in the mass of the sample. The crystal size ranges from 0.2 to 0.7 mm, on average 0.4 to 0.5 mm. Crystals of the formed Ibupr-Cu(II) complex in well-developed dendritic forms are also shown. Crystals show weak pleochroism; they interfere in vivid colours of the II order. The crystal size ranges from 0.3 to 0.8 mm, with an average of 0.5 mm. The crystals show a radial-ray orientation.

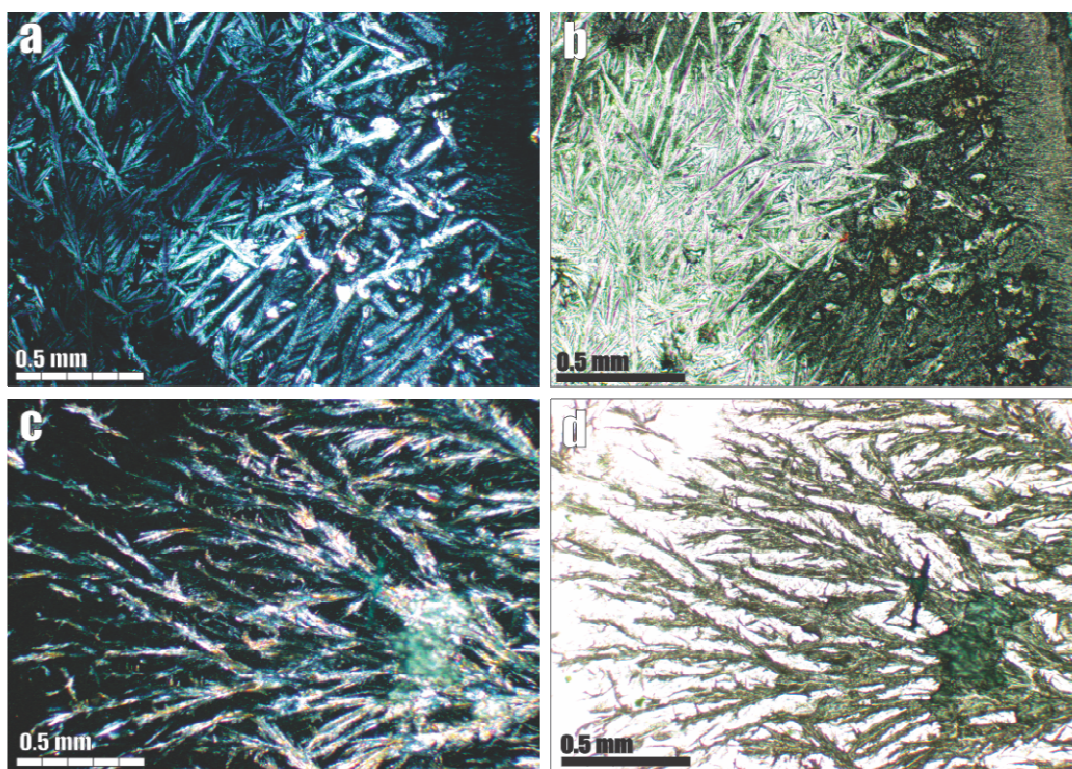


Figure 3. Optical microscopy of pure ibuprofen (a and b) and synthesized complex (c and d)

### <sup>1</sup>HNMR spectrum

<sup>1</sup>HNMR spectra of ibuprofen-Cu in DMSO-d<sub>6</sub> (Figure 4) show multiplets at: 0.85 and 1.21 ppm corresponding to methyl propyl and methyl with -COOH; singlets at: 1.78 for -CH middle singlet at 2,36 ppm for CH<sub>2</sub>, weak singlet at 6.96 and 7.16 ppm for -CH aromatic. <sup>1</sup>HNMR spectrum of complex Cu-Ibuprofen in DMSO-d<sub>6</sub> shows a peak at 3.21 ppm, due to the presence of water in the complexes. In the spectrum of this ligand (Figure 5), it is known as the carboxyl proton (COOH), while in the spectrum of the complex the carboxyl proton (COOH) is not recorded as coordination of ibuprofen via 12 carboxylate (Sadeek, EL-Shwiniy, 2010:130-138). Comparing Ibuprofen with its complex, all peaks of the free ligand present are in the spectra of the complexes with some shifts in relation to the binding of the ligand to the metal.

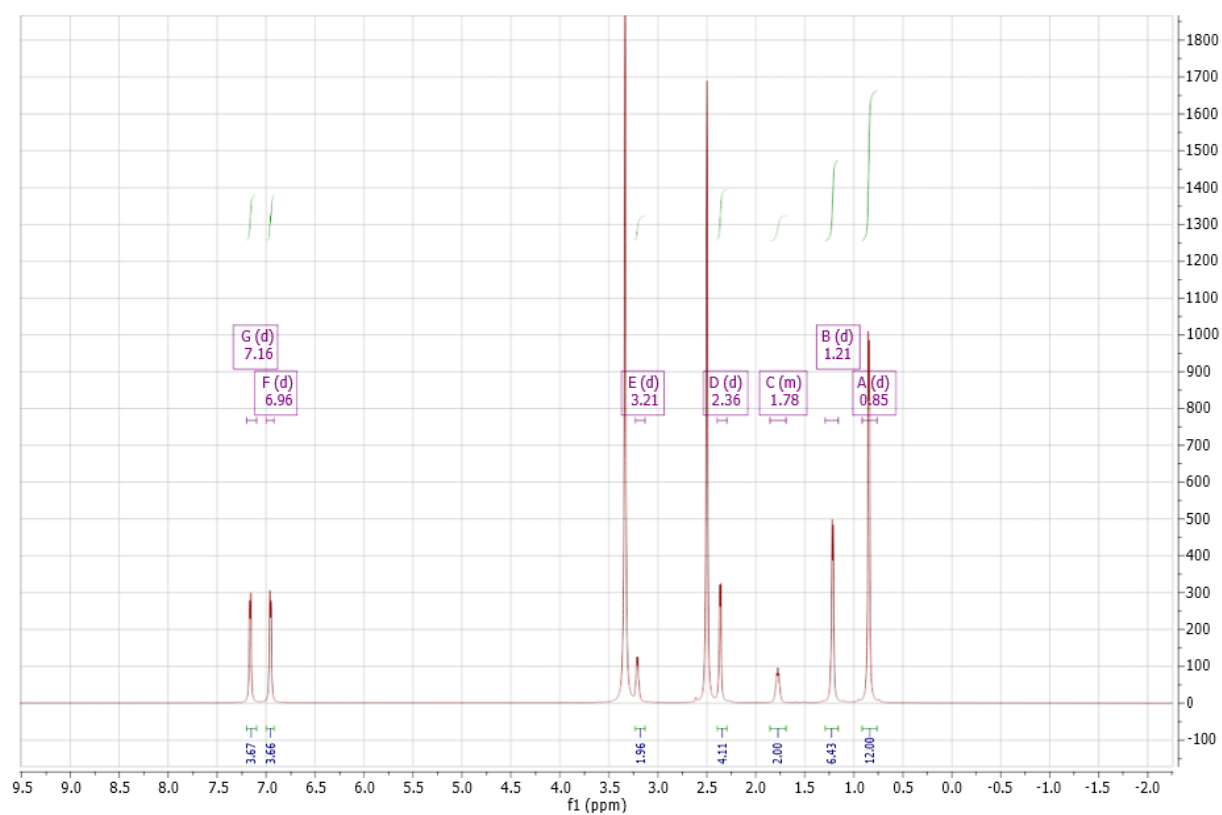


Figure 4.  $^1\text{H}$  NMR spectrum of the synthesized complex



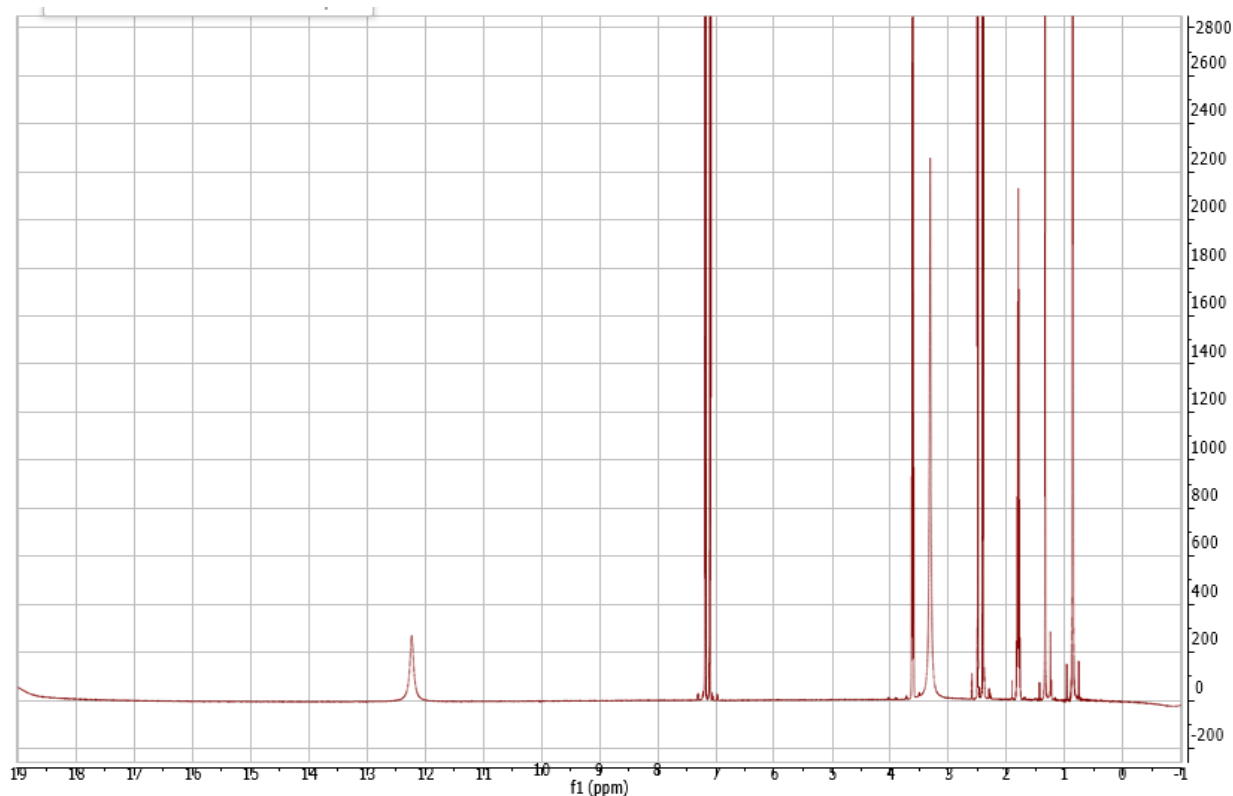


Figure 5. <sup>1</sup>H NMR spectrum of pure ligand

### Conclusion

Based on the obtained results and the analysis of FTIR, UV, <sup>1</sup>HNMR methods and optical microscopy, an interaction between the Ibuprofen molecule and the Cu (II)-ion can be assumed. One of the most relevant methods is the <sup>1</sup>HNMR method, which confirmed the interaction between Cu(II)-ion and Ibuprofen through the O oxygen of the hydroxyl group of the carboxylate. In this research, the corresponding metal is the Cu (II)-ion, precisely because it is one of the metals due to the supposed positive effects on the Ibuprofen molecule, as well as its direct effect on various diseases.

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# Model for Predicting Density and Viscosity of CO<sub>2</sub> for Enhanced Gas Recovery and Carbon Sequestration in Depleted Gas Reservoir: A Case study of Niger-Delta Formation

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## ABSTRACT

In response to United Nations Paris Agreement of 2050 Carbon Neutrality Goal and in compliance with Kyoto Protocol on Clean Development Mechanism (CDM), all hands must be on deck to achieve these goals, including Niger-Delta region of Nigeria. No mathematical correlation in place for predicting density and viscosity of supercritical carbon-dioxide (CO<sub>2</sub>) for Enhanced Gas Recovery-Carbon Capture and Sequestration (EGR-CCS). Three categories of mathematical correlations were developed by Split Regression Analytical method (SRA) and validated using Equation of State Models (EOS-M) for predicting density and viscosity of pure carbon-dioxide under supercritical conditions at varying reservoir depths. The models ranges from reservoir depths of 1000 - 5000m which are ideal for EGR-CCS projects. The new "NDF-Model" matched with Peng Robinson and Soave-Redlich-Kwong Equation of States (EOS) at the tested reservoir conditions showing low Absolute Average Deviation (AAD) with the EOS models. Application of the new models on four gas reservoirs (Res.1, Res.2, Res.3 & Res.4) in Niger-Delta Formation (NDF) shows encouraging Relative Density Difference (RDD) and Relative Viscosity Difference (RVD). The RDD and RVD of "Carbon-dioxide on Natural Gas" ranges from 65.28-80.22% and 59.02-76.82% respectively, which promises smoother displacement of natural gas by CO<sub>2</sub> during Enhanced Gas Recovery.

**Keywords:** Model, Density, Viscosity, Enhanced Gas Recovery, CO<sub>2</sub> sequestration, Equation of state.

## 1.0 INTRODUCTION

There have been few correlations proposed for predicting CO<sub>2</sub> phase behavior under supercritical condition in the subsurface but non-has been specifically formulated, designed, and developed for use in Niger-Delta formation.

Oil exploration activity has gained prominence in Niger-Delta, Nigeria for over 60 years. This has enabled the accumulation of thousands of informative reservoir data including temperature and pressure from well logs and other source. Long time production

over these years has led to depletion and abandonment of most reservoirs in Niger-Delta and on that context, many are today termed marginal fields. CO<sub>2</sub> sequestration is a sure tool for reducing the concentration of emitted CO<sub>2</sub> in the environment. The technology in a depleted gas reservoir is a win-win venture because the revenue accruing from produced gas could contribute to defray the cost of CO<sub>2</sub> sequestration project

(Abba et al., 2018; Leeuwenburgh et al., 2014; Mohammed et al., 2020)

Before embarking on any capital-intensive project such as CS - EGR projects, it is necessary to evaluate the potential benefits or setbacks from the project using the reservoir property data to conduct preliminary simulation or experimental test. Enhanced Gas Recovery and Sequestration projects needs adequate knowledge and estimates of formation pressures and temperatures to determine the expected in-situ fluid density and viscosity which would enable proper design for injection. The efficiency of gas-gas displacement dynamics are not only affected by injection rate, rock and fluids properties but also by the density and viscosity of the fluids (Hamza et al., 2021)

In petroleum engineering, enhancement recovery from gas or oil reservoirs requires accurate PVT data gathered at the reservoir conditions (Ghanbari et al., 2017). Also, experimental data are not only expensive but time consuming and, in some case, the validity of the reported experimental results are doubtful (Polishuk et al., 2001), hence the need for simulation and mathematical models.

Geological storage for CO<sub>2</sub> is mainly in saline aquifers, but its injection into depleted oil or gas reservoirs are advantageous due to its ability to produce the residual oil or gas that was not producible during the primary production stage. Also, the presence of basic infrastructures already in place for injection makes it easier to develop, operate and maintain. (Adebayo Thomas Ayotunde, 2013; Gou et al., 2014) (Anene, C. Z., & Odumodu, C. F 2021).

Additionally, Depleted Gas Reservoirs (DGR) have the potential to, securely sequester CO<sub>2</sub> with a storage capacity between 390 and 750 Giga-tons based on the replacement ratio. (Hamza et al., 2021; Hoteit et al., 2019; Regan, 2010; Vega & Kovsky, 2010), concluded that residual gas saturation vary from 15% to 50%, depending on the type of reservoir, indicating substantial amount of natural gas remaining in the reservoir after depletion.

### 1.1 Carbon-Dioxide Property Prediction

To appropriately design and operate on Enhanced Gas Recovery - Carbon Sequestration (EGR-CS) projects, the accurate representation of carbon-dioxide properties, mainly density and viscosity is a must (Ouyang, 2011). These are the two critical properties required for well injectivity for carbon-capture projects as well as stable displacement and sweep efficiency for EGR projects.

Carbon-dioxide density and viscosity can be calculated using black oil PVT Model, Equation of States (EOS) Model or Empirical Mathematical Model (EMM) (Ghanbari et al., 2017; Ouyang, 2011; Perez et al., 2017). Black oil PVT model is a simplified fluid model used for surface gas and oil. This model cannot be applied to pure carbon-dioxide but for oil and gas where CO<sub>2</sub> component is less than three percent (3%) and where the CO<sub>2</sub> component can reach 10-20% as in the case of sour gas (Ouyang, 2011). An EOS is a function that relates the thermodynamic properties of CO<sub>2</sub>, such as pressure, temperature, and volume while the mathematical model in this context is the representation of density and viscosity of CO<sub>2</sub> using mathematical correlations, equations or algorithms.

EOS are important tools in PVT calculations designed for predicting phase equilibria, thermo-physical properties, and volumetric behavior of fluid system, both in subcritical and supercritical domain, which gives foundation for other calculations like reservoir simulation, fluid mapping, surface processing etc. (Ghanbari et al., 2017). Models by Peng-Robinson (PR-EOS) (Donald B. Robinson, 1978) and that of Soave-Redlich-Kwong (SRK-EOS) (Soave, 1972) are the two common and primary Equation of State (EOS) for two-phase modeling in different areas of petroleum and chemical engineering.

**1.2 Geothermal and Pressure Gradient of Niger-Delta Formation**

Geothermal gradient is a measure of the rate of change of temperature with depth (Emujakporue & Ekine, 2014; Godec, 2013). The geothermal gradients of subsurface formations are computed using a linear relationship as shown in equation (1)

$$T = G * D + T_o \dots \dots \dots (1)$$

Where: T = Wellbore temperature (°C); G = Geothermal Gradient (°C/Km)  
 D = Depth of reference (KM); T<sub>o</sub> = Mean Surface Temperature (°C)

Formation pressure is the pressure acting on the fluids (gas, oil, water) in the pore spaces of the rock (Hussain Rabia, 2002.). It is affected by the density of the in-situ fluid and the weight of the overlying rock materials, with respect to the depth of reference. Mathematically,

$$Fp = 0.052 \times \rho(f,r) \times D \dots \dots \dots (2)$$

Fp= Formation pressure (Psi); D = True vertical depth (ft)  
 ρ(f,r) = formation fluid/rock matrix density

Accumulated reservoir data in Niger-Delta over the years led to the development of the following mathematical correlation. (Lawal, 2011; Lawal & Adenuga, 2010)

$$P_r = 0.434D + 14.7 \dots \dots \dots (3)$$

$$T_r = 0.0105D + 71.4 \dots \dots \dots (4)$$

Where,  
 Pr = Reservoir pressure (Psia); Tr = Reservoir temperature (°F);  
 D = Reservoir depth (ft).

**2.0 MATERIALS AND METHOD**

This study is divided into two parts: First is focussed on model development for CO<sub>2</sub> density and viscosity and second part is the application of the predicted results from the models for EGR-CS project in Niger-Delta formation. Niger-Delta Formation data and PVTsim software were the basic tools employed in this research.

**2.1 Model development**

The study adopts extensive literature review and analytical framework to validate the Niger-Delta formulation gradients as reported in equation (3 & 4) of the work.

**2.1.1 Validation of the Adopted Niger-Delta Formation Gradient using Absolute Average Deviation (AAD) Approach.**

Below is sensitivity analyses on reservoir gradients formulated few years after the models (equation 3 & 4) was developed.

$$\text{Pressure Gradient (Psi/ft)} = \frac{\text{Pressure (Psi)}}{\text{Depth (ft)}} \dots \dots \dots (5)$$

Where;

$$\text{Pressure (Psi)} = \text{Gradient} \times \text{Depth}$$

$$\text{AAD (\%)} = \frac{|Xi^A - Xi^B|}{Xi^A} * 100 \dots \dots \dots (6)$$

AAD (%) = Percentage Absolute Average Deviation

$Xi^A$ =Niger-Delta Formation gradient (Pressure/Temperature) adopted for this work

$Xi^B$  = Other Reported Formation gradient (Pressure/Temperature) for Niger-Delta

Table 1: Comparative Analysis of the adopted Pressure Gradient Correlation with other Gradient Correlations.

MODEL (Equation.3)	(Nwozor & Onuorah, 2014)	(Ogbamikhumi et al., 2017)	(JE & DO, 2018)	(Agbasi et al., 2013)	Remark					
Depth (m)	Pressure @ Model (Psi)	Pressure (Psi)	AAD (%)	Pressure (Psi)	AAD (%)	Pressure (Psi)	AAD (%)	Pressure (Psi)	AAD (%)	MFFP
1000	1,438.58	1,407.46	2.16	1,420.59	1.25	1,459.96	1.49	1,427.15	0.79	MFFP
1200	1,723.36	1,688.96	1.99	1,704.70	1.08	1,751.95	1.66	1,712.58	0.63	MFFP
1400	2,008.14	1,970.45	1.88	1,988.82	0.96	2,043.94	1.78	1998.01	0.51	MFFP

MFFP: Model Fit For Purpose; MNFFP: Not Fit For Purpose

In the same vein the AAD’s for the adopted Thermal Gradient (Equation 4) are less than 3% for those reported by (Akpabio et al., 2013.; Emujakporue & Ekine, 2014; Mosto Onuoha & Ekine, 1999)

**2.2 Model Development Approach**

Carbon-dioxide properties, specifically density and viscosity were generated from PVT simulation software known as (PVTsim) using Niger-Delta pressure and temperature gradients data generated from equations (3 & 4) of this work at reservoir depths ideal for sequestration and EGR.

Below is a flow diagram on how the model was developed.

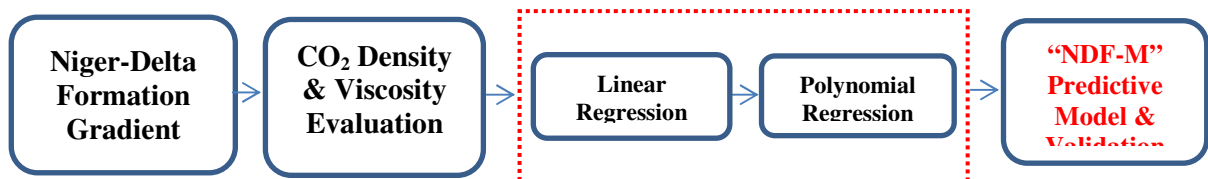


Figure 1: Model Development Algorithm

The developed correlations and the associated constants were adjusted to meet two significant criteria as defined below:

**2.2.1 Criteria One: Least Square Curve:**

$$Sum = \sum_{i=1}^n [\rho(NDF)_{PiTi} - \rho(EOS)_{PiTi}]^2 = Minimum \dots \dots \dots (7)$$

$$Sum = \sum_{i=1}^n [\mu(NDF)_{PiTi} - \mu(EOS)_{PiTi}]^2 = Minimum \dots \dots \dots (8)$$

**2.2.2 Criteria Two: Absolute deviation from standard:**

$$Sum = \sum_{i=1}^n \left[ \frac{\rho(NDF)_{PiTi} - \rho(EOS)_{PiTi}}{\rho(EOS)_{PiTi}} \right] = Minimum \dots \dots \dots (9)$$

$$Sum = \sum_{i=1}^n \left[ \frac{\mu(NDF)_{PiTi} - \mu(EOS)_{PiTi}}{\mu(EOS)_{PiTi}} \right] = Minimum \dots \dots \dots (10)$$

Where:

(NDF)<sub>Pi,Ti</sub> = Niger-Delta Formation Model as a function of Pressure and Temperature

(EOS)<sub>Pi,Ti</sub> = Equation of State Model as function of Pressure and Temperature

μ = Viscosity (cP) ρ = Density (g/cm<sup>3</sup>)

**2.2.3 The Generalised Equation for formulation of the Models**

The general equation for model formulation is as shown in equation (11)

$$\check{R}_{(P,T)} = \delta_0 + \delta_1 P + \delta_2 T + \delta_3 P^2 + \delta_4 T^2 + \delta_5 P.T \dots \dots \dots (11)$$

Where:  $\check{R}$  = Estimator of the mean response of density and viscosity at test conditions.

$\delta_j$  = Estimator of the Model constants; P = Reservoir Pressure; T = Reservoir Temperature

**2.2.4 Split Regression Approach (SRA)**

Split 1: From generalised equation (11)

$$\check{R}_{(P,T)} = \delta_0 + \delta_1 P + \delta_2 T \dots \dots \dots (12)$$

The normal equations from Split 1:

$$\sum_{i=1}^n (\check{R}) = \delta_0 N + \delta_1 \sum_{i=1}^n P + \delta_2 \sum_{i=1}^n T$$

$$\sum_{i=1}^n (\check{R}.P) = \delta_0 \sum_{i=1}^n P + \delta_1 \sum_{i=1}^n (P^2) + \delta_2 \sum_{i=1}^n (P.T)$$

$$\sum_{i=1}^n (\check{R}.T) = \delta_0 \sum_{i=1}^n (T) + \delta_1 \sum_{i=1}^n (P.T) + \delta_2 \sum_{i=1}^n (T^2)$$

Split 2: From generalised equation (11)

$$\check{R}_{(P,T)} = \delta_0 + \delta_1 P^2 + \delta_2 T^2 + \delta_3 P.T \dots \dots \dots (11)$$

The normal equations from Split 2:

$$\begin{aligned} \sum_{i=1}^n (\check{R}) &= \delta_0 N + \delta_1 \sum_{i=1}^n (P^2) + \delta_2 \sum_{i=1}^n (T^2) + \delta_3 \sum_{i=1}^n (P.T) \\ \sum_{i=1}^n (\check{R}.P^2) &= \delta_0 \sum_{i=1}^n (P^2) + \delta_1 \sum_{i=1}^n (P^4) + \delta_2 \sum_{i=1}^n (P^2 T^2) + \delta_3 \sum_{i=1}^n (P^3.T) \\ \sum_{i=1}^n (\check{R}.T^2) &= \delta_0 \sum_{i=1}^n (T^2) + \delta_1 \sum_{i=1}^n (P^2 T^2) + \delta_2 \sum_{i=1}^n T^4 + \delta_3 \sum_{i=1}^n (P.T^3) \\ \sum_{i=1}^n (\check{R}.P.T) &= \delta_0 \sum_{i=1}^n (P.T) + \delta_1 \sum_{i=1}^n (P^3.T) + \delta_2 \sum_{i=1}^n (P.T^3) + \delta_3 \sum_{i=1}^n (T^2 P^2) \end{aligned}$$

The split functions below at varying validity

$$\left\{ \begin{aligned} \sum_{i=1}^n (\check{R}) &= \delta_0 N + \delta_1 \sum_{i=1}^n P + \delta_2 \sum_{i=1}^n T \\ \sum_{i=1}^n (\check{R}.P) &= \delta_0 \sum_{i=1}^n P + \delta_1 \sum_{i=1}^n (P^2) + \delta_2 \sum_{i=1}^n (P.T) \\ \sum_{i=1}^n (\check{R}.T) &= \delta_0 \sum_{i=1}^n (T) + \delta_1 \sum_{i=1}^n (P.T) + \delta_2 \sum_{i=1}^n (T^2) \end{aligned} \right\} \dots \dots \dots \left\{ \begin{aligned} \sum_{i=1}^n (\check{R}) &= \delta_0 N + \delta_1 \sum_{i=1}^n (P^2) + \delta_2 \sum_{i=1}^n (T^2) + \delta_3 \sum_{i=1}^n (P.T) \\ \sum_{i=1}^n (\check{R}.P^2) &= \delta_0 \sum_{i=1}^n (P^2) + \delta_1 \sum_{i=1}^n (P^4) + \delta_2 \sum_{i=1}^n (P^2 T^2) + \delta_3 \sum_{i=1}^n (P^3.T) \\ \sum_{i=1}^n (\check{R}.T^2) &= \delta_0 \sum_{i=1}^n (T^2) + \delta_1 \sum_{i=1}^n (P^2 T^2) + \delta_2 \sum_{i=1}^n T^4 + \delta_3 \sum_{i=1}^n (P.T^3) \\ \sum_{i=1}^n (\check{R}.P.T) &= \delta_0 \sum_{i=1}^n (P.T) + \delta_1 \sum_{i=1}^n (P^3.T) + \delta_2 \sum_{i=1}^n (P.T^3) + \delta_3 \sum_{i=1}^n (T^2 P^2) \end{aligned} \right\}$$

Validity: Reservoir depth (1000-5000m)

Validity: Reservoir depth: (>5000m)

### 2.3 Viability of EGR-CS Project in Niger-Delta Gas Reservoirs

The second part of this research is to test the viability of EGR-CS project in Depleted Gas reservoirs in Niger- Delta. The efficiency of displacing Natural Gas (Gas-in-Place) by CO<sub>2</sub> (Injected Gas) during Enhanced Gas Recovery (EGR) operation is affected by the operating conditions i.e (reservoir pressure, temperature and injection rate), the fluids properties i.e (reservoir petrophysical property, connate water saturation, pore geometry and fractures) (Hamza et al., 2021).

Howbeit, the displacement efficiency here was tested based on the influence of density and viscosity at the stated reservoir conditions. Samples from four depleted gas reservoirs (Table 2) from Niger-Delta region were evaluated to examine the applicability EGR with regards to displacement efficiency using the predicted CO<sub>2</sub> density and viscosity as yardsticks.

Table 2: Data for four Depleted Gas Reservoirs (DGR) in Niger-Delta

Parameter	Res.1	Res.2	Res.3	Res.4
Sampling Depth (ft)	8501	9755	5525	11237
Pressure (Psi)	3561	2291	2412	4906
Temperature (°C)	88.00	79.44	54.44	88.33
Swc	N/A	N/A	N/A	N/A
Sgr	0.135	0.153	0.141	0.092
Elements	Composition			
C1	79.48	82.72	82.05	72.53
C2	7.62	7.25	7.42	8.58
C3	7.06	4.47	4.55	5.42
n-C <sub>4</sub>	3.39	1.34	1.4	3.39
n-C <sub>5</sub>	0.7	0.38	0.43	0.7
C <sub>6</sub>	0.21	0.42	0.47	0.21
C <sub>7+</sub>	0.2	0.66	0.73	0.2
N <sub>2</sub>	0.17	0.78	0.9	0.17
CO <sub>2</sub>	1.17	0.5	0.45	1.17

### 3.0 RESULTS AND DISCUSSION

#### 3.1 CO<sub>2</sub> Density Correlation for Niger-Delta Formation (NDF) at varying depths

$$CO_2(\rho) = 0.104 + 5.300 \times 10^{-5}P + 8.400 \times 10^{-3}T \dots \dots \dots (14)$$

Validity Depth (1000-1500m)

$$CO_2(\rho) = 11.2631 + 6.630 \times 10^{-3}P - 4.916 \times 10^{-1}T \dots \dots \dots (15)$$

Validity Depth (1600-5000m)

$$CO_2(\rho) = 500.53 \times 10^{-3} - 1.64 \times 10^{-8}P^2 + 7.431 \times 10^{-3}T^2 + 7.644 \times 10^{-8}P * T.. (16)$$

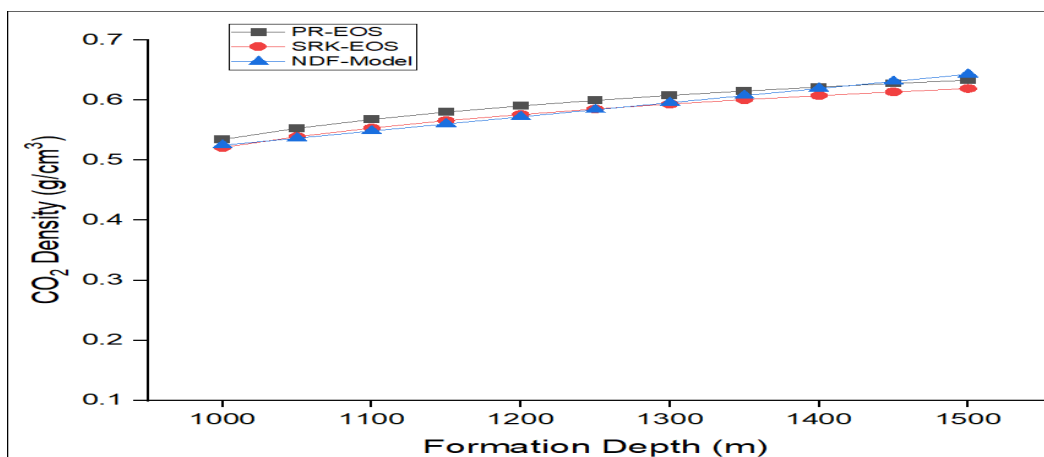
Validity Depth (>5000m)

Where:

T= Temperature (°C); P= Pressure (Psi),

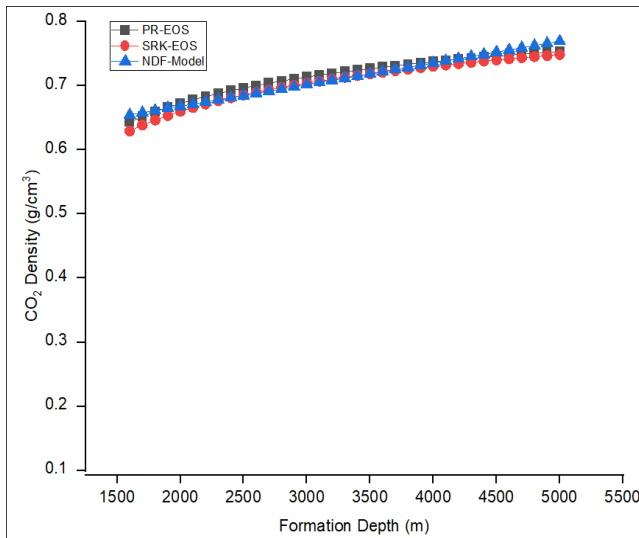
ρ= Density (g/cm<sup>3</sup>); μ=Viscosity (cP).

#### Graphical Comparison between the new Model (NDF), PR-EOS and SRK-EOS

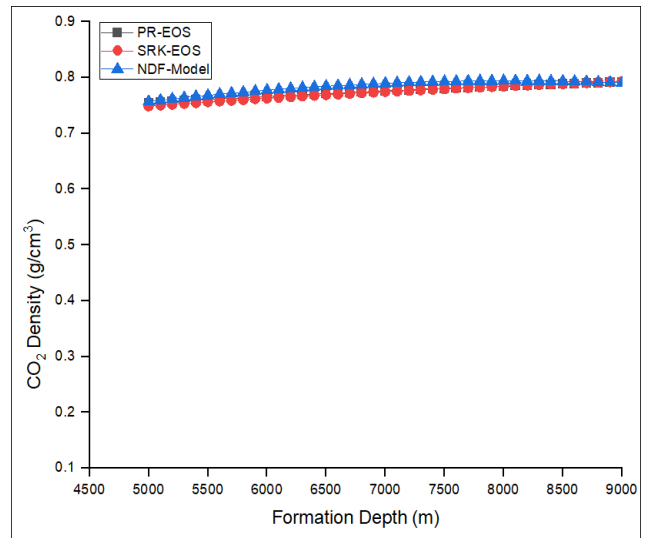




**Figure 2: Density Model comparison with PR-EOS & SRK-EOS at depth of 1000-1500m**



**Figure 3: Density Model comparison with PR-EOS & SRK-EOS at depth of**



**Figure 4: Density Model comparison with PR-EOS & SRK-EOS at depth**

**3.2 CO<sub>2</sub> Viscosity Correlation for Niger-Delta Formation (NDF) at varying depths**

$$CO_2(\mu) = 5.960 \times 10^{-2} + 1.971 \times 10^{-5}P - 6.806 \times 10^{-4}T \dots \dots \dots (17)$$

Validity Depth (1000-1500m)

$$CO_2(\mu) = 3.350 \times 10^{-3}T - 8.568 \times 10^{-3} - 4.285 \times 10^{-5}P \dots \dots \dots (18)$$

Validity Depth (1600-5000m)

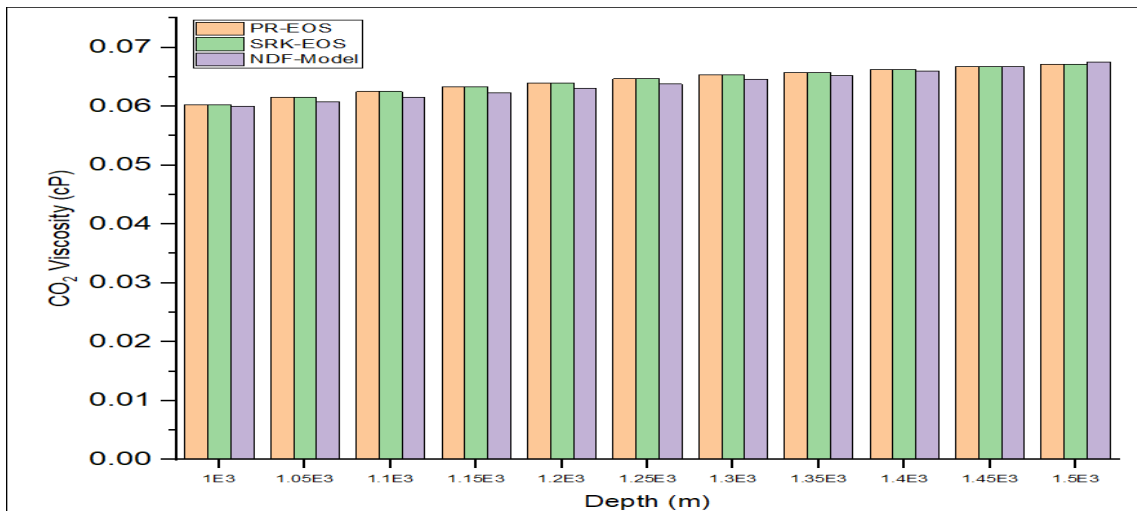
$$CO_2(\mu) = 56.290 \times 10^{-3} - 1.373 \times 10^{-9}P^2 + 6.262 \times 10^{-6}T^2 + 7.073 \times 10^{-9} P * T \dots (19)$$

Validity Depth (>5000m)

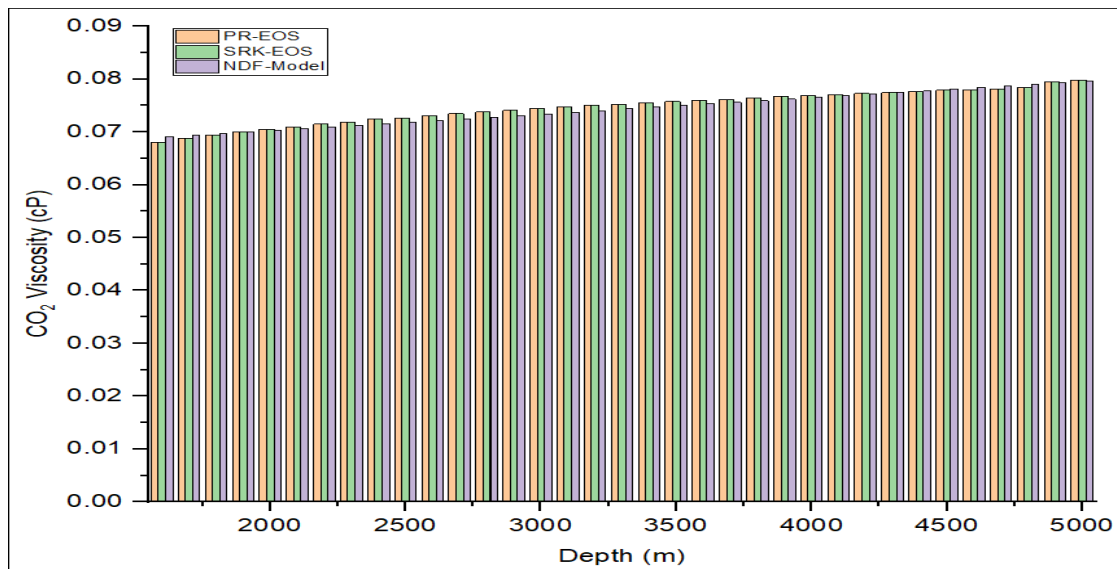
Where: T= Temperature (°C), P= Pressure (Psi),

$\rho$ = Density (g/cm<sup>3</sup>),  $\mu$ =Viscosity (cP).

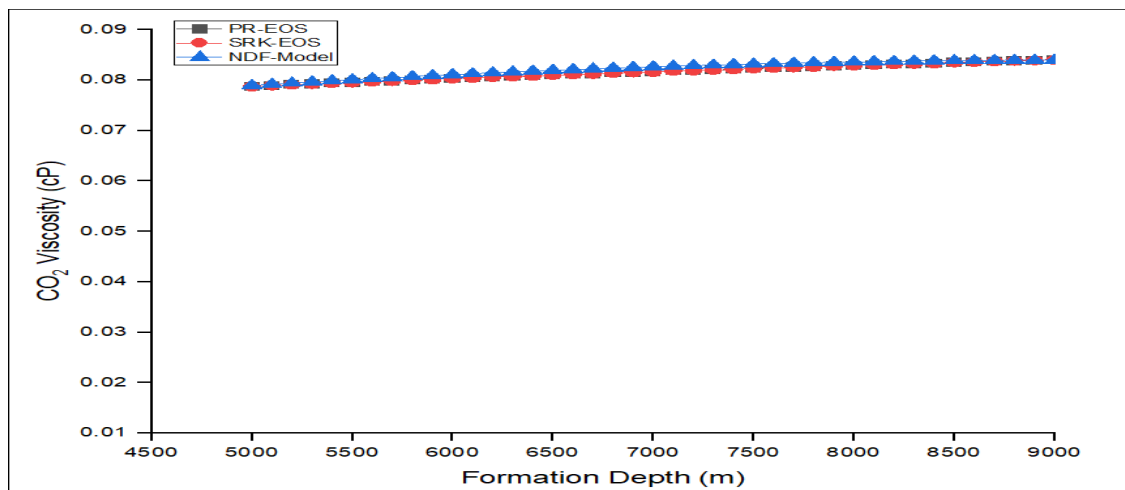
**Graphical Comparison between the new Model (NDF), PR-EOS and SRK-EOS**



*Figure 5: Viscosity Model comparison with PR-EOS & SRK-EOS at depth of 1000-1500m*



*Figure 6: Viscosity Model comparison with PR-EOS & SRK-EOS at depth of 1600-5000m*



*Figure 7: Viscosity Model comparison with PR-EOS & SRK-EOS at depth >5000m*

### Determination of Absolute Average Deviation (AAD)

The Percentage AAD as evaluated for the newly developed “NDF-Model” vis-à-vis “PR-EOS” and “SRK-EOS” are shown in tables (3, 4 & 5)

Table 3: Category 1: Reservoir depths between (1000 -1500m)

Depth (m)	CO <sub>2</sub> Density, $\rho$ (g/cm <sup>3</sup> )			AAD (%) for $\rho$		CO <sub>2</sub> Viscosity, $\mu$ (cP)			AAD (%) for $\mu$	
	PR-EOS	SRK-EOS	NDF Model	PR-EOS	SRK-EOS	PR-EOS	SRK-EOS	NDF Model	PR-EOS	APD SRK
1000	0.5347	0.5213	0.5249	<b>-1.86</b>	<b>0.69</b>	0.0603	0.0603	0.0600	<b>-0.45</b>	<b>-0.45</b>
1050	0.5531	0.5392	0.5367	<b>-3.05</b>	<b>-0.46</b>	0.0615	0.0615	0.0608	<b>-1.18</b>	<b>-1.18</b>
1100	0.5679	0.5537	0.5486	<b>-3.53</b>	<b>-0.94</b>	0.0625	0.0625	0.0615	<b>-1.57</b>	<b>-1.57</b>
1150	0.5801	0.5658	0.5604	<b>-3.52</b>	<b>-0.97</b>	0.0633	0.0633	0.0623	<b>-1.63</b>	<b>-1.63</b>
1200	0.5905	0.5761	0.5722	<b>-3.20</b>	<b>-0.68</b>	0.0640	0.0640	0.0630	<b>-1.52</b>	<b>-1.52</b>
1250	0.5997	0.5853	0.5840	<b>-2.69</b>	<b>-0.22</b>	0.0647	0.0647	0.0638	<b>-1.43</b>	<b>-1.43</b>
1300	0.6079	0.5935	0.5958	<b>-2.03</b>	<b>0.39</b>	0.0653	0.0653	0.0645	<b>-1.17</b>	<b>-1.17</b>
1350	0.6152	0.6009	0.6076	<b>-1.25</b>	<b>1.11</b>	0.0658	0.0658	0.0653	<b>-0.77</b>	<b>-0.77</b>
1400	0.6218	0.6076	0.6194	<b>-0.38</b>	<b>1.91</b>	0.0663	0.0663	0.0660	<b>-0.38</b>	<b>-0.38</b>
1450	0.6278	0.6137	0.6312	<b>0.54</b>	<b>2.78</b>	0.0668	0.0668	0.0668	<b>0.00</b>	<b>0.00</b>
1500	0.6333	0.6193	0.6431	<b>1.52</b>	<b>3.69</b>	0.0672	0.0672	0.0676	<b>0.52</b>	<b>0.52</b>

Table 4: Category 2: Reservoir depths between (1600-5000m)

Depth (m)	CO <sub>2</sub> Density, $\rho$ (g/cm <sup>3</sup> )			AAD (%) for $\rho$		CO <sub>2</sub> Viscosity, $\mu$ (cP)			AAD (%) for $\mu$	
	PR-EOS	SRK-EOS	NDF Model	PR-EOS	SRK-EOS	PR-EOS	SRK-EOS	NDF Model	PR-EOS	APD SRK
1600	0.6433	0.6295	0.6545	<b>1.72</b>	<b>3.82</b>	0.0680	0.0680	0.0691	<b>1.60</b>	<b>1.60</b>
1800	0.6595	0.6464	0.6613	<b>0.27</b>	<b>2.25</b>	0.0694	0.0694	0.0697	<b>0.47</b>	<b>0.47</b>
2000	0.6725	0.6600	0.6680	<b>-0.67</b>	<b>1.20</b>	0.0705	0.0705	0.0703	<b>-0.21</b>	<b>-0.21</b>
2200	0.6833	0.6714	0.6748	<b>-1.26</b>	<b>0.51</b>	0.0715	0.0715	0.0710	<b>-0.75</b>	<b>-0.75</b>
2400	0.6925	0.6812	0.6816	<b>-1.60</b>	<b>0.05</b>	0.0724	0.0724	0.0716	<b>-1.13</b>	<b>-1.13</b>
2600	0.7004	0.6897	0.6883	<b>-1.75</b>	<b>-0.20</b>	0.0731	0.0731	0.0722	<b>-1.23</b>	<b>-1.23</b>
2800	0.7074	0.6973	0.6951	<b>-1.77</b>	<b>-0.32</b>	0.0738	0.0738	0.0728	<b>-1.33</b>	<b>-1.33</b>
3000	0.7137	0.7041	0.7019	<b>-1.69</b>	<b>-0.32</b>	0.0744	0.0744	0.0735	<b>-1.29</b>	<b>-1.29</b>
3200	0.7193	0.7102	0.7086	<b>-1.51</b>	<b>-0.22</b>	0.0750	0.0750	0.0741	<b>-1.25</b>	<b>-1.25</b>
3400	0.7244	0.7159	0.7154	<b>-1.26</b>	<b>-0.07</b>	0.0755	0.0755	0.0747	<b>-1.07</b>	<b>-1.07</b>
3600	0.7291	0.7210	0.7221	<b>-0.96</b>	<b>0.16</b>	0.0760	0.0760	0.0753	<b>-0.90</b>	<b>-0.90</b>
3800	0.7334	0.7258	0.7289	<b>-0.62</b>	<b>0.43</b>	0.0765	0.0765	0.0759	<b>-0.74</b>	<b>-0.74</b>
4000	0.7374	0.7302	0.7357	<b>-0.24</b>	<b>0.74</b>	0.0769	0.0769	0.0766	<b>-0.44</b>	<b>-0.44</b>
4200	0.7411	0.7344	0.7424	<b>0.18</b>	<b>1.08</b>	0.0773	0.0773	0.0772	<b>-0.15</b>	<b>-0.15</b>
4400	0.7445	0.7383	0.7492	<b>0.63</b>	<b>1.45</b>	0.0777	0.0777	0.0778	<b>0.13</b>	<b>0.13</b>
4600	0.7477	0.7419	0.7559	<b>1.09</b>	<b>1.86</b>	0.0780	0.0780	0.0784	<b>0.54</b>	<b>0.54</b>
4800	0.7508	0.7454	0.7627	<b>1.56</b>	<b>2.27</b>	0.0784	0.0784	0.0790	<b>0.82</b>	<b>0.82</b>
5000	0.7537	0.7487	0.7695	<b>2.05</b>	<b>2.70</b>	0.0787	0.0787	0.0797	<b>1.21</b>	<b>1.21</b>

Table 5: Category 3: Reservoir depths between (&gt;5000m)

Depth (m)	CO <sub>2</sub> Density, $\rho$ (g/cm <sup>3</sup> )			AAD (%) for $\rho$		CO <sub>2</sub> Viscosity, $\mu$ (cP)			AAD (%) for $\mu$	
	PR- EOS	SRK- EOS	NDF Model	PR- EOS	SRK- EOS	PR- EOS	SRK- EOS	NDF Model	PR- EOS	APD SRK
5000	0.7537	0.7487	0.7568	<b>0.41</b>	<b>1.07</b>	0.0787	0.0787	0.0789	<b>0.29</b>	<b>0.29</b>
5100	0.7551	0.7503	0.7592	<b>0.54</b>	<b>1.18</b>	0.0789	0.0789	0.0792	<b>0.35</b>	<b>0.35</b>
5200	0.7564	0.7518	0.7615	<b>0.67</b>	<b>1.28</b>	0.0791	0.0791	0.0794	<b>0.39</b>	<b>0.39</b>
5300	0.7577	0.7533	0.7638	<b>0.79</b>	<b>1.37</b>	0.0792	0.0792	0.0796	<b>0.55</b>	<b>0.55</b>
5400	0.7590	0.7547	0.7659	<b>0.90</b>	<b>1.46</b>	0.0794	0.0794	0.0799	<b>0.58</b>	<b>0.58</b>
5500	0.7602	0.7562	0.7680	<b>1.01</b>	<b>1.54</b>	0.0795	0.0795	0.0801	<b>0.72</b>	<b>0.72</b>
5600	0.7615	0.7576	0.7700	<b>1.10</b>	<b>1.61</b>	0.0797	0.0797	0.0803	<b>0.74</b>	<b>0.74</b>
5700	0.7626	0.7589	0.7719	<b>1.20</b>	<b>1.68</b>	0.0798	0.0798	0.0805	<b>0.87</b>	<b>0.87</b>
5800	0.7638	0.7603	0.7737	<b>1.28</b>	<b>1.74</b>	0.0800	0.0800	0.0807	<b>0.86</b>	<b>0.86</b>
5900	0.7649	0.7616	0.7755	<b>1.36</b>	<b>1.79</b>	0.0801	0.0801	0.0809	<b>0.98</b>	<b>0.98</b>
6000	0.7661	0.7629	0.7772	<b>1.42</b>	<b>1.83</b>	0.0803	0.0803	0.0811	<b>0.96</b>	<b>0.96</b>
6100	0.7672	0.7642	0.7788	<b>1.48</b>	<b>1.87</b>	0.0804	0.0804	0.0813	<b>1.06</b>	<b>1.06</b>
6200	0.7682	0.7654	0.7803	<b>1.55</b>	<b>1.91</b>	0.0806	0.0806	0.0814	<b>1.03</b>	<b>1.03</b>
6300	0.7693	0.7666	0.7817	<b>1.59</b>	<b>1.93</b>	0.0807	0.0807	0.0816	<b>1.11</b>	<b>1.11</b>
6400	0.7703	0.7678	0.7831	<b>1.63</b>	<b>1.95</b>	0.0808	0.0808	0.0818	<b>1.19</b>	<b>1.19</b>
6500	0.7713	0.7690	0.7843	<b>1.66</b>	<b>1.96</b>	0.0810	0.0810	0.0819	<b>1.14</b>	<b>1.14</b>
6600	0.7723	0.7701	0.7855	<b>1.69</b>	<b>1.97</b>	0.0811	0.0811	0.0821	<b>1.20</b>	<b>1.20</b>
6700	0.7732	0.7712	0.7867	<b>1.71</b>	<b>1.97</b>	0.0812	0.0812	0.0822	<b>1.25</b>	<b>1.25</b>
6800	0.7742	0.7723	0.7877	<b>1.71</b>	<b>1.96</b>	0.0814	0.0814	0.0824	<b>1.18</b>	<b>1.18</b>
6900	0.7751	0.7734	0.7887	<b>1.72</b>	<b>1.94</b>	0.0815	0.0815	0.0825	<b>1.22</b>	<b>1.22</b>
7000	0.7760	0.7745	0.7895	<b>1.72</b>	<b>1.91</b>	0.0816	0.0816	0.0826	<b>1.25</b>	<b>1.25</b>
7100	0.7769	0.7755	0.7903	<b>1.70</b>	<b>1.88</b>	0.0818	0.0818	0.0828	<b>1.16</b>	<b>1.16</b>
7200	0.7778	0.7766	0.7911	<b>1.68</b>	<b>1.83</b>	0.0819	0.0819	0.0829	<b>1.18</b>	<b>1.18</b>
7300	0.7787	0.7776	0.7917	<b>1.64</b>	<b>1.78</b>	0.0820	0.0820	0.0830	<b>1.19</b>	<b>1.19</b>
7400	0.7795	0.7786	0.7923	<b>1.61</b>	<b>1.73</b>	0.0821	0.0821	0.0831	<b>1.19</b>	<b>1.19</b>
7500	0.7804	0.7796	0.7928	<b>1.56</b>	<b>1.66</b>	0.0823	0.0823	0.0832	<b>1.07</b>	<b>1.07</b>
7600	0.7812	0.7806	0.7932	<b>1.51</b>	<b>1.58</b>	0.0824	0.0824	0.0833	<b>1.06</b>	<b>1.06</b>
7700	0.7820	0.7815	0.7935	<b>1.45</b>	<b>1.51</b>	0.0825	0.0825	0.0834	<b>1.04</b>	<b>1.04</b>
7800	0.7828	0.7825	0.7937	<b>1.38</b>	<b>1.42</b>	0.0826	0.0826	0.0835	<b>1.02</b>	<b>1.02</b>
7900	0.7836	0.7834	0.7939	<b>1.30</b>	<b>1.32</b>	0.0828	0.0828	0.0835	<b>0.87</b>	<b>0.87</b>
8000	0.7844	0.7843	0.7940	<b>1.21</b>	<b>1.22</b>	0.0829	0.0829	0.0836	<b>0.83</b>	<b>0.83</b>
8100	0.7851	0.7852	0.7940	<b>1.12</b>	<b>1.11</b>	0.0830	0.0830	0.0837	<b>0.79</b>	<b>0.79</b>
8200	0.7859	0.7861	0.7939	<b>1.01</b>	<b>0.99</b>	0.0831	0.0831	0.0837	<b>0.74</b>	<b>0.74</b>
8300	0.7866	0.7870	0.7938	<b>0.90</b>	<b>0.85</b>	0.0832	0.0832	0.0838	<b>0.68</b>	<b>0.68</b>
8400	0.7873	0.7879	0.7936	<b>0.79</b>	<b>0.71</b>	0.0833	0.0833	0.0838	<b>0.61</b>	<b>0.61</b>
8500	0.7881	0.7887	0.7932	<b>0.65</b>	<b>0.57</b>	0.0835	0.0835	0.0839	<b>0.42</b>	<b>0.42</b>

Table 6: Relative density and viscosity comparison of CO<sub>2</sub> and Natural Gas at varying reservoirs

Reservoir I.D & Depth	Reservoir condition		CO <sub>2</sub> Property		N. G Property		Relative Difference		
	Depth (ft)	Tempt. (°C)	Pres. (Psi)	Density (g/cm <sup>3</sup> )	Viscosity (cP)	Density (g/cm <sup>3</sup> )	Viscosity (cP)	RDD (%)	RVD (%)
Res.1	8501	88.00	3561	0.6689	0.0784	0.1989	0.0250	70.26	68.11
Res.2	9755	79.44	2291	0.6471	0.0798	0.1280	0.0185	80.22	76.82
Res.3	5525	54.44	2412	0.6605	0.0698	0.1569	0.0200	76.25	71.35
Res.4	11237	88.33	4906	0.6959	0.0737	0.2416	0.0302	65.28	59.02

$$CO_2(\rho) > N.G(\rho) \text{ \& } CO_2\mu > N.G(\mu)$$

Where:

RDD = Relative Density difference (RDD); RVD= Relative Viscosity difference N.G = Natural Gas

### 3.4 NDF Model Development Discussion

In this work, the adopted correlation for pressure and temperature gradients of Niger-Delta formation (NDF) was validated using reported gradients in literature by Absolute Average Deviation (AAD) method as shown in table (1).

Stepwise reservoir depth was used to compute the pressures and temperatures of NDF using the adopted Niger-Delta formation gradients equations (3 & 4) respectively. The generated densities and viscosities at those reservoir depths as evaluated by PVTsim software were used to develop three Novel Models (NM) using Regression Split Approach (RSA). This was after the data were rigorously trained and tested at those conditions to meet criteria (1) and (2) of this report. The developed models were transversed from Linear - Second degree - Interactive (LSI) terms of (P;T),(P<sup>2</sup>;T<sup>2</sup>) and (P\*T) respectively. This was necessitated due to the non-linearity relationships between density, viscosity (dependent variables) and pressure, temperature (independent variables) at some depths in the formation.

The in-situ density ( $\rho$ ) and viscosity ( $\mu$ ) relationship with the independent variables appears to have presents of interactions and curvilinear relationships, hence the need for two algorithms (Linear- quadratic split models) at varying depths. For significant improvement in the fit, three types of models were generated independently at different reservoir depths that formed correlations.

#### 3.4.1 NDF Model Validation

Peng Robinson (PR-EOS) and Soave-Redlich-Kwong (SRK-EOS) are the most successful equation of states which have been modified repeatedly to improve their accuracy in different ranges of pressure and temperatures, alongside their extrapolative ability to condition reservoir parameters outside their correlation ranges. These PVT models (PR-SRK-EOS) have attracted a lot of attentions for predicting the properties of pure and mixed components both in subcritical and supercritical states, hence considered for validating the newly developed NDF Mathematical Models.

Sensitivity analysis was used to examine the responses of the newly developed correlation (NDF-Model) vis-à-vis that of Peng Robinson (PR-EOS) and Soave-Redlich-Kwong (SRK-EOS) under defined boundaries. The predicted results from the models were

assessed and validated by comparing percentage Absolute Average Deviation (AAD%) between NDF model and PR-SRK-EOS using the relationship below:

$$AAD (\%) = \frac{|X_i^{NDF} - X_i^{EOS}|}{X_i^{NDF}} * 100 \dots \dots \dots (20)$$

Where;

X = Evaluated CO<sub>2</sub> property (Density and Viscosity)

EOS= Equation of state (PR-EOS and SRK-EOS);

n = Number of data.

### 3.5 Application of EGR-CCS in Niger-Delta Formation

Table (6) revealed that CO<sub>2</sub> at those simulated depths possess higher density and viscosity than in-situ natural gas at same reservoir conditions. The calculated Relative Density difference (RDD) of "CO<sub>2</sub> on Natural Gas" ranges from 65.28 - 80.22% and Relative Viscosity difference (RVD) ranges from 59.02 - 76.82% for the four gas reservoirs under study.

Therefore, under optimum injection rate, using CO<sub>2</sub> as the displacement fluid would encourage infinitesimal gas mixing and stable displacement due to expected low mobility ratio between the displacing and the displaced fluid. The results are in agreement with (Al-Hashami, 2005; Clemens & Wit, 2002; Hamza et al., 2021; Hoteit et al., 2019; Oldenburg & Benson, 2002)

### 4.0 CONCLUSION

Niger-Delta formation screening and ranking for CO<sub>2</sub> sequestration are rated "Very Good" and "Excellent" in all assessed scenarios for carbon sequestration as reported by researchers like (Davies et al., 2020; Umar et al., 2020). However, field deployment of EGR-CS project in Niger-Delta is dependent on reliable experimental assessment or reservoir simulation.

Over the last decade, geological sequestrations of CO<sub>2</sub> have been an area of active research to mitigate greenhouse gas emission in our environment. Understanding phase behaviors of CO<sub>2</sub> at varying subsurface associated PVT conditions are essential for knowing the flow dynamics as a displacing fluid for enhanced recovery and sequestration. On that basis, comprehensive reservoir characterization data of formations to be injected are required for numerical simulations and laboratory investigation. Density and viscosity are the two critical parameters for pure CO<sub>2</sub> in supercritical conditions needed for EGR-CS projects in depleted gas reservoirs.

In this work, three categories of mathematical models within reservoir depths of 1000-1500m, 1600-5000m and beyond 5000m were developed for CO<sub>2</sub> density ( $\rho_{CO_2}$ ) and viscosity ( $\mu_{CO_2}$ ) necessary for EGR-CS projects in Niger-Delta formation. CO<sub>2</sub> densities at those depths ranges from 0.5-0.6 g/cm<sup>3</sup>, 0.6-0.7g/cm<sup>3</sup> and 0.7-0.8g/cm<sup>3</sup> respectively while the viscosities ranges from 0.05-0.06cP, 0.06-0.07cP and 0.07-0.08cP respectively.

The new correlation was validated using Peng Robinson and Soave-Redlich-Kwong Equation of States Model (EOS-M) by Absolute Average Deviation (AAD) method as shown in tables 3, 4 & 5 of this work. The model was consequently applied to four depleted gas reservoirs (Res.1, Res.2, Res.3 and Res.4) in Niger-Delta for recovery potential. It revealed promising relative density and viscosity differences as shown in table 6. These indicates

smooth displacement potentials and promising less dispersion coefficient of CO<sub>2</sub> on the displaced natural gas under optimum injection rate.

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# Trigger Sound Signal Processing for Activating Automated Engineering Systems

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## ABSTRACT

An engineering system can be programmed to initiate operations automatically upon detecting a trigger sound signal, paving the way for more advanced and efficient robotic system control. This study introduces a straightforward example of such a solution, employing a simple signal processing method to activate a robotic system using a specific sound wave. A microphone, connected to a Raspberry Pi via wireless communication, was used for sound detection. The Raspberry Pi transformed the detected 5 kHz sound wave into a digital format. A Python script on the device converted the 4-bit digital signal into a 16-bit signal and saved the recorded audio to a designated file. Noise was then filtered out, and the Fast Fourier Transform (FFT) of the sound signal was calculated. If the maximum signal power occurred at 5 kHz, the activation signal was sent to the system's startup module; otherwise, the system remained inactive. This model was tested successfully using 5 and 10 kHz sound waves under both high and low signal-to-noise ratio (SNR) conditions. Only the 5 kHz signals, regardless of SNR, activated the robot successfully, demonstrating the robustness of the proposed solution.

**Keywords:** Electronics engineering, signal processing, robotics

## INTRODUCTION

Automated engineering systems often rely on precise input signals to trigger their operations, enhancing their utility in fields ranging from robotics to home automation<sup>[Coombs, 2020: 101600]</sup>. Sound-based activation is a promising approach due to its simplicity and the ubiquity of devices capable of generating sound signals<sup>[Zhang, 2020: 1-26]</sup>. However, challenges arise in accurately detecting and processing these signals amidst background noise, and recently incorporate deep-learning techniques as solution<sup>[Ahmed, 2023: 13521-13617]</sup>.

This study explores a sound-triggered activation system using a Raspberry Pi to process sound signals and activate a robotic system. The system utilizes a 5 kHz sound wave as the trigger signal, utilizing Fast Fourier Transform (FFT) for accurate frequency identification in noisy environments. Previous works have demonstrated the feasibility of sound-based control <sup>[Fonseca, 2020; Bakouri, 2023: 4033]</sup>, so this study aims to show a simplified in-house implementation of using a processed trigger sound to activate a robotic system. By

examining the system's performance under varying signal-to-noise ratios, we evaluate its robustness and practical applicability.

## METHODS

**System Overview.** The activation system consists of a microphone, a Raspberry Pi, and a Python-based signal processing script. A 5 kHz sine wave generated by a smartphone serves as the trigger signal. The microphone—integrated into a webcam (as shown in the Figure 1)—transfers the sound signal to the Raspberry Pi for processing.

**Signal Processing.** The signal processing workflow is outlined as follows. First, the signal acquisition was performed by the webcam microphone capturing the incoming sound and transmitting it to the Raspberry Pi. Then, analogue-to-digital conversion was done via converting the incoming sound signal from a 4-bit signal into a 16-bit digital format. The protocol then filtered out the noise using predefined thresholds, after which the signal FFT was calculated to identify the dominant frequency. Finally, the robotic system was activated if the dominant frequency was 5 kHz; in other words, only when the dominant frequency was registered to be 5 kHz, the signal was sent to the robotic system's start-up module to initiate movement. Otherwise, the system remained idle.

**Testing Protocols.** The system was tested using three input sound signals: pure 5 kHz signal under high and low SNR conditions, pure 10 kHz signal under high and low SNR conditions, and noise-only signals. FFT plots were generated for each test to verify frequency identification accuracy. The robotic system's response was recorded to assess activation reliability.



**Figure 1:** Camera with built-in microphone and its shortened base

## RESULTS

### Signal Processing Accuracy

FFT plots demonstrated that the system accurately identified the 5 kHz frequency under all tested conditions. First, for the noise-only input, as demonstrated in Figure 2, the FFT revealed no significant peaks at 5 kHz, as expected, and the robot remained inactive. Second, for the 10 kHz input in Fig.3, despite a strong peak at 10 kHz, the absence of a 5 kHz signal prevented activation. Thirdly, for the noisy 10 kHz input, the system filtered the noise effectively but still correctly identified the dominant frequency as 10 kHz, resulting in no

activation, as shown in Fig.4. Then, for a pure 5 kHz input in Fig.5, the FFT displayed a sharp peak at 5 kHz, triggering the robotic system reliably. Finally, for the case of a noisy 5 kHz input signal in Fig.6, even with significant noise, the system accurately isolated the 5 kHz peak and activated the robot.

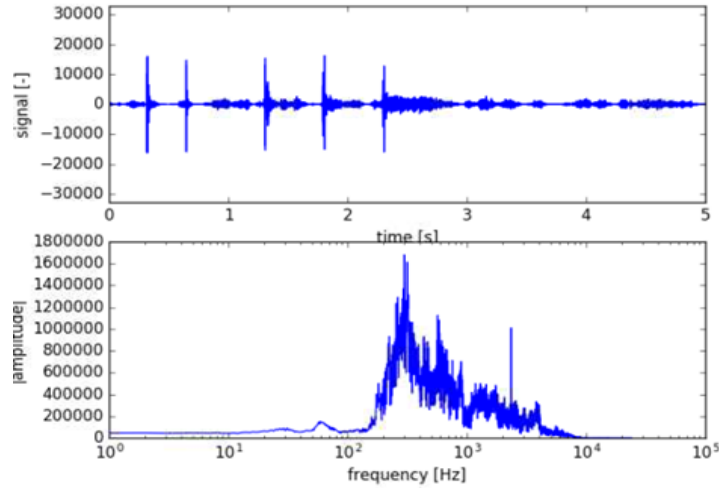


Figure 2: The signal caught by the microphone and its FFT: just noise

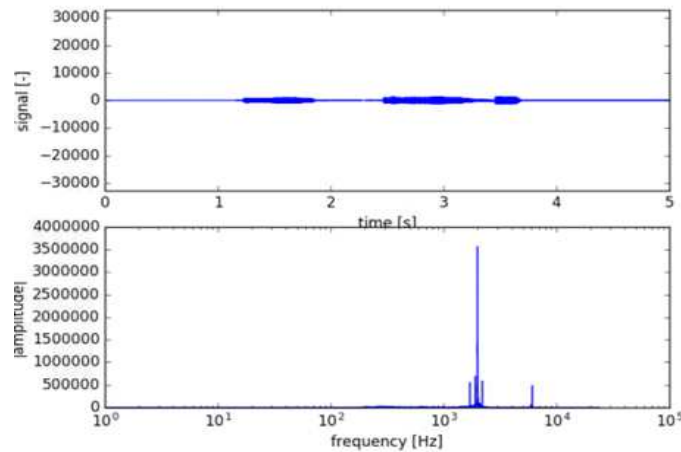
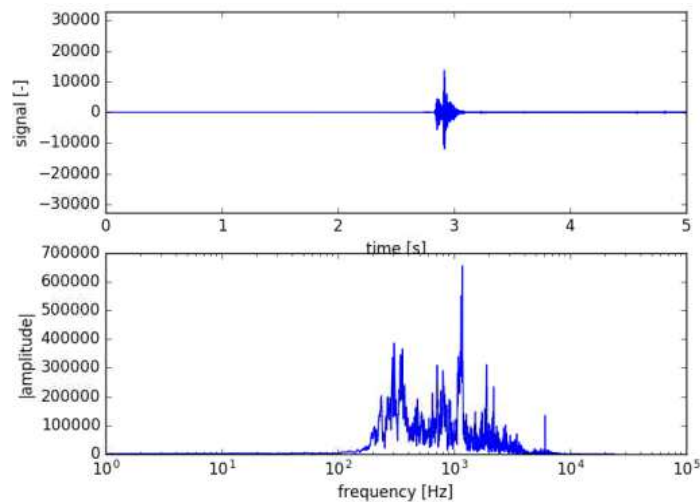
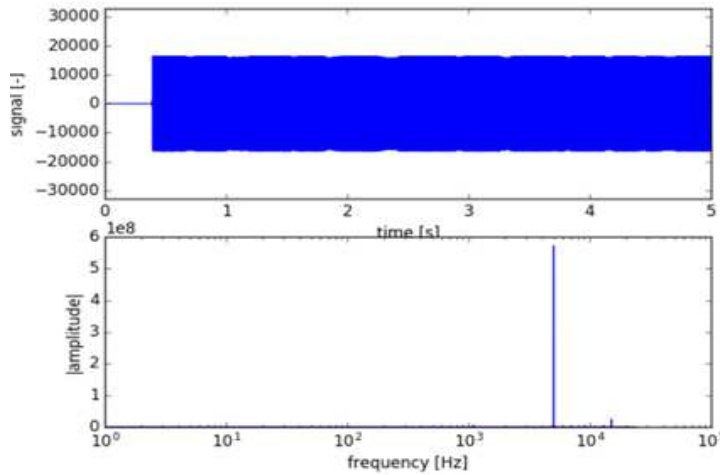


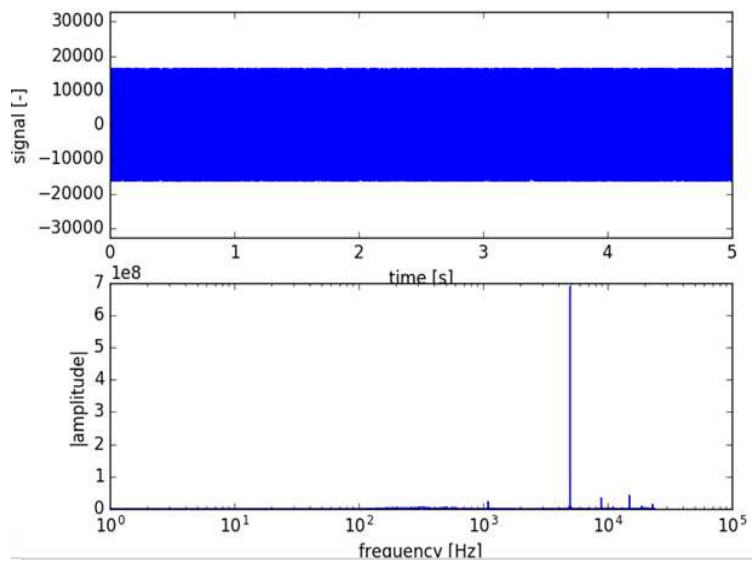
Figure 3: The signal caught by the microphone and its FFT: 10 kHz signal with low signal-to-noise ratio



**Figure 4:** The signal caught by the microphone and its FFT: 10 kHz signal with high signal-to-noise ratio



**Figure 5:** The signal caught by the microphone and its FFT: 5 kHz signal with low signal-to-noise ratio

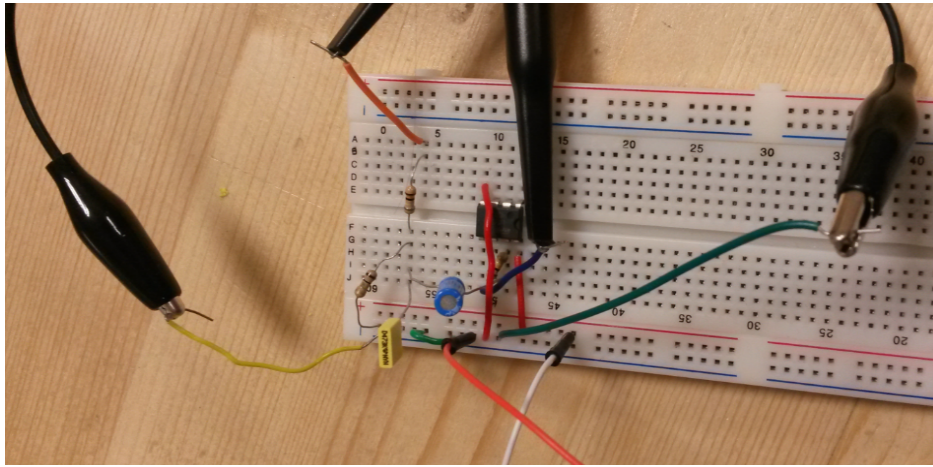


**Figure 6:** The signal caught by the microphone and its FFT: Noisy 5 kHz signal

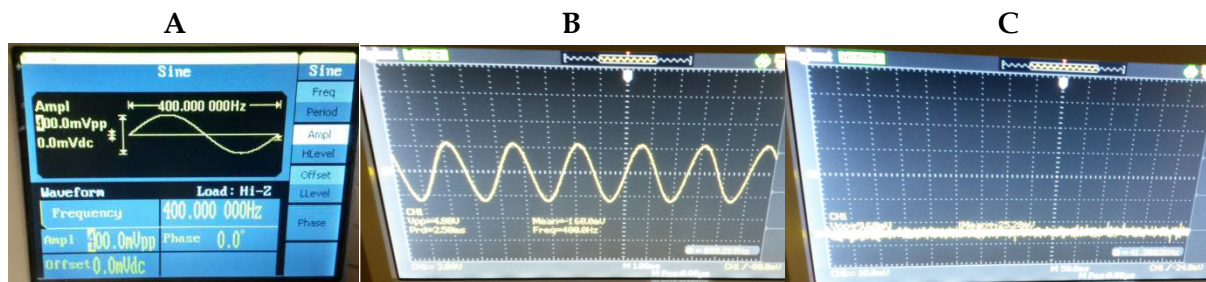
**Comparative Analysis of Microphone Designs**

Initial tests using a custom-built microphone circuit demonstrated significant limitations, including signal clipping and noise susceptibility (Figures 7 and 8). The circuit design (Fig.7) when the microphone was incorporated into the circuit with the output signal presented in Fig.8.C is composed mostly of noise. Even though the signal at the output of the filtering circuit is a perfect sinusoid (Fig.8.B), the microphone output is mainly noise, signifying potentially a faulty microphone, or a failed circuit combination with the microphone. Therefore, a different implementation of the microphone circuit was tested, and the issues presented here were addressed by transitioning to a webcam microphone directly

interfaced with the Raspberry Pi, which improved signal clarity and processing reliability, as described in the previous section.



**Figure 7:** Testing circuit prototype with signal generator and oscilloscope probes



**Figure 8:** Output signals. **A:** Signal generator's output sine wave as an input test signal. **B:** Output microphone circuit signal for 9V positive feed to operational amplifier, and negative feed of -9V, with 10k $\Omega$  potentiometer used and fine-tuned to produce perfect sinusoid with the circuit parameters changed to give smaller gain and produce output in the range of -2.5 V to 2.5 V. **C:** Output microphone signal – mainly noise.

### System Activation Performance

Under all test scenarios involving a 5 kHz signal with the microphone, the robotic system responded consistently. This performance highlights the robustness of the FFT-based processing and the effectiveness of noise filtering techniques employed.

### DISCUSSION

The findings demonstrate the feasibility of a sound-based activation system using simple hardware and signal processing techniques. The robustness of FFT-based frequency detection ensures reliable operation even in noisy environments. This approach has broad implications for robotics, home automation, and industrial systems where low-cost, efficient activation mechanisms are desirable.

However, certain limitations should be addressed in future work. The system's reliance on a single frequency makes it vulnerable to unintentional activation if similar frequencies are present in the environment. Enhancing the signal processing algorithm to

include additional checks, such as pattern recognition or multi-frequency validation, could improve reliability.

The simplicity of the proposed system makes it accessible for various applications, but scalability remains a concern. Integrating multiple microphones for spatial sound detection and expanding the frequency range for activation signals could enhance its applicability.

## CONCLUSION

This study presents a robust and cost-effective method for activating automated systems using sound signals. By using a Raspberry Pi and FFT-based processing, the system achieves high reliability in identifying and responding to a 5 kHz trigger signal. Future improvements could focus on scalability and enhanced signal verification to broaden its application scope.

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# Parametric Impedance Matching in Coplanar Wavelength Transmission Lines for Radiofrequency Sensors

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## ABSTRACT

Radio-frequency (RF) sensors are increasingly utilized in object detection technologies and hold promise for identifying microorganisms in various media of interest. These media can be represented as additive harmonic oscillators whose interactions with electromagnetic (EM) fields are analysed using computational techniques such as finite element methods, exemplified by the High Frequency Simulation Software (HFSS). Impedance matching is a crucial design aspect for RF engineers, as it ensures optimal performance of RF sensors. This study introduces a parametric analysis tool for evaluating impedance in RF designs, exemplified through coplanar wavelength transmission lines (CPWTLs). The HFSS parametric port impedance analysis was applied to several CPWTL configurations, including air-gold-glass, distilled water-gold-glass, and silicon-gold-glass interfaces. Additionally, the effect of varying the air gap length on the impedance behaviour was explored. The findings highlight the comparative performance of different designs, showcasing the method's efficiency in simulating and optimizing CPWTLs and its broader applicability in potentially designing advanced RF sensors.

**Keywords:** Radiofrequency engineering, electromagnetics, high frequency simulation

## INTRODUCTION

The rapid growth of RF sensor applications in fields such as communication, biomedical diagnostics, and environmental monitoring necessitates precise design and optimization techniques Bhatia, 2024: 100257. Impedance matching plays a pivotal role in these designs, as it ensures maximum power transfer and minimizes signal reflections in transmission lines Shete, 2013, 4706-4715. Coplanar wavelength transmission lines (CPWTLs) have emerged as a preferred configuration due to their compatibility with planar fabrication processes and their capacity to integrate with microfluidic systems and sensor arrays Balanis, 2024, 30-49. This study aims to explore parametric impedance matching for CPWTLs by using HFSS, a high-frequency electromagnetic field simulation tool. By evaluating configurations with varying material interfaces and air gap lengths, this work demonstrates the adaptability and precision of HFSS in optimizing RF designs. The study's outcomes not only provide insights into CPWTL design but also highlight the broader applicability of the parametric impedance matching approach in RF sensor technology.

## METHODS

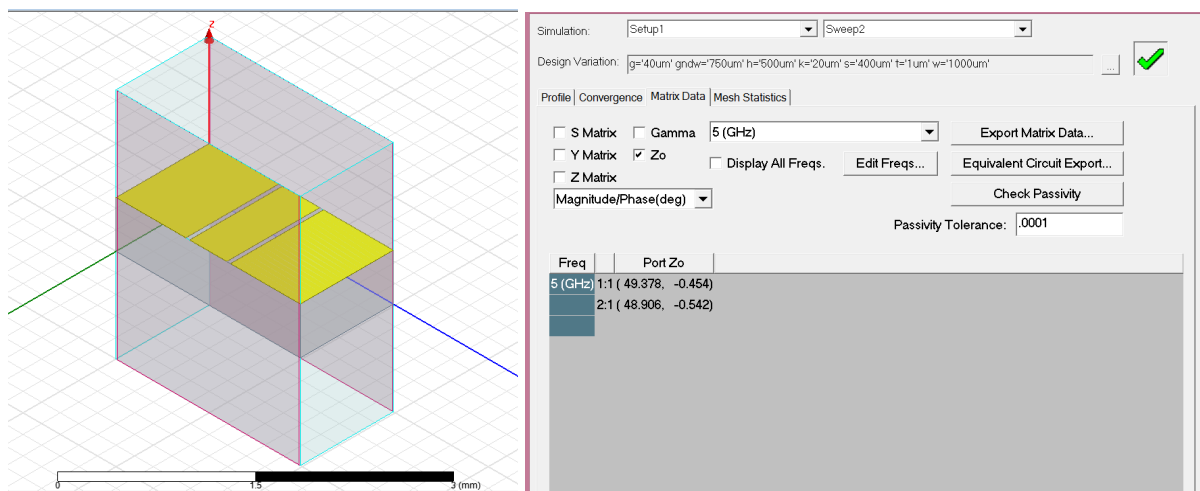
The behaviour of electromagnetic fields in transmission lines is governed by Maxwell's equations and their interaction with material properties such as permittivity and permeability <sup>Li, 2009: 919-927</sup>. Impedance matching involves aligning the characteristic impedance of the transmission line with the load impedance to optimize power transfer <sup>Wang, 2022: 348-349</sup>.

**Simulation Framework.** HFSS was employed to model and simulate CPWTLs. Three material configurations were analysed: air-gold-glass, distilled water-gold-glass, silicon-gold-glass interface. For each configuration, the air gap length between conductive elements was varied parametrically, ranging from 150  $\mu\text{m}$  to 1500  $\mu\text{m}$ . The HFSS parametric analysis feature allowed for efficient evaluation of impedance characteristics across these variations. Frequency range was always between 1 to 10 GHz. Target impedance was 50  $\Omega$ . Analysis outputs were mainly the S-parameters, port impedances.

## RESULTS

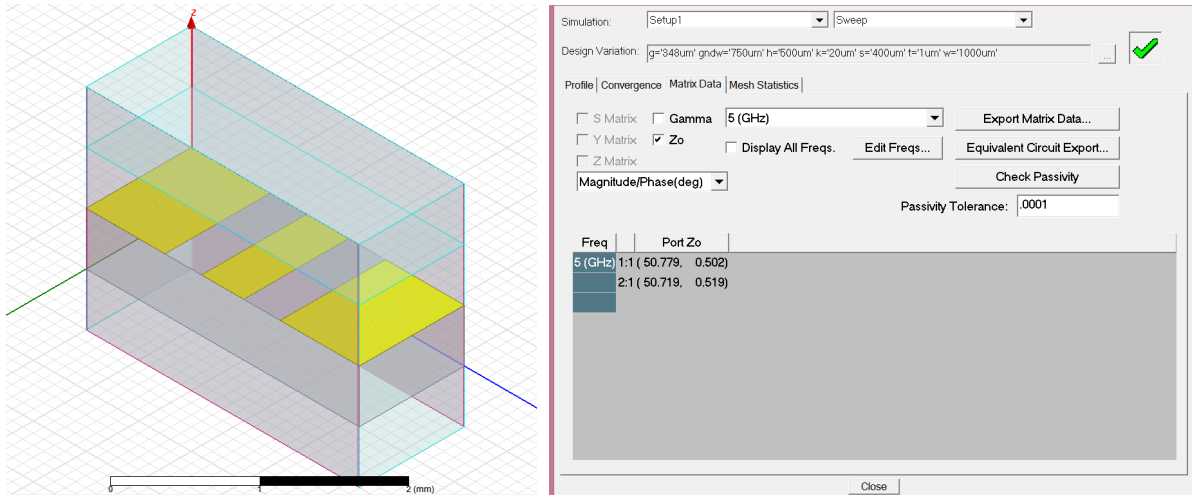
### Air-Gold-Glass Interface

The Air-Gold-Glass configuration demonstrated a stable port impedance near 50  $\Omega$  at an air gap length of 40 to 348  $\mu\text{m}$  (Figures 1 and 2). Increasing the air gap to 600  $\mu\text{m}$  resulted in a slight deviation from the target impedance, emphasizing the sensitivity of CPWTL designs to the variations of the air gap between the golden plates (Figure 3).

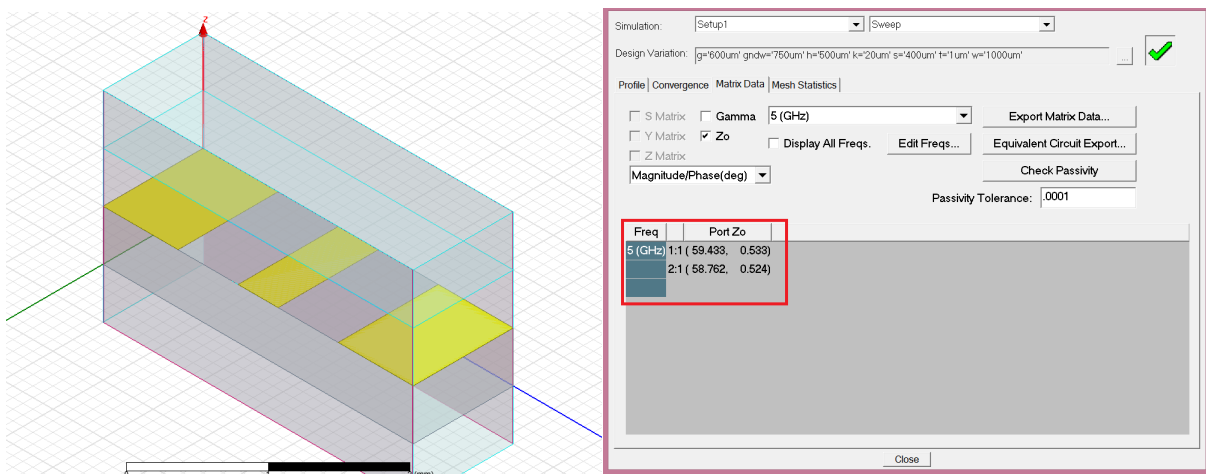


**Figure 1:** Left: CPW with Air-gold-glass interface with golden plates gap of 40  $\mu\text{m}$ : 3D model. Right: Solution window showing the port impedance  $Z_0$  approximately at 50  $\Omega$  at 5 GHz.





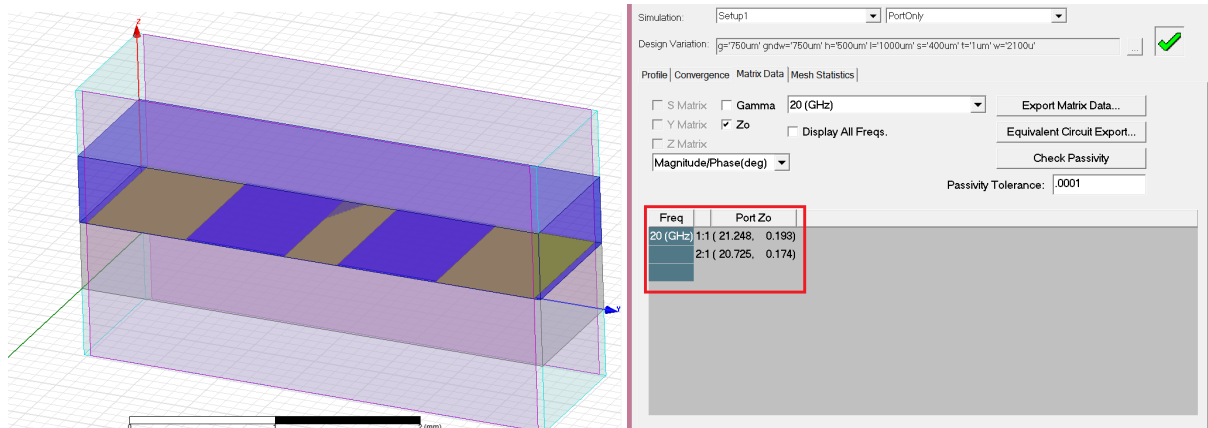
**Figure 2:** Left: CPW with Air-gold-glass interface with golden plates gap of 348  $\mu\text{m}$ : 3D model. Right: Solution window showing the port impedance  $Z_0$  approximately at 50  $\Omega$  at 5 GHz.



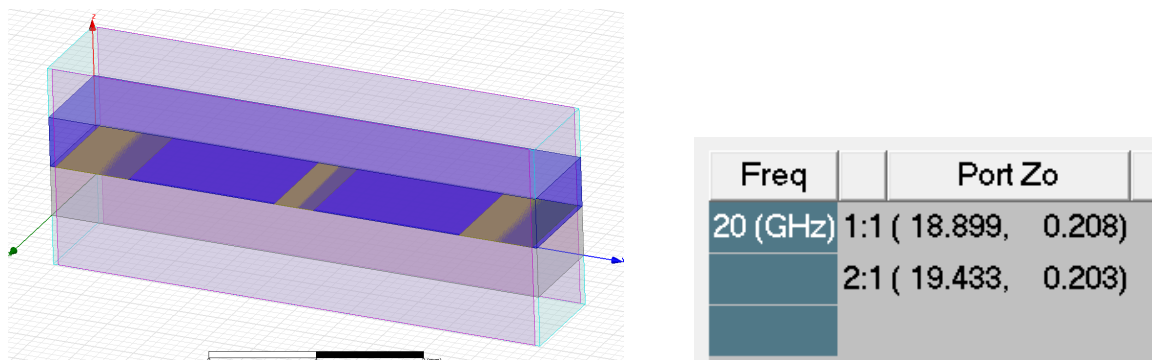
**Figure 3:** Left: CPW with Air-Gold-Glass interface with golden plates gap of 600  $\mu\text{m}$ : 3D model. Right: Solution window showing the port impedance  $Z_0$  at  $\sim 59 \Omega$  at 5 GHz.

### Distilled Water-Gold-Glass Interface

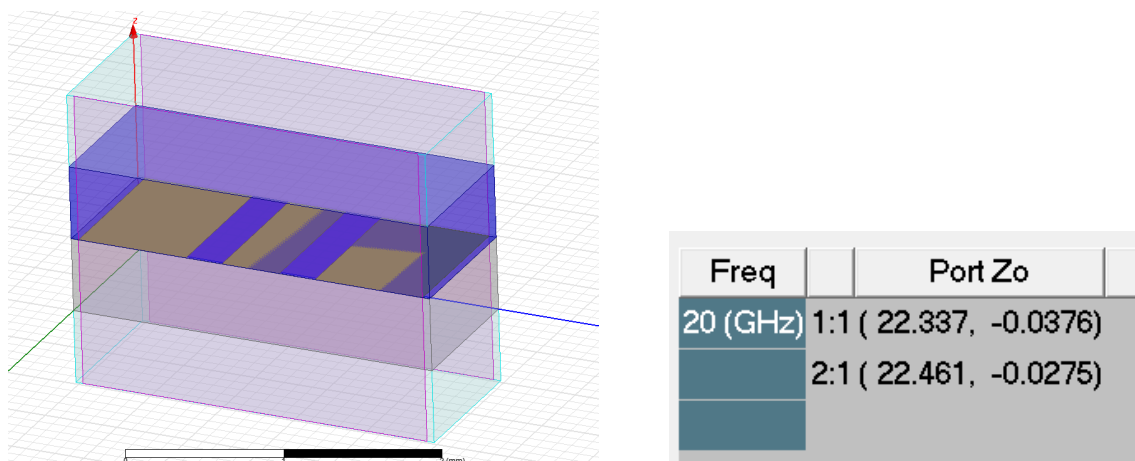
The distilled water interface exhibited low impedance variability with changing gap lengths, but different to the air-gold-glass interface. At 750  $\mu\text{m}$ , the impedance was approximately 21  $\Omega$  (Figure 4). Increasing the gap to 1500  $\mu\text{m}$  led to a slightly lower impedance ( $\sim 19 \Omega$ ) in Fig.5, while a decrease to 250  $\mu\text{m}$  resulted in higher impedance values ( $\sim 22 \Omega$ ) in Fig.6. These results underline the impact of dielectric properties on impedance matching.



**Figure 4:** Left: CPW with Distilled water – Gold – Glass interface with plates gap of 750 μm – 3D model. Right: Solution window showing the port impedance Z0 at ~21 Ω at 5 GHz.



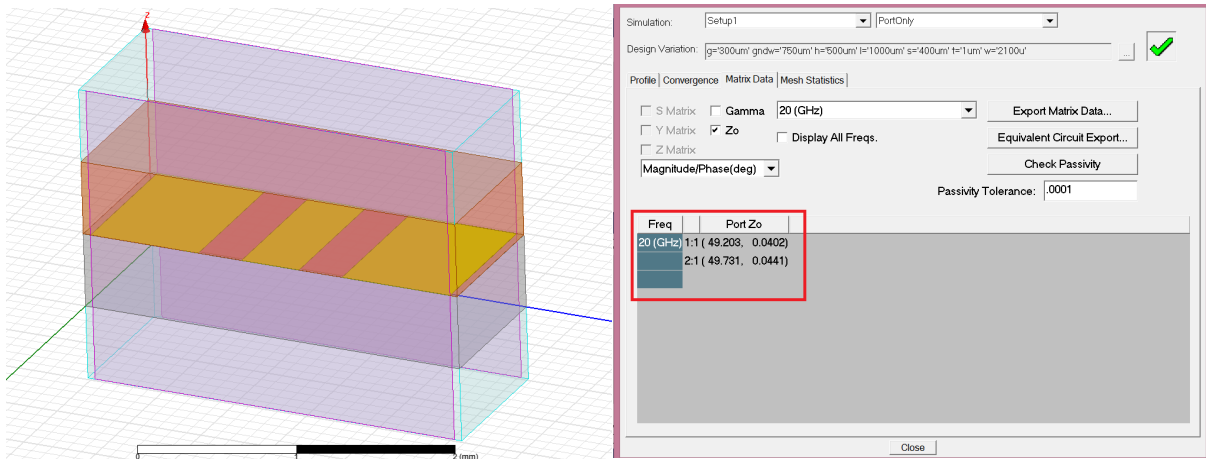
**Figure 5:** Left: CPW with Distilled water – Gold – Glass interface with plates gap of 1500 μm – 3D model. Right: Solution window showing the port impedance Z0 at ~19 Ω at 5 GHz.



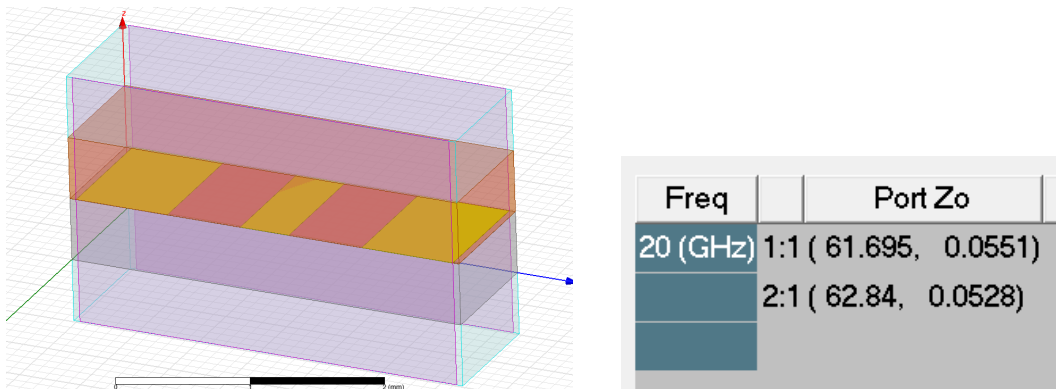
**Figure 6:** Left: CPW with Distilled water – Gold – Glass interface with plates gap of 250 μm – 3D model. Right: Solution window showing the port impedance Z0 at ~22 Ω at 5 GHz.

### Silicon-Gold-Glass Interface

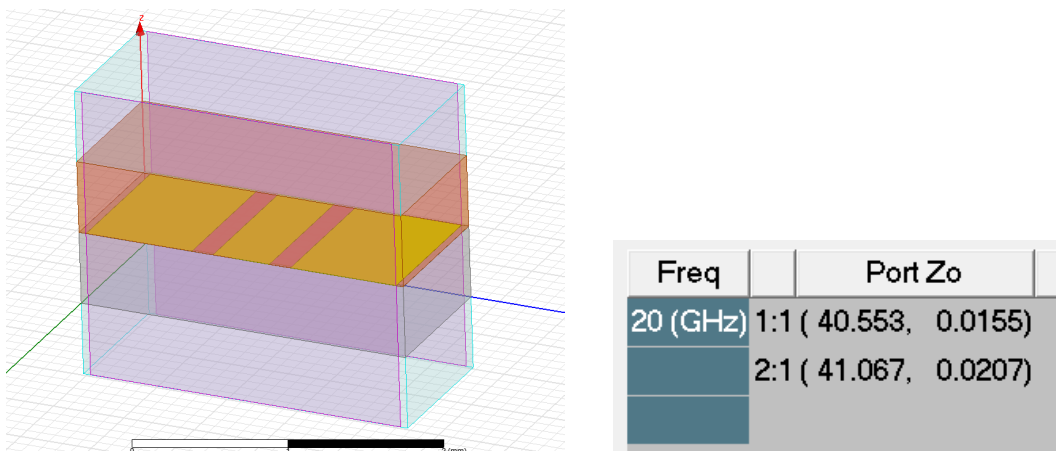
The silicon interface showed similar trend in impedance sensitivity to golden plates distance. At a distance of 300 μm, the impedance was ~49 Ω, aligning well with design expectations of 50 Ω (Figure 7). Increasing the gap to 600 μm raised the impedance to ~62 Ω (Fig.8), while reducing it to 150 μm lowered the impedance to ~41 Ω (Fig.9).



**Figure 7:** Left: CPW with Silicon – Gold – Glass interface with plates gap of 300 μm – 3D model. Right: Solution window showing the port impedance Z0 at ~49 Ω at 5 GHz.



**Figure 8:** Left: CPW with Silicon – Gold – Glass interface with plates gap of 600 μm – 3D model. Right: Solution window showing the port impedance Z0 at ~62 Ω at 5 GHz.



**Figure 9:** Left: CPW with Silicon – Gold – Glass interface with plates gap of 150 μm – 3D model. Right: Solution window showing the port impedance Z0 at ~41 Ω at 5 GHz.

## Comparative Analysis

The results demonstrate the effectiveness of HFSS in modelling impedance characteristics across varied material interfaces and distances between plates. Air-gold-glass provided the most stable performance, while distilled water-gold-glass exhibited greater sensitivity to gap variations deviating strongly from the target design specification. Silicon-gold-glass presented a balanced profile, suggesting its suitability for applications requiring moderate impedance stability.

## DISCUSSION

Parametric impedance matching offers a robust methodology for optimizing CPWTLs in RF sensor designs. The HFSS tool's ability to simulate and analyse complex electromagnetic interactions enables engineers to evaluate multiple configurations efficiently. The findings highlight the following. First, the critical role of dielectric properties in determining impedance behaviour is presented. Second, the importance of precise control over plates gap lengths to achieve target impedance values is shown. Finally, the adaptability of HFSS for varying design scenarios and material interfaces is explored. Future work could expand on these findings by exploring dynamic impedance matching techniques, incorporating additional material properties such as temperature-dependent permittivity, and optimizing the design via a more effective, iterative protocol. The integration of CPWTLs with advanced sensor technologies, including those for biological and environmental monitoring, also presents an exciting avenue for research.

## CONCLUSION

This study demonstrates the application of parametric impedance matching in CPWTL designs using HFSS. By evaluating air-gold-glass, distilled water-gold-glass, and silicon-gold-glass configurations, the analysis underscores the importance of material properties and structural dimensions in achieving optimal impedance matching. The presented methodology serves as a foundation for designing advanced RF sensors, with potential applications in diverse fields such as biomedical diagnostics and environmental sensing.

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# Effect of Synthesized Nanocomposite Photo-Cathode Electrodes on the Performance of Dye-Sensitized Solar Cells

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## ABSTRACT

Dye-sensitized solar cells (DSSCs) have attracted significant attention in the field of renewable energy due to their low-cost manufacturing processes and wide design flexibility. New generation photo-cathode structures that can serve as alternatives to Pt are being developed for DSSCs. For use in the photo-cathode electrode of DSSCs, nanocomposite structures of Graphene Oxide (GO) and Reduced Graphene Oxide (rGO) synthesized by the Hummers method were formed between binary metal oxides, with spinel-type  $\text{NiFe}_2\text{O}_4$  synthesized via the hydrothermal method. Additionally, the photo-anode  $\text{TiO}_2$  was synthesized using the sol-gel method. J-V analysis, Incident Photon-to-Current Efficiency (IPCE), and Electrochemical Impedance Spectroscopy (EIS) analyses were performed to evaluate the photovoltaic performance of the synthesized DSSCs. The Power Conversion Efficiency (PEC) and Incident Photon-to-Current Efficiency (IPCE) values for the  $\text{TiO}_2\text{-N719-(GO-Ni-Fe)}$  cell were 0.31% and 3.4%, respectively, while for the  $\text{TiO}_2\text{-N719-(rGO-Ni-Fe)}$  cell, the values were 0.71% and 6.2%. Through EIS analysis, the resistances occurring at the interfaces of the DSSCs were identified in order to comprehensively investigate the kinetics of the photoelectrochemical processes. In conclusion, it is anticipated that the efficiency levels of DSSCs can be enhanced through optimization of the photo-cathode materials and improvements in cell design. This study provides a foundation for the development of new strategies and material designs to improve low efficiency values.

**Keywords:** Counter electrode, Dye-sensitized solar cell, Graphene Oxide, GO-rGO/ $\text{NiFe}_2\text{O}_4$  Nanocomposite, Hydrothermal Method, Reduced Graphene Oxide

## INTRODUCTION

Climate change, the negative effects of fossil fuel consumption, and the limited availability of these resources are among the most important issues that have come to the forefront. Energy is a crucial element that supports both the economic growth and overall development of a country, playing a central role in achieving prosperity. To address energy deficits and environmental degradation, our critical goal should be to develop an energy production strategy that ensures sustainability and ecological balance. Among the methods for sustainable energy production, reducing energy consumption on a demand basis, increasing efficiency in production processes, and replacing fossil fuels with renewable

energy sources are key strategies. Renewable energy sources include hydroelectric, solar, biomass, wind, and hydrogen energy. Among these energy sources, solar energy is the most abundant and fundamental energy source on Earth (Lana, 2024:1,2). The conversion of solar energy into electricity lies in the production of solar cells within photovoltaic systems. Among the four generations of solar cells, Dye-Sensitized Solar Cells are included. DSSCs were first investigated by Gratzel and O'Reagan in 1991. DSSCs have advantages such as versatile manufacturing methods, wide application areas, and cost-effectiveness (Lana, 2024:2) (Jia, 2015:1) (Nguyen, 2025:1).

One of the key components of DSSCs, the counter electrode (CE), serves the function of facilitating the reduction of triiodide ( $I_3$ ) to iodide ( $I$ ) at the CE/electrolyte. Therefore, the counter electrode (CE) must possess high electrical conductivity, good electrochemical activity, and stability. Pt is the most commonly used CE in DSSCs, and it is responsible for achieving the highest efficiency. The disadvantage of Pt is that it is expensive and not resistant to corrosion (Kim, 2014:1) (Jia, 2015:1) (Alexeeva, 2019:1). Scientists have focused on developing different CE materials. Carbon materials, carbides, selenium, nitrides, and conductive polymers are among the CEs used so far (Jia, 2015:1). Graphene, one of the carbon structures, has been studied since the 1840s. At the University of Manchester (UK), in 2004, after Novoselov and colleagues explained its unique properties, graphene began to attract significant attention, and Geim and Novoselov later won the 2010 Nobel Prize in Physics. Graphene structures, including graphene oxide (GO) and reduced graphene oxide (rGO), continue to be investigated by scientists. In particular, rGO exhibits an ultra-low bandgap energy of approximately 0 eV, excellent electrical conductivity ( $200,000 \text{ cm}^2 \cdot \text{V}^{-1} \cdot \text{s}^{-1}$ ), and a large specific surface area (Nguyen, 2025:1). Graphene stands out as an electrocatalyst due to its low crystalline structure and the ability of edge defects to exhibit catalytic activity. However, the  $\pi$ - $\pi$  conjugation structure imparts both excellent electrical properties and electrochemical stability to graphene. GO and rGO can acquire different functionalities depending on the incorporation of various elements. Transition metal doping introduces multiple oxidation states, potentially leading to multi-step electron transfer pathways (Mahalingam, 2025:2).

The development of composite materials stands out as an effective method for enhancing catalytic activity. In particular, the hybridization of graphene with binary metal oxides prevents the restacking of graphene, while ensuring rapid ion movement and fast electron transfer at the CE and electrolyte interface. The composite structure enhances the electrical conductivity of binary metal oxides while strengthening the mechanical stability of graphene oxide, leading to a significant improvement in electrocatalytic activity. Therefore, the development of well-defined composite structures is considered an ideal approach for high-performance and cost-effective CEs. Due to its physicochemical properties, low cost, environmentally friendly structure, electrochemical stability, and rich redox regions, spinel-type  $\text{NiFe}_2\text{O}_4$  has become a prominent material among binary metal oxides (Samson, 2022:2).

In this study, nickel (Ni) and iron (Fe) doped nanocomposites were formed by synthesizing GO and rGO using the hydrothermal method, resulting in the synthesis of GO- $\text{NiFe}_2\text{O}_4$  and rGO- $\text{NiFe}_2\text{O}_4$  spinel nanocomposite structures, which were then used as counter electrodes (CE) in DSSCs. In the anode electrode of the DSSCs,  $\text{TiO}_2$  was synthesized using the sol-gel method, and N-719 dye was used as the sensitizer. A comparison of the GO and rGO nanocomposites used in the counter electrodes (CEs) has been made. J-V analysis, Incident Photon to Current Conversion Efficiency (IPCE), and Electrochemical Impedance Spectroscopy (EIS) analyses were performed to evaluate the photovoltaic performance of the fabricated DSSCs.

## MATERIALS AND METHODS

### A. Materials

In this study, the following materials were used: Fluorine-doped Tin Oxide Glass (FTO), Graphite, N-719, Acetic Acid, 3-Methoxypropionitrile, 1-Butyl-3-methylimidazolium iodide, DMF, TiO<sub>2</sub> Sigma-Aldrich, Ethanol, Iodine (I<sub>2</sub>) Isolab, S4-tert-butylpyridine, Lithium iodide hydrate (Acros Organics), P25 Degussa, and Triton-X 100 (Afg Bioscience LLC).

### B. Preparation of the Electrolyte

The liquid electrolyte solution was prepared by mixing 0.6 M 1-butyl-3-methylimidazolium iodide, 0.1 M 4-tert-butylpyridine, 0.01 M iodine, and 0.1 M lithium iodide hydrate in 3-methoxypropionitrile solvent using a magnetic stirrer.

### C. Preparation of N-719 Dye

The N-719 dye solution was prepared by mixing  $5 \times 10^{-4}$  M of N-719 in ethanol using a magnetic stirrer.

### D. Preparation of Counter Electrodes

Graphene oxide was synthesized according to the Hummers method (Çalışkan, 2024:86). For the synthesis of rGO from the synthesized GO, 0.8 g of GO was subjected to a 6-hour reflux process in 400 ml of DMF. To form the NiFe<sub>2</sub>O<sub>4</sub> nanocomposite on GO and rGO, 1:2 ratio of Iron nitrate nonahydrate [(Fe(NO<sub>3</sub>)<sub>3</sub>(H<sub>2</sub>O)<sub>9</sub>] and Nickel nitrate hexahydrate [(Ni(NO<sub>3</sub>)<sub>2</sub>(6H<sub>2</sub>O))] were dissolved in 60 ml of distilled water under magnetic stirring for 30 minutes. Simultaneously, rGO and GO (25 mg) were dispersed in distilled water under sonication for 1 hour. Then, the dispersed rGO and GO solutions were transferred to the Nickel and Iron solution to form a mixed homogeneous suspension. Then, a 2 M NaOH solution was added until the pH of the solution reached 10. Then, the mixed solution was transferred to a Teflon-lined stainless steel autoclave (200 ml), and the reaction temperature was maintained at 180°C for 13 hours (Samson, 2022: 2). After washing with distilled water and ethanol to remove impurities, the solution was boiled in 20 ml of acetic acid at 140°C for 1 hour. The prepared solution was applied to the FTO substrates using the dip coating method. The calcination process was carried out by holding the material at 350°C for 15 minutes.



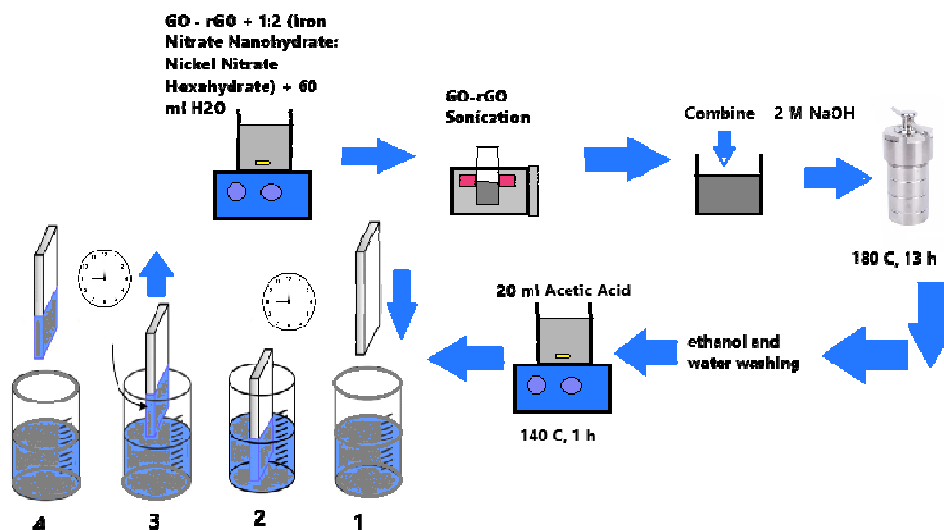


Fig.1: Preparation Procedure of the Counter Electrodes

### E. Preparation of Photo-Anodes

The TiO<sub>2</sub> photo-anodes were synthesized using the sol-gel method. The TiO<sub>2</sub> synthesis was carried out in two stages. In the first stage, 1.7 ml of titanium tetra isopropoxide (TTIP) was mixed in ethanol. In the second stage, 8 ml of ethanol and 3 ml of acetic acid were added dropwise to the mixture prepared in the first stage. Afterward, the mixture was stirred and left to rest for 48 hours. In the preparation of the TiO<sub>2</sub> pastes, 0.5 ml of the 48-hour aged synthesis, 0.25 g of P25 TiO<sub>2</sub> powder, 0.5 ml of acetic acid, and a few drops of Triton-X 100 were added. After the mixture was stirred on a magnetic stirrer, the obtained TiO<sub>2</sub> paste was applied to the cleaned FTO substrate using the Doctor Blade technique. Then, calcination was performed at 500°C for 1 hour (Çalışkan, 2024:99).

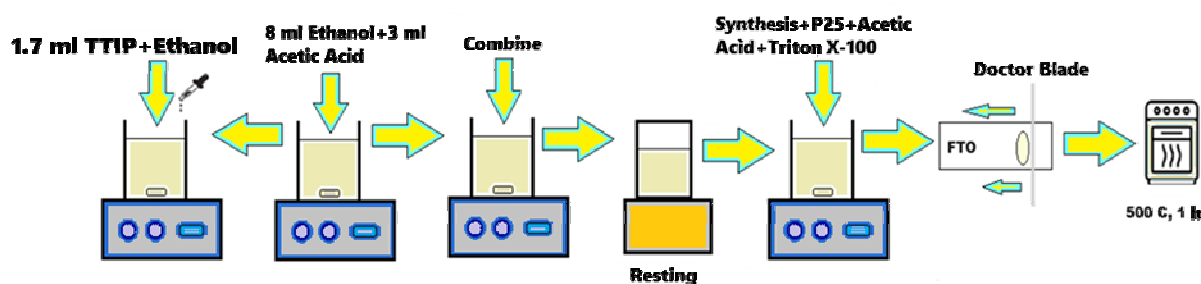


Fig. 2: Sol-gel Method for Preparing TiO<sub>2</sub> Paste

### F. Fabrication of DSSCs

After the photo-anodes adsorbed with the N-719 sensitizer were drop-cast with liquid electrolyte, the surfaces of the photo-cathodes coated with GO-NiFe<sub>2</sub>O<sub>4</sub> or rGO-NiFe<sub>2</sub>O<sub>4</sub> were clamped in a sandwich geometry, facing each other.



## RESULTS

### Photovoltaic Performance of DSSCs

The performance tests of the fabricated DSSCs were conducted using current-voltage (I-V) curves. Voltage was applied, and current values were recorded at specific intervals using a Keithley 2400 device under illumination conditions of 100 mW/cm<sup>2</sup> with an AM 1.5 G standard filter, provided by a HelioSim CL60 solar simulator. The photovoltaic performance values were calculated using the following formulas.

**Fill Factor (FF):** Fill Factor (FF) represents the energy losses occurring during the operation of the cell, expressed as electrical (ohmic) resistance and electrochemical (overvoltage) losses.

$$FF = \frac{V_{MAX}I_{MAX}}{V_{OC}I_{SC}} = \frac{P_{MAX}}{V_{OC}I_{SC}}$$

**Power Conversion Efficiency (PCE) ( $\eta$ ):** Efficiency is the most fundamental and defining criterion when describing a solar cell device.

$$\eta = \frac{I_{SC} \times V_{OC} \times FF}{P_{in}} \times 100$$

$$CE = \frac{P_{MAX}}{P_{in}} = \frac{J_{SC} V_{OC} FF}{P_{in}}$$

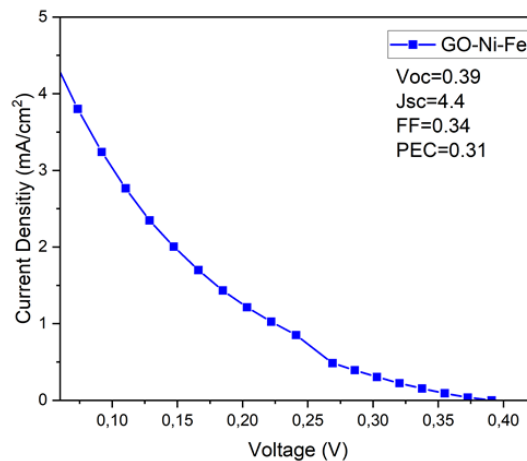
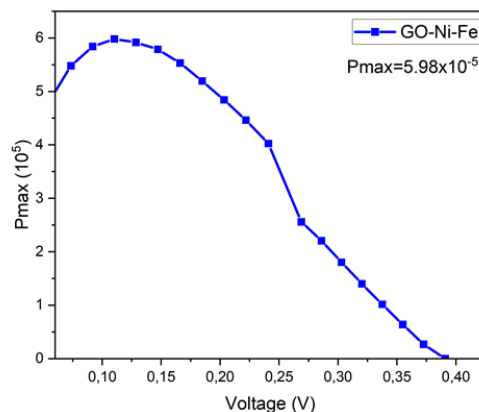
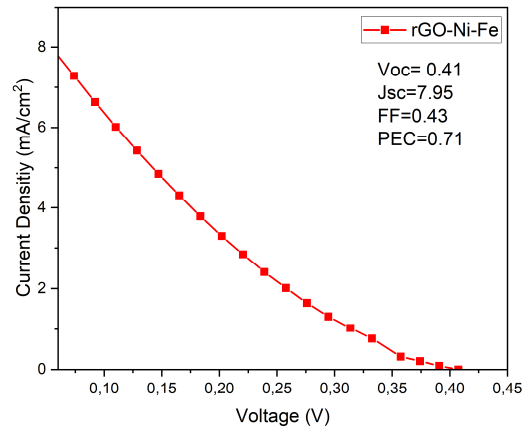


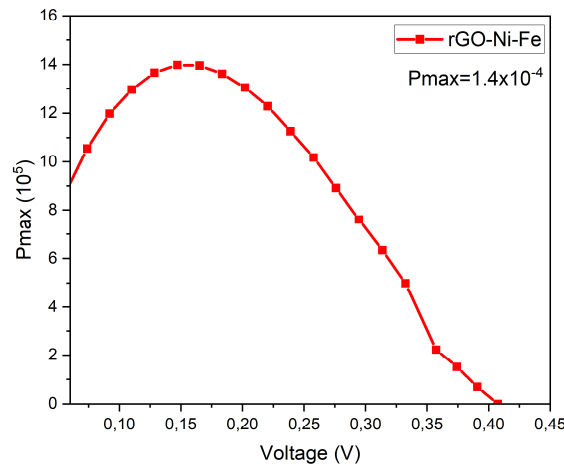
Fig. 3: J-V Curve of TiO<sub>2</sub>-N719-(GO-Ni-Fe) DSSC



**Fig. 4:** Pmax-V Curve of TiO<sub>2</sub>-N719-(GO-Ni-Fe) DSSC



**Fig. 5:** J-V Curve of TiO<sub>2</sub>-N719-(rGO-Ni-Fe) DSSC



**Fig. 6:** Pmax-V Curve of TiO<sub>2</sub>-N719-(rGO-Ni-Fe) DSSC

**Table 1:** Performance Results of DSSCs

Photo-anode	Dye	Photo-cathode	Cell Code	J <sub>SC</sub> (mA/cm <sup>2</sup> )	V <sub>OC</sub> (V)	P <sub>MAX</sub>	FF	PCE (η) (%)
TiO <sub>2</sub>	N-719	GO-Ni-Fe	TiO <sub>2</sub> -N719-(GO-Ni-Fe)	4.4	0.39	5.98x10 <sup>-5</sup>	0.34	0.31
TiO <sub>2</sub>	N-719	rGO-Ni-Fe	TiO <sub>2</sub> -N719-(rGO-Ni-Fe)	7.95	0.41	1.4x10 <sup>-4</sup>	0.43	0.71

The PTS-2-QE model quantum efficiency measurement system from Sciencetech was used to measure the quantum efficiency of the prepared DSSCs.

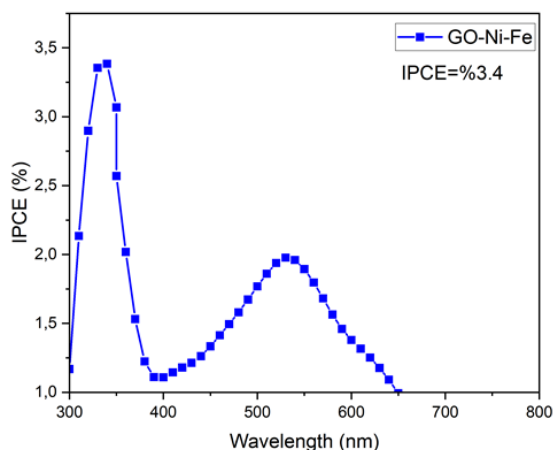


Fig. 7: Photon-to-current conversion efficiency of  $\text{TiO}_2\text{-N719-(GO-Ni-Fe)}$  DSSC.

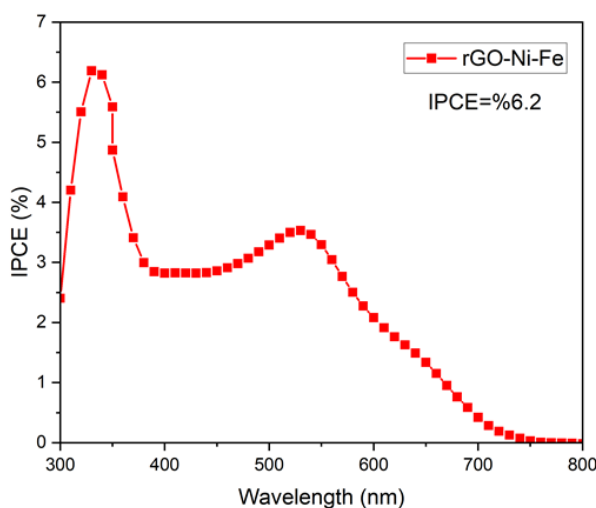


Fig. 8: Photon-to-current conversion efficiency of  $\text{TiO}_2\text{-N719-(rGO-Ni-Fe)}$  DSSC.

### Electrochemical Properties of DSSCs

The electrochemical impedance spectroscopy (EIS) analyses of the DSSC samples were performed under dark conditions and at room temperature, using a potentiostat/galvanostat operating in the frequency range of  $10^{-2}$ – $10^5$  Hz. During the measurements, the open-circuit voltage ( $V_{oc}$ ) value was selected as the pre-bias, and an alternating current (AC) amplitude of 10 mV was applied. The obtained Nyquist diagrams were simulated with a suitable equivalent circuit model in the device software. The resistance values of the elements in the equivalent circuit model were determined by analyzing them through the EC-Lab software program.

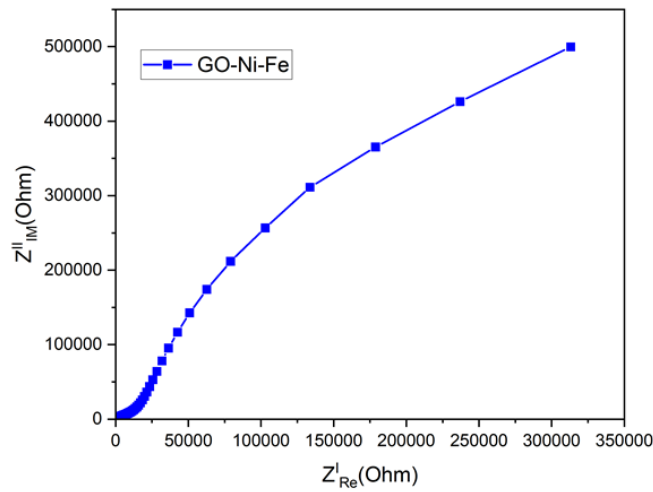


Fig. 9: Nyquist diagram of TiO<sub>2</sub>-N719-(GO-Ni-Fe) DSSC

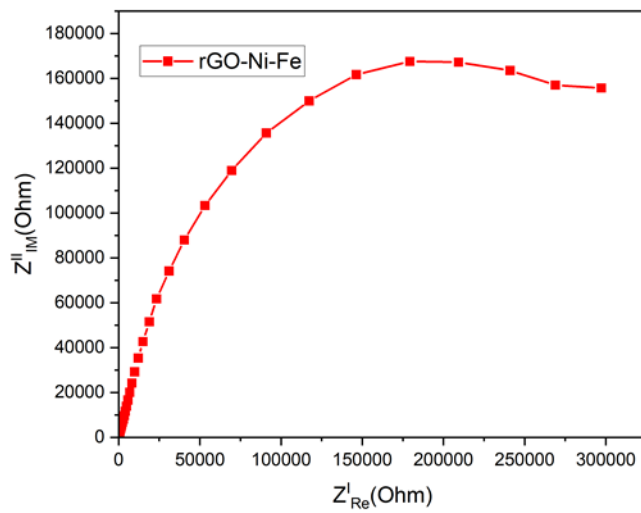


Fig. 10: Nyquist diagram of TiO<sub>2</sub>-N719-(rGO-Ni-Fe) DSSC

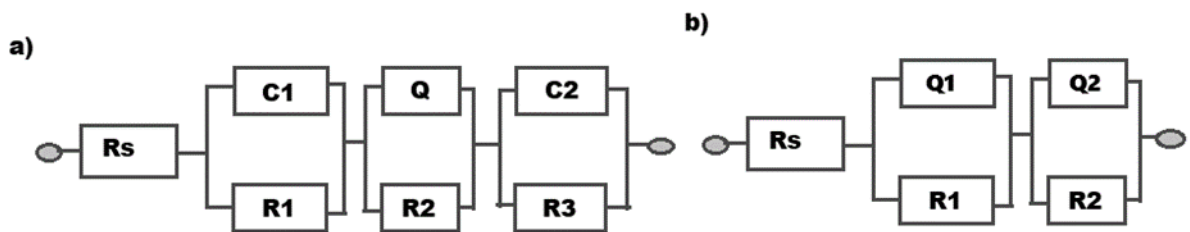


Fig. 11: a) Circuit model of TiO<sub>2</sub>-N719-(GO-Ni-Fe) DSSC, b) Circuit model of TiO<sub>2</sub>-N719-(rGO-Ni-Fe) DSSC.

**Table 2:** Resistance Values of TiO<sub>2</sub>-N719-(GO-Ni-Fe) DSSC

Cell	R <sub>s</sub> (Ω)	C1 (μF)	R1 (Ω)	Q (10 <sup>-6</sup> )	R2 (Ω)	C2 (μF)	R3 (Ω)
TiO <sub>2</sub> -N719-(GO-Ni-Fe)	23,63	22,27	997 173	5,27	10 066	18,21	15 754

**Table 3:** Resistance Values of TiO<sub>2</sub>-N719-(rGO-Ni-Fe) DSSC

Cell	R <sub>s</sub> (Ω)	Q1(10 <sup>-6</sup> )	R1 (Ω)	Q2 (10 <sup>-3</sup> )	R2 (Ω)
TiO <sub>2</sub> -N719-(rGO-Ni-Fe)	14,55	13,82	417 559	0,81	5059

## DISCUSSION

The performance of the prepared DSSCs was tested using a solar simulator, and calculations were made based on the J-V graphs. According to Figures 5 and 6, the efficiency of the TiO<sub>2</sub>-N719-(rGO-Ni-Fe) cell is approximately 129% higher compared to the TiO<sub>2</sub>-N719-(GO-Ni-Fe) cell. According to Table 1, the approximate 81% increase in current density (J<sub>sc</sub>) and the increase in P<sub>max</sub> values have influenced this situation. As the current density in a cell increases, the power conversion efficiency also increases in parallel. The FF value of the TiO<sub>2</sub>-N719-(rGO-Ni-Fe) cell ranged between 0.4 and 0.85, which is typical for medium-range cells. The FF value of the TiO<sub>2</sub>-N719-(GO-Ni-Fe) cell remained low. Low FF values indicate that more recombination occurs within the cell, and that there are defective regions and high charge transfer resistance at the electrolyte and counter electrode interface. Voc and J<sub>sc</sub> values are generally related to the photo-anode. Tests measuring the conversion of incoming photons to current have been conducted to analyze the photovoltaic properties of the DSSCs in detail. The IPCE, which determines the conversion rate of photons reaching the active surface of a solar cell to electron production under monochromatic light (300-800 nm) in the UV and visible regions, provides important data on the performance of the DSSC. According to Figures 7 and 8, the IPCE value of the TiO<sub>2</sub>-N719-(GO-Ni-Fe) DSSC is 3.4%, while the IPCE value of the TiO<sub>2</sub>-N719-(rGO-Ni-Fe) DSSC is 6.2%. An approximately 82% higher IPCE efficiency has been achieved in rGO compared to GO. When examining Figures 7 and 8, it can be observed that the prepared DSSCs generally respond to light in the visible region. It remained weak in the infrared region. The cause of these quantum efficiency losses is due to trap states that lead to the recombination of holes and electrons. As supported by the J-V graphs, it is observed that the power conversion efficiency (PCE) value is consistent with the IPCE value. EIS analysis is used to examine the charge transport and electron-hole recombination kinetics in the DSSCs. The equivalent circuit model shown in Figure 11a, which is consistent with the DSSCs, aligns with the study by Lohar (2020:5). The structure, which shows a linear trend at low frequencies, exhibits a semicircular curve as it transitions to high frequencies. The width of the semicircle reveals the change in charge transfer resistance on the surface of electroactive samples due to Faradaic reactions. Smaller semicircles indicate higher electron transport capacity and lower charge transfer resistance. The ability of DSSCs to be an effective absorption material depends on their ability to facilitate efficient electron transport. Low charge transfer resistance supports the production of more electrons in the sample, significantly enhancing the photoconversion efficiency (Panneer, 2023:10). The R<sub>s</sub> series resistance in the circuit represents the sheet resistance of the TCO glass and the contact resistance between the electrolyte and the cell. C//R1 represents

the FTO/TiO<sub>2</sub>/electrolyte system resistance; Q//R<sub>2</sub> reflects the resistance of the electrolyte; and C//R<sub>3</sub> represents the resistance of the FTO//GO-rGO-NiFe<sub>2</sub>O<sub>4</sub>//electrolyte system. The C elements represent capacitive constant phase elements. Low resistance values indicate less recombination at the interface and improved conductivity. In Figure 11b, the equivalent circuit components of the cell have the following meanings: R<sub>s</sub> represents the series resistance or solution resistance, R<sub>1</sub>//Q<sub>1</sub> represents the impedance at the TiO<sub>2</sub>/dye/electrolyte interface, and the impedance at the counter electrode/electrolyte interface is represented by R<sub>2</sub>//Q<sub>2</sub>. The real part of the impedance is represented by R<sub>1</sub> and R<sub>2</sub>, while the constant phase element (CPE) is represented by Q<sub>1</sub> and Q<sub>2</sub> (Ezema, 2016:7). The charge transfer resistance is an important factor in the efficiency of a solar cell.

## CONCLUSION

In this study, the effect of creating GO and RGO Ni and Fe nanocomposites on the device efficiency in DSSCs was investigated. A DSSC has many components that affect its PEC. The surface area of the photoanode, the spectral sensitivity and electron transport properties of the dye molecules used, and the properties of the electrodes are all effective. The PEC value of the DSSC created with the RGO/NiFe<sub>2</sub>O<sub>4</sub> photo-cathode electrode is higher than that of the GO/NiFe<sub>2</sub>O<sub>4</sub>. The reduction process increases the sp<sup>2</sup> hybridized areas between carbon atoms by reducing the oxygen-containing groups in GO. This significantly improves the electrical conductivity of rGO compared to GO. The removal of oxygen groups increases the thermal conductivity of rGO compared to GO. rGO has a more hydrophobic surface than GO, making it more suitable for certain applications. At the same time, rGO is still flexible in terms of functionalizability thanks to the partial oxygen groups. The reason for this may be that rGO contains less oxygen, increasing its optical transparency. The nanocomposite formed with Ni and Fe remained poor in terms of overall efficiency of DSSC. Additionally, NiFe<sub>2</sub>O<sub>4</sub> can be prepared by a different method to form the spinel structure and different ratios of Ni and Fe can be tried.

## ACKNOWLEDGMENT

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# The Role of Technoparks in Education

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## **Abstract**

Technology parks, in addition to playing a key role in the education and innovation environment, have become a means of communication between scientific institutions, educational organizations and industry. Their importance is not limited only to the commercialization of scientific research, but also includes the formation of new educational models, the development of startups and the training of highly qualified personnel, which makes them an important tool for the formation of an innovative economy.

Technology parks, along with their main goal of supporting innovation, are organizations that create favorable conditions for the education and professional development of specialists. In many countries, technology parks actively cooperate with universities and scientific institutions, providing students and researchers with resources for the implementation of scientific projects, the creation of startups and the application of new technologies. Such cooperation allows students to be involved in research and development processes, which contributes to improving the quality of education.

Many technoparks actively cooperate with foreign scientific and educational institutions, which opens up new horizons for students and researchers. Such cooperation may include the exchange of knowledge and experience, joint research and development, and the creation of international educational programs. This contributes not only to improving the quality of education, but also to the integration of students and young scientists into the global innovation ecosystem.

The presence of the following in the technology park can play a positive role in improving the quality of education:

- Internet of Things (IoT);
- Cloud services;
- Modernization of Educational Programs;
- Increasing the Professionalism of Teachers;
- Active Interactivity of Students;
- Development of Learning Resources

**Keywords:** technopark, interactivity, education, cloud technology, Internet of Things



The aim of the subject is to reveal the potential of technoparks in organizing practical training of students in modern laboratories created in technoparks, to review the problems of creating interdisciplinary practical training in technopark conditions and to review the advantages of technoparks as an educational component. Increasing the efficiency of students' professional practice-oriented training at the university.

In order to truly increase the quality of education, the following problems need to be solved in technology parks:

### **Practical experience**

The conditions created in technoparks allow students to work with modern technology and equipment, which creates conditions for improving their practical skills. In technoparks, students can work with real projects and modern technologies, which helps them not only master theoretical knowledge, but also apply it in practice. In addition, students often have the opportunity to participate in advanced laboratories and research based on technoparks.

Regular training and seminars from leading industry experts organized in technoparks help students stay up-to-date with the latest technologies. At the same time, teamwork with representatives of various specialties develops an integrated approach to solving problems.

### **Innovation and research**

Innovation and research implemented in technoparks significantly contribute to improving the quality of education. As students get the opportunity to work with the latest technological developments, which allows them to be aware of the most modern trends and innovations. The creation of startups - supporting innovative ideas and projects - contributes to the development of entrepreneurship among students. These aspects make technoparks important centers for promoting innovation and research, which in turn increases the quality of education and prepares students for successful careers in modern conditions.

### **Interdisciplinary training:**

Interdisciplinary training can indeed make a significant contribution to improving the quality of education. It is easier to implement this in technoparks.

- Students from different fields of knowledge can work together on projects, combining their unique skills and approaches. This helps to solve problems in a more comprehensive and innovative way.
- Soft skills development: interdisciplinary work requires good communication, collaboration, and the ability to work in a team, which are skills essential for future careers.
- Broader perspective: students get the chance to see how their major can interact with other fields, broadening their understanding and perspectives.
- Solving complex problems: Many modern challenges and problems require an interdisciplinary approach for effective solutions. Technoparks create an environment where such approaches can be developed and implemented. These aspects make interdisciplinary learning an important component of modern educational institutions, helping to prepare students for real-world work environments and innovative tasks.

Let's look at some examples of interdisciplinary project development:

- Smart city: Architects, civil engineers, IT specialists, and ecologists come together to develop innovative solutions in the fields of urban planning, energy, transportation, and environmental management.
- Internet of Things (IoT) for Agriculture: Agronomists, engineers, IT specialists, and economists are coming together to work on projects to develop systems that monitor and manage the condition of agricultural fields, increasing agricultural productivity and sustainability.
- Green energy: Environmentalists, engineers, economists, and other professionals work together to develop and implement renewable energy and clean energy policies.
- Health and artificial intelligence: In this project, doctors, IT specialists, and psychologists are working to create systems that can predict diseases, personalize treatment, and improve patient outcomes with artificial intelligence.

These projects demonstrate how interdisciplinary learning and collaboration can lead to significant innovations and improvements in the quality of life.

### **Modernization of educational programs**

Modernization of educational programs within technoparks can significantly improve the quality of education. Thus, technoparks help to adapt educational programs to current market requirements and technological trends by providing students with the skills and knowledge necessary for employers. The introduction of new educational technologies and methods, such as distance learning, virtual laboratories and simulations, located in technoparks, increases the accessibility and efficiency of the educational process. In addition, the creation of courses that combine different fields of knowledge contributes to the development of students' comprehensive skills and a deeper integration of science and technology.

### **Cloud services**

The presence of cloud services in technoparks provides students and teachers with access to powerful computing resources and tools, which expands learning and research opportunities. Cloud services serve as a reliable and scalable data warehouse that allows for the secure storage of large amounts of educational materials, research data, and projects. Cloud platforms also promote easy information exchange and project collaboration, allowing students and teachers to easily interact even when they are far from each other, and students can access learning materials and resources from anywhere in the world and on any device, which increases the flexibility and accessibility of learning. These advantages make cloud services an essential element in modern educational institutions, helping to improve the quality of education with new learning and interaction opportunities.

**Increasing the professionalism of teachers:** Technoparks can play an important role in increasing the professionalism of teachers. In technoparks, teachers have the opportunity to learn and work with advanced technology solutions and tools that allow them to stay abreast of the latest trends and innovations.

- **Regular training:** Technoparks often organize trainings, seminars and workshops where teachers can develop their knowledge and skills and exchange experiences with colleagues and experts from different fields.
- **Research activities:** Teachers can participate in scientific research and projects, which helps to develop their professional skills and improve their teaching performance.

- **Collaboration with industry:** Interaction with business and industry representatives allows teachers to better understand the needs of the labor market and adapt their curricula to the requirements of the modern economy.
- **Innovative teaching methods:** Technoparks actively implement new teaching methods and technologies, such as distance learning, virtual reality, and gamification, which help teachers make the teaching process more interesting and effective. These aspects increase the professionalism of teachers and the quality of education, preparing students for successful careers in the modern world.

### **Active interactivity of students**

Ensuring active interactivity of students in technoparks is one of a number of factors that have a positive impact on improving the quality of education. Thus, laboratories and practice centers equipped with modern equipment should be provided for students to acquire practical knowledge, opportunities should be created to realize their ideas and work on startup projects. Social spaces should be created for students to communicate with each other, which increases their collaborative work skills.

Students should be given the opportunity to work under the guidance of experienced professionals and academics, and clubs and associations in various technology fields should be organized so that students can develop their areas of interest.

Thus, these factors can help improve the quality of education in technoparks and create conditions for students to develop in a more motivated and interactive educational environment.

### **Development of learning resources**

The development of learning resources in technoparks significantly enriches the educational experience of students. As the digitization of educational materials and the use of interactive learning platforms allow students to learn content in a more easy and interesting way.

By enabling the creation of virtual classrooms and the use of educational equipment such as smart boards in technoparks, students are provided with opportunities to study in an interactive and personalized learning environment, while also creating opportunities for students to work on projects as a team, which develops their collaborative skills and problem-solving abilities.

In technoparks, modern laboratories and equipment are provided to students to work on various research and development projects. The use of robotics, artificial intelligence, IoT and other modern technologies helps students acquire practical knowledge and skills in these areas.

### **Conclusion**

Technoparks play an important role in education and the following results can be achieved:

- Technoparks provide opportunities for students to put their theoretical knowledge into practice, giving them real-world experience.
- Innovation centers and laboratories provide students with opportunities to work on new technologies and find creative solutions.
- In technoparks, students have the opportunity to work in teams and collaborate on various projects.

- Technoparks provide students with access to the most modern technologies and tools, which expands their educational and career prospects.
- Mentoring and training programs from experienced professionals have a great impact on students' professional development and preparation for their future careers.
- Technoparks equip students with knowledge and skills relevant to the demands of the job market, making them more attractive to employers.

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# The Effect of Different Solvents and Their Aqueous Mixtures on the Polyphenol Content and Antioxidant Activity of *NIGELLA Sativa* Seed Extracts

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## ABSTRACT

*Nigella sativa* L. (black cumin) is an annual herbaceous plant belonging to the Ranunculaceae family. Seeds of plant *Nigella sativa* are known for their therapeutic potential and are widely used in herbal medicine. These seeds are applied in the treatment of various health issues, including digestive system disorders, respiratory diseases, and inflammation relief. This study examined the impact of organic solvents and their aqueous mixtures on the efficiency of polyphenol extraction, flavonoid isolation, and antioxidant activity of *Nigella sativa* seeds. Radical scavenging was tested using the DPPH method, while the FRAP method was employed to assess the potential for reducing oxidative stress. Extracts prepared by mixing organic solvents with water demonstrated significant efficiency, with the highest antioxidant capacity recorded in these combinations. The results indicated that pure acetone was the most effective solvent for extracting polyphenols from *Nigella sativa* seeds, while the best result for flavonoid isolation was achieved using pure ethanol.

**Keywords:** *Nigella sativa*, antioxidant capacity, polyphenols, flavonoid, solvents

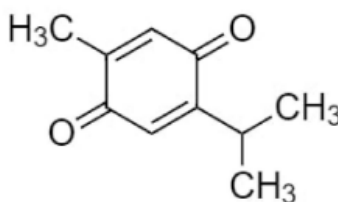
## INTRODUCTION

In recent decades, increasing attention has been devoted by researchers to natural antioxidants due to their role in the prevention of various diseases, including cardiovascular diseases, diabetes, and neurodegenerative disorders.

Antioxidants neutralize free radicals, thereby reducing oxidative stress in the body. Due to their numerous benefits, they have become scientifically intriguing compounds. As a result, studies continue to accelerate in order to determine the antioxidant activities of natural foods and their main components. Additionally, the significance of antioxidants has grown due to their use in pharmacology, cosmetics, and medicine (Zehiroglu and Sarikaya, 2019, 991-1003). Phenols and flavonoids, as the main components of natural antioxidants, are present in various plants and significantly contribute to their beneficial effects on the organism.

*Nigella sativa* L., commonly known as black cumin, is an annual plant from the Ranunculaceae family. It is an herbaceous flowering plant that typically grows to a height of 20-30 cm. It has linear leaves, bluish flowers, capsule-shaped fruits, and small black seeds that resemble cumin, which is why it is often referred to as black cumin. It is found in countries around the Mediterranean, as well as in Pakistan, India, and Iran (Begum and Mannan, 2020, 213-219). Black cumin is known for its medicinal properties, and its seeds are rich in bioactive compounds that play a key role in the antioxidant activity of black cumin, making it an interesting subject of research. Among the most prominent bioactive compounds are thymoquinone, nigellone, carvacrol, p-cymene, terpinene, as well as other components such as essential fatty acids, flavonoids, phenolic acids, alkaloids, and saponins (Wajs et al., 2008, 126-132).

Thymoquinone is considered the most important active compound and is responsible for many biological effects, including anti-inflammatory, anticancer, and immunomodulatory properties. (Khader and Eckl, 2014, 950-7). Thymoquinone, or 2-isopropyl-5-methylbenzo-1,4-quinone, is recognized as one of the most effective bioactive components of *Nigella sativa* seeds. Structurally, TQ consists of a quinone ring made up of six carbon atoms, with a methyl group at position C2 and an isopropyl group extending from position C5, making it a compound with 10 carbon atoms. The molecule contains two carbon-carbon double bonds, as well as two carbon-oxygen double bonds (C=O), indicating its functional versatility (Ahmad et al., 2019, 1113-1126).



**Figure 1.** Chemical structure of thymoquinone

Nigellone is another significant component of black cumin, primarily used for its antispasmodic and bronchodilator properties, making it beneficial in the treatment of respiratory conditions such as asthma. Carvacrol, p-cymene, and terpinene are monoterpenes present in the essential oil of black cumin, known for their antimicrobial, antioxidant, and anti-inflammatory effects (Chroho, 2024, 139; Pyo et al., 2024, 488). These compounds exhibit significant activity in combating pathogenic microorganisms, including bacteria and fungi, while also reducing oxidative stress. Additionally, black cumin contains essential fatty acids

such as linoleic acid (omega-6) and oleic acid (omega-9), which play a role in maintaining cardiovascular health, reducing inflammation, and improving lipid metabolism (Rahim, 2022, 2826). Flavonoids and phenolic acids possess strong antioxidant properties that help reduce oxidative stress and protect cells from damage (Roy et al., 2022, 5445291). Moreover, alkaloids and saponins may contribute to the modulation of metabolic processes, including the regulation of blood glucose levels and the reduction of blood pressure.

Recent studies suggest that black cumin extracts possess significant antioxidant activity. Given the variability in the content of bioactive components, it is important to investigate the impact of different solvents on the efficiency of their extraction. Therefore, selecting the right solvent can result in higher levels of phenols and flavonoids, which directly affect the antioxidant activity of the extract.

The aim of this study was to analyze the antioxidant activity, as well as the content of phenols and flavonoids in black cumin extracts prepared with different solvents, such as water, ethanol, methanol, and acetone. These studies may contribute to a better understanding of the potential of *Nigella sativa* as a natural source of antioxidants and provide insights into optimizing extraction methods for future research and applications in the food and pharmaceutical industries.

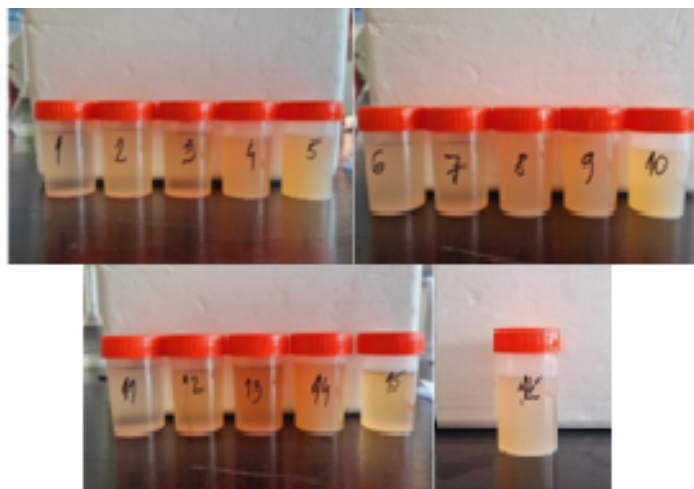
## METHODS AND MATERIALS

The *Nigella sativa* powder used in this analysis was purchased from a local market in Tuzla, known for its wide range of natural and environmentally friendly products. The black cumin powder was subjected to necessary checks to ensure its quality and safety for consumption. The aqueous solutions used for the analysis were prepared with demineralized water to ensure maximum purity and accuracy of the prepared solutions. High-purity reagents, labeled as p.a., were used in the analysis without the need for further purification or processing.

All tested chemicals were from the manufacturer Sigma-Aldrich and were applied as pure substances. The reagent 2,2-diphenyl-1-picrylhydrazyl (DPPH) was used for the analysis of DPPH radical neutralization. To prepare the FRAP reagent for determining antioxidant activity using the FRAP method, reagents 2,4,6-tripyridyl-s-triazine, iron (III) chloride, hydrochloric acid, and sodium acetate were used. For determining the total flavonoid content in the tested extract, sodium nitrite, aluminum chloride, and sodium hydroxide were used. Spectroscopic measurements were performed using a Perkin Elmer Lambda 25 spectrophotometer, within the wavelength range of 510 nm to 765 nm.

### Preparation of plant extract of black cumin

The black cumin extracts were prepared by mixing 0.5 grams of ground plant material with 50 mL of an appropriate solvent or their mixture (solvent and water). The plant material was thoroughly mixed on a vibromixer for 60 minutes to achieve maximum extraction of bioactive compounds. Afterward, the mixture was filtered to separate the solid residues, and the resulting liquid extract was immediately subjected to analysis. All prepared extracts were clear after filtration, indicating the efficiency of the extraction process.



**Figure 2.** Black cumin extracts after filtration

#### **Determination of Total Phenolic Content in a sample (TPC)**

This method is based on the reaction between phenolic compounds in the sample and the Folin-Ciocalteu reagent, leading to the reduction of molybdenum-tungsten complexes in the reagent. This reaction results in a measurable color change, typically from yellow to blue, the intensity of which is proportional to the concentration of phenolic compounds. The color change enables the quantification of the total phenolic content in the sample, as absorbance at a specific wavelength can be used to calculate the phenol concentration. The quantification of total phenolic compounds in the extracts was carried out spectrophotometrically using the Folin-Ciocalteu assay, following the protocol of Singleton et al. (Singleton et al. 1999, 152-178), with some minor modifications. 200  $\mu\text{L}$  of the extract was mixed with 2540  $\mu\text{L}$  of 10% Folin-Ciocalteu reagent. The Folin-Ciocalteu reagent contains a mixture of phosphomolybdate and phosphotungstate oxides, which react with phenolic compounds to form a blue-colored complex. After 5 minutes of reaction, 420  $\mu\text{L}$  of 10% sodium carbonate was added, which provides an alkaline environment, enhancing the development of the blue complex. The samples were then incubated at room temperature for 1 hour to ensure complete color development and reaction stability. After incubation, 910  $\mu\text{L}$  of distilled water was added to each sample to dilute the solution before measuring the absorbance. The absorbance of the blue-colored solution, which formed after the reaction, was measured spectrophotometrically at a wavelength of 765 nm.

The total phenolic content was expressed as gallic acid equivalent (GAE), with the result presented in milligrams of gallic acid per gram of dry plant material.

This approach allows for the quantification of phenolic compounds in the sample relative to a standard substance, gallic acid, which is used as a reference indicator for comparison and precise determination of the total phenolic content.



### **Determination of Total Flavonoid Content (TFC)**

The total flavonoid content in the extracts was quantified using a modified colorimetric method. This method involves the formation of a complex between flavonoids and specific reagents, where the flavonoids interact with reagents that selectively react with the hydroxyl groups of flavonoid compounds. The resulting complex produces an intense color that is proportional to the concentration of flavonoids in the sample. The total flavonoid content in the extracts was determined using the previously described method (Olajire and Azeez, 2011, 022-029), with certain modifications. To the extract solution of 1 mL, 0.3 mL of 5% sodium nitrite was added, initiating a reaction that allows the flavonoids to form a colored complex. After 5 minutes of incubation at room temperature, 0.3 mL of 10% aluminum chloride was added to the reaction mixture. Aluminum chloride forms stable complexes with flavonoids, which is a critical step for the successful execution of the colorimetric reaction. The mixture was then incubated for 6 minutes at room temperature, after which 1 mL of 1 M sodium hydroxide was added to the reaction mixture. The total volume of the mixture was adjusted to 10 mL by adding distilled water, ensuring the appropriate concentration of reactants for precise measurement. The absorbance of the sample was measured at a wavelength of 510 nm relative to the blank sample using a spectrophotometer. The results were calculated based on the calibration curve of quercetin and expressed as quercetin equivalent (QE) per gram of dry plant material, allowing the quantification of the total flavonoid content in the sample.

### **Analysis of Antioxidant Power Using the FRAP Method (Ferric Reducing Antioxidant Power)**

To assess the reducing power of *Nigella sativa*, the Ferric Reducing Antioxidant Power (FRAP) method was used. This method is based on measuring the antioxidant capacity of a substance by its ability to neutralize free radicals, donating electrons and reducing iron ions ( $\text{Fe}^{3+}$ ) to their reduced forms ( $\text{Fe}^{2+}$ ), which results in a color change in the reaction mixture.

The color change, typically to a bluish hue, is proportional to the concentration of reduced iron and is used to quantify the total antioxidant activity of the sample.

In accordance with the procedure established by Benzie and Strain (Singleton et al., 1999, 15-27), the reducing power of the extracts, which reflects their antioxidant activity, was determined through a series of specific steps outlined in their protocol. For the analysis, 0.1 mL of *Nigella sativa* extract was added to 3 mL of freshly prepared FRAP reagent. The mixture was incubated at 37°C for 30 minutes, resulting in the formation of a colored complex. After incubation, the absorbance of the sample was measured at 593 nm using a spectrophotometer. This wavelength corresponds to the maximum absorption of the iron-TPTZ complex formed during the reaction, enabling precise measurement of the sample's antioxidant activity. The FRAP value was calculated based on the calibration curve of iron(II) sulfate heptahydrate, which is used to quantify the antioxidant activity of the sample. The results were expressed in moles per gram of plant material, allowing precise measurement of the reducing power of the extract relative to the standard reference.

### DPPH Radical Scavenging Activity

This method is based on assessing the ability of the tested samples to neutralize or "scavenge" the stable DPPH radical, thereby quantifying their antioxidant activity. The 2,2-diphenyl-1-picrylhydrazyl (DPPH) method was applied following the protocol previously described by Horozić et al. (Horozić et al., 2019, 14-19), with specific modifications for this analysis. The percentage inhibition of DPPH radicals was estimated by mixing 2 mL of the extract solution (concentration 0.5 mg/mL) with 0.5 mL of 0.5 mM DPPH radical solution. The mixture was then incubated at room temperature in a dark room for 30 minutes to allow the reaction between the extract and the DPPH radicals. For the control sample, a 0.5 mL solution of 0.5 mM DPPH, previously diluted with 4 mL of methanol, was used to provide a reference value for absorbance in the absence of the extract. The radical scavenging effect, expressed as the percentage inhibition of DPPH radicals, was calculated using the following equation:

$$[(A_c - A_s) / A_c] \times 100$$

Where  $A_s$  represents the absorbance of the solution containing the sample, measured at 517 nm, while  $A_c$  denotes the absorbance of the control solution containing DPPH radicals (without the sample). This calculation allows for the assessment of the sample's ability to reduce the concentration of DPPH radicals, or its antioxidant activity, based on the decrease in absorbance.

### RESULTS AND DISCUSSION

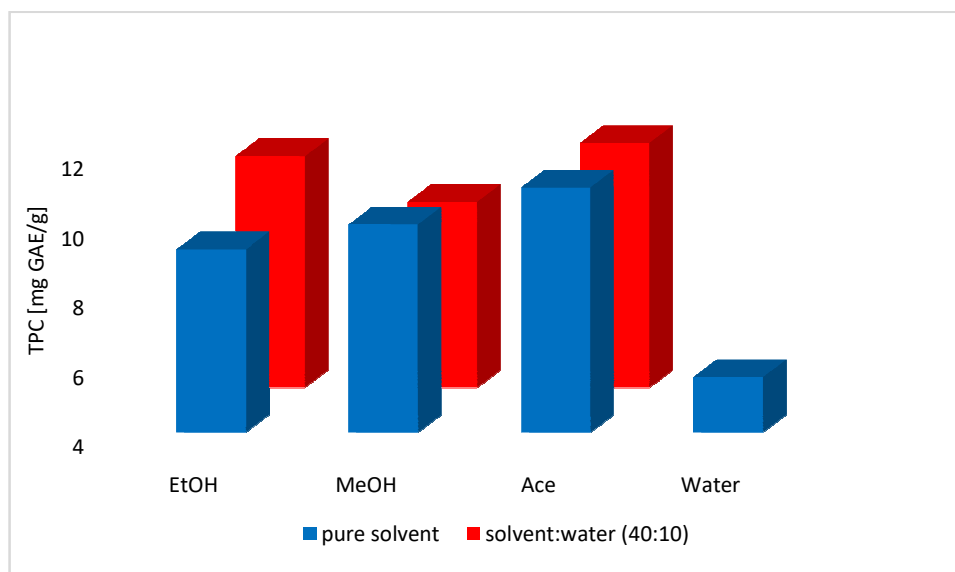
Phenolic compounds extracted from black cumin seeds exhibit significant biological properties, including antioxidant, anti-inflammatory, and antimicrobial activities. Therefore, investigating the efficiency of different organic solvents in extracting these compounds is crucial for exploring their potential in the pharmaceutical and nutritional industries. The ability of phenolic compounds to neutralize free radicals can be assessed through various methodological approaches. One of the most widely used and recognized tests for measuring the concentration of phenolic compounds is the Folin-Ciocalteu colorimetric method (Vuolo et al., 2019, 33-50). This method enables precise quantification of phenolic compounds based on their capacity to absorb light at specific wavelengths, thus providing insight into their potential for free radical elimination (Bhawani et al., 2015, 170239). The total polyphenol and flavonoid content in the black cumin seed extracts is shown in Table 1.

Table 1. Results of content of bioactive components and antioxidant activity of *Nigella sativa*

Sample	Extraction solvent	Solvent ratio (v/v)	TPC [mg GAE/g]	TFC [mg QE/g]
A-1	EtOH	-	9,259	0,0496
A-2	EtOH:Water	40:10	10,66	0,0913
A-3	EtOH:Water	30:20	5,252	0,0339
A-4	EtOH:Water	20:30	3,609	0,0644
A-5	EtOH:Water	10:40	3,516	0,0455
A-6	MeOH	-	9,980	0,1401
A-7	MeOH:Water	40:10	9,347	0,0858
A-8	MeOH:Water	30:20	3,580	0,0463
A-9	MeOH:Water	20:30	3,340	0,0514
A-10	MeOH:Water	10:40	3,707	0,0516
A-11	Ace	-	11,042	0,0613
A-12	Ace:Water	40:10	14,35	0,0737
A-13	Ace:Water	30:20	10,828	0,0246
A-14	Ace:Water	20:30	4,311	0,0477
A-15	Ace:Water	10:40	4,183	0,0162
A-16	Water	-	5,588	0,0281

The highest concentration of phenolic compounds was recorded in extracts prepared using aqueous mixtures of organic solvents. Among the different solvent combinations, the most effective system was the one in which water was mixed with the organic solvent in a 40:10 ratio, which showed the highest capacity for phenolic compound extraction, 14.35 mg GAE/g. The lowest yield of phenolic compound extraction was observed in samples prepared using a mixture of organic solvents and water in a 20:30 ratio. This system demonstrated significantly lower extraction efficiency, with the concentration of phenolic compounds being three times lower compared to the more optimal mixture of water and organic solvent in a 40:10 ratio. These results suggest that changes in solvent ratios can significantly affect extraction efficiency, highlighting the importance of balancing proportions in extraction systems to achieve the maximum concentration of bioactive compounds.

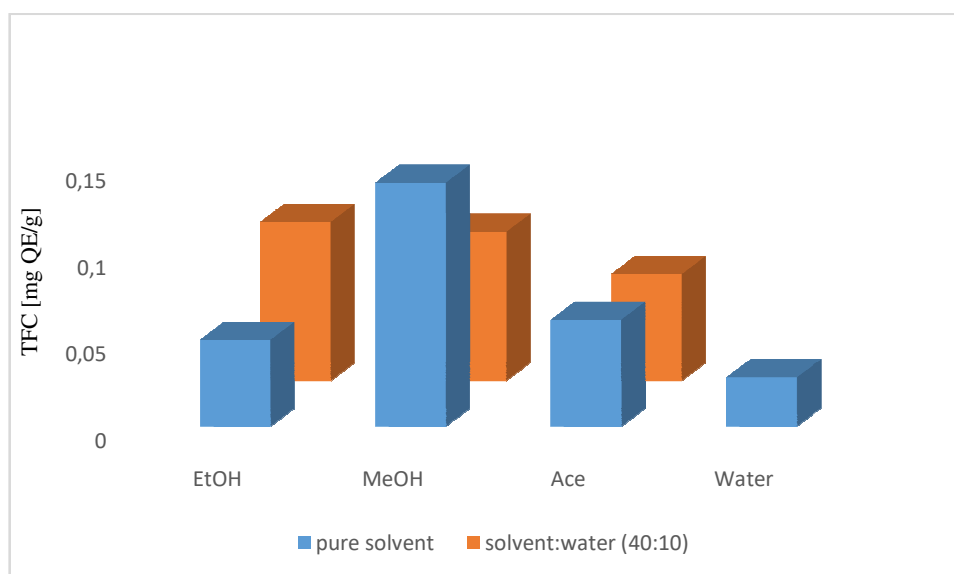
This result contributes to a deeper understanding of the dynamics of phenolic compound extraction and aids in optimizing methods for obtaining high-quality extracts.



**Figure 3.** Content of total polyphenols in extracts of *Nigella sativa*

Among the various organic solvents, acetone demonstrated the highest efficiency in phenolic compound extraction from black seed (*Nigella sativa*) due to its specific chemical properties, which make it highly suitable for extracting phenolic compounds.

Phenolic compounds, such as phenolic acids and flavonoids, are characterized by being polar molecules but often contain nonpolar or weakly polar groups in their structure. Acetone, as a more polar organic solvent, has an excellent ability to interact with these molecules through its hydroxyl and methyl groups. The extraction mechanism with acetone can be explained by its ability to dissolve a wide range of more polar molecules, while still maintaining enough nonpolar characteristics to include nonpolar phenolic compounds. For this reason, acetone effectively "prepares" phenolic compounds for dissolution, facilitating their extraction from solid materials such as black seed.



**Figure 4.** Content of total flavonoids in extracts of *Nigella sativa*

Methanol has shown superiority in extracting flavonoids from black seed (*Nigella sativa*) due to its specific chemical and physical properties that enable efficient flavonoid extraction, while water, as a solvent, has the least potential for this type of extraction (Figure 4). The differences in extraction efficiency can be explained by several key factors, including the polarity of the solvent, its interaction with flavonoid molecules, and the solvent's ability to penetrate the cellular structure of plant materials.

Methanol's superiority in flavonoid extraction from black seed can be attributed to its ability to dissolve both polar and nonpolar components of flavonoids, as well as its lower viscosity, which allows for faster extraction.

On the other hand, water, as a solvent, has limited efficiency in extracting flavonoids due to its polar nature and its inability to fully interact with the complex structural characteristics of flavonoids. These results highlight the importance of selecting appropriate solvents for the extraction of specific bioactive compounds, thus contributing to the optimization of extraction procedures in research involving natural plant materials.

The antioxidant activity of black seed extracts was assessed using two different methods: the FRAP (Ferric Reducing Antioxidant Power) and DPPH (2,2-diphenyl-1-picrylhydrazyl) methods.

The FRAP method measures the ability of a sample to reduce the ferric ion complex ( $\text{Fe}^{3+}$  to  $\text{Fe}^{2+}$ ), indirectly evaluating its potential to neutralize free radicals. The DPPH method is based on measuring the sample's ability to inhibit DPPH free radicals, specifically reacting with free radicals and causing a color change, which allows for the quantification of antioxidant activity. The results of antioxidant capacity are presented in Table 2.

**Table 2.** Results of content of bioactive components and antioxidant activity of *Nigella sativa*

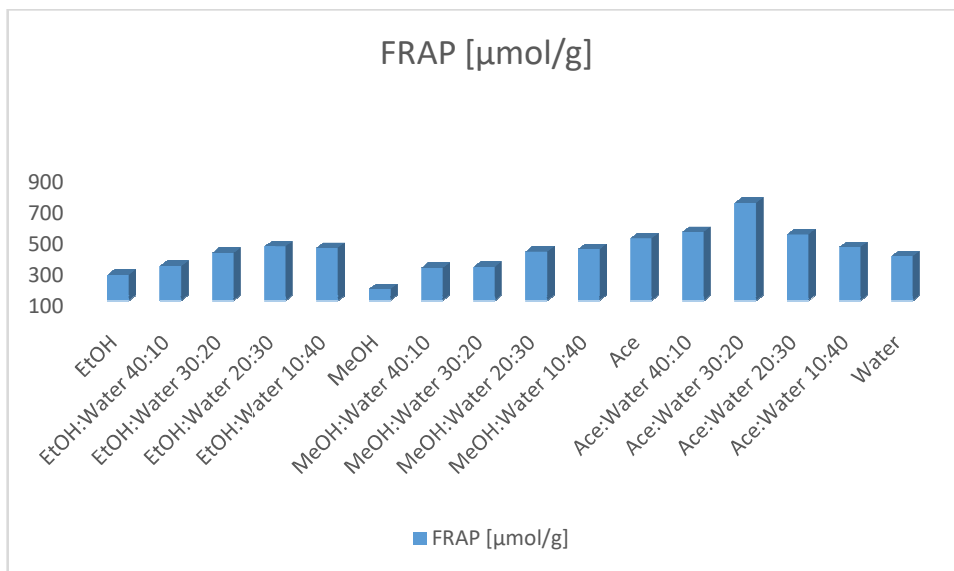
Sample	Extraction	Solvent ratio (v/v)	FRAP [ $\mu\text{mol/g}$ ]	DPPH inhibition [%]
	solvent			
A-1	EtOH	-	264,3	11,27
A-2	EtOH:Water	40:10	321,3	24,71
A-3	EtOH:Water	30:20	405,6	26,28
A-4	EtOH:Water	20:30	446,2	27,66
A-5	EtOH:Water	10:40	438,2	16,42
A-6	MeOH	-	172,2	14,57
A-7	MeOH:Water	40:10	309,2	21,17
A-8	MeOH:Water	30:20	315,1	27,27
A-9	MeOH:Water	20:30	414,8	27,76
A-10	MeOH:Water	10:40	428,3	27,69
A-11	Ace	-	498,1	6,28
A-12	Ace:Water	40:10	540,9	19,28
A-13	Ace:Water	30:20	728,8	33,47
A-14	Ace:Water	20:30	523,8	29,40
A-15	Ace:Water	10:40	442,5	26,00
A-16	Water	-	384,2	21,81

The results of the study obtained through both tests showed that, generally, with an increase in the water content in the extraction system, the antioxidant potential of the obtained extracts also increases. This trend can be explained by the fact that water, as a polar solvent, has the ability to extract hydrophilic components from the extract, including bioactive compounds with pronounced antioxidant properties, such as flavonoids and phenolic acids.

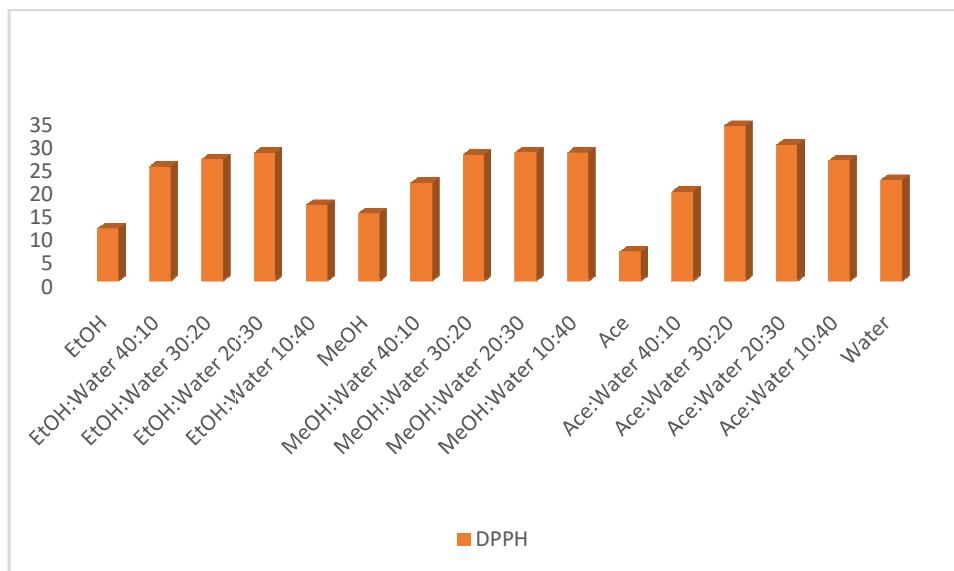
Due to its polarity, water is efficient in dissolving polyphenolic compounds, which are known for their potential to neutralize free radicals. As the water content in the extraction solution increases, the solutions become more efficient at extracting these compounds, resulting in higher levels of antioxidant activity.

However, an interesting exception in this study is acetone, which showed the highest antioxidant potential when used in a mixture with water in a 20:30 ratio. This can be explained by the specific structural properties of acetone, which combines both polar and non-polar characteristics, making it highly efficient for extracting a wide range of polyphenolic compounds. The mixture of acetone and water in the optimal ratio provides the best combination of solvating ability for both polar and non-polar components, leading to the

extraction of a greater number of bioactive compounds with a high capacity to neutralize free radicals, as confirmed by the high antioxidant activity in both tests (FRAP and DPPH).



**Figure 5.** Antioxidant activity of *Nigella sativa* seed extract according to the FRAP method



**Figure 6.** Efficiency of DPPH radical inhibition depending on the concentration of the extracts

## CONCLUSION

This study analyzed the efficiency of different solvents, as well as their aqueous mixtures, in the extraction of bioactive components with pronounced antioxidant activity from *Nigella sativa* seeds. Based on the obtained results, it was found that acetone showed the highest efficiency in extracting polyphenolic compounds, which can be attributed to its chemical properties. Acetone, as a polar solvent, enables effective extraction of a wide range of polyphenolic compounds, including flavonoids and phenolic acids, which are key to the expressed antioxidant properties. Furthermore, the research demonstrated that the combination of water with organic solvents significantly improves the efficiency of bioactive component extraction compared to the use of pure organic solvents. Mixtures of water with organic solvents, such as acetone, allow for a synergistic effect that enhances the dissolution and extraction of polyphenolic compounds with antioxidant activity. These results suggest that water, as a polar solvent, contributes to better extraction of hydrophilic components, while organic solvents help in extracting nonpolar or weakly polar compounds.

In comparison to the use of pure organic solvents, which demonstrated lower efficiency in extracting polyphenolic compounds in this study, the use of solvent mixtures allows for a balance between polar and nonpolar characteristics, resulting in a higher overall yield of bioactive compounds.

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# Typological Characteristics of Nakhchivan Mosques in XI-XIX Centuries

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## **ABSTRACT**

The territory of Nakhchivan is rich in irreplaceable works of art of Turkish-Islamic architecture. Researches suggest that the medieval mosques of Nakhchivan differ from each other in terms of their plan-volume structure and the solution and functional purpose of the architectural composition. Based on the research, it can be said that there have been certain changes in the plan-volume structure of religious architectural monuments over time, they have developed and acquired new features. The conducted research allows to follow the traditionality and succession in the development of mosques. The mosques with domes and double-layered lighting system typical for XI-XV centuries underwent certain changes in the later periods. Research shows that although the traditional architectural structure of XI-XV centuries continued with certain changes in XVII-XVIII centuries, it changed significantly in XIX century. Single-layer lighting systems appear mainly in mosques built in XIX century. The characteristics observed in the plan-volume structure of the mosques built in previous times, including their double-layer lighting system, have gradually changed. Over time, the architectural structure of the mosques built in our cities and villages has become even simpler. The gabled arched windows, characteristic of earlier periods, gradually disappeared and were replaced by flat-roofed constructions and square windows. The mosques built in this period differ in that their plan-volume structure is simpler. However, the architectural structure of mosques allows us to observe the traditionality, innovation and Turkish-Islamic architecture features in their construction.

**Keywords:** Nakhchivan, Mosque, Architecture, Turkish-Islamic architecture, Dome

## **Introduction**

The medieval mosques and sanctuaries of Nakhchivan differ from each other in terms of their plan-volume structure and the solution and functional purpose of the architectural composition. Mosques have undergone some weathering over time and have been restored. Despite this, most of the religious architectural monuments were able to preserve their archaic structure. While defining their typological groups, their modern situation was taken into account. When defining typological groups of mosques and shrines, their plan-volume structure and architectural composition are taken as a basis. Studies show that there have been certain changes in the plan-volume structure of religious architectural

monuments over time, they have developed and acquired new characteristics. In order to follow the tradition and succession in the development of mosques and sanctuaries, we consider it appropriate to review and analyze them by periods.

**Mosques of XI-XV centuries.** There are very few architectural monuments from XI-XV centuries in Nakhchivan. Few of them consist of mosques. Although all the mosques are rectangular in shape, they differ from each other due to the solution of the roof covering. The first group of mosques is represented only by Juma Mosque in Nakhchivan. This architectural monument was built on a square base, its body is surrounded by columns on three sides. Arch-shaped arches are placed in the body of the columns. The square-shaped columns are completed with arches on top, and the transition to the semi-circular dome is made with triangular planes separated from the top of the columns. The arched windows placed in the dome of the mosque are also a remarkable architectural element. According to researchers, this was due to the fact that the mosque was surrounded by rooms or passages from the sides (Salamzadeh, 1976, p. 29). The layout of the Nakhchivan Juma Mosque is similar to the structure of the Marand and Urmiya Juma Mosques XIV century (Bayramov 2013, p. 123).

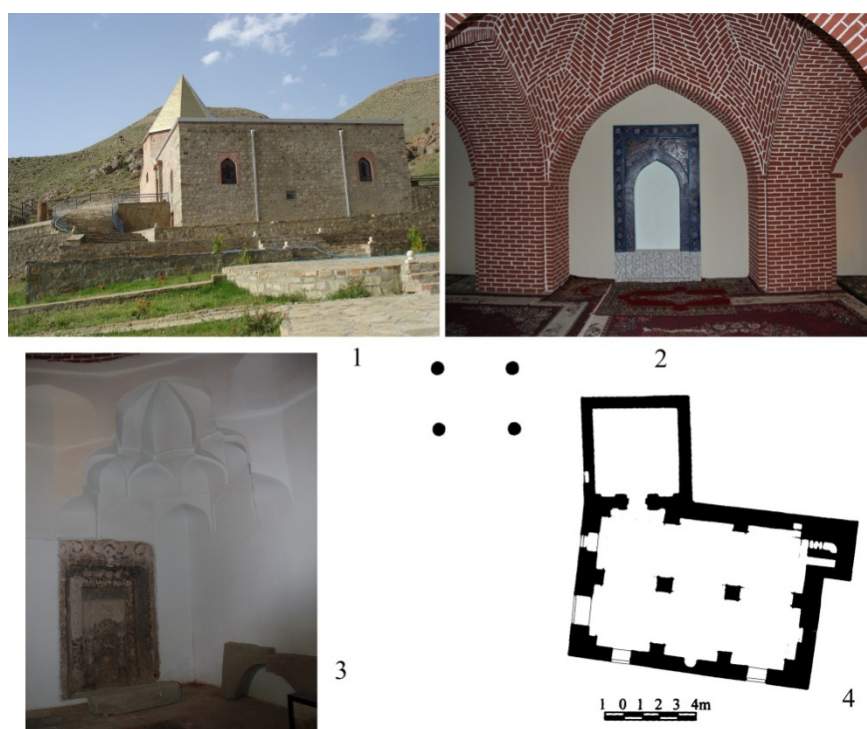
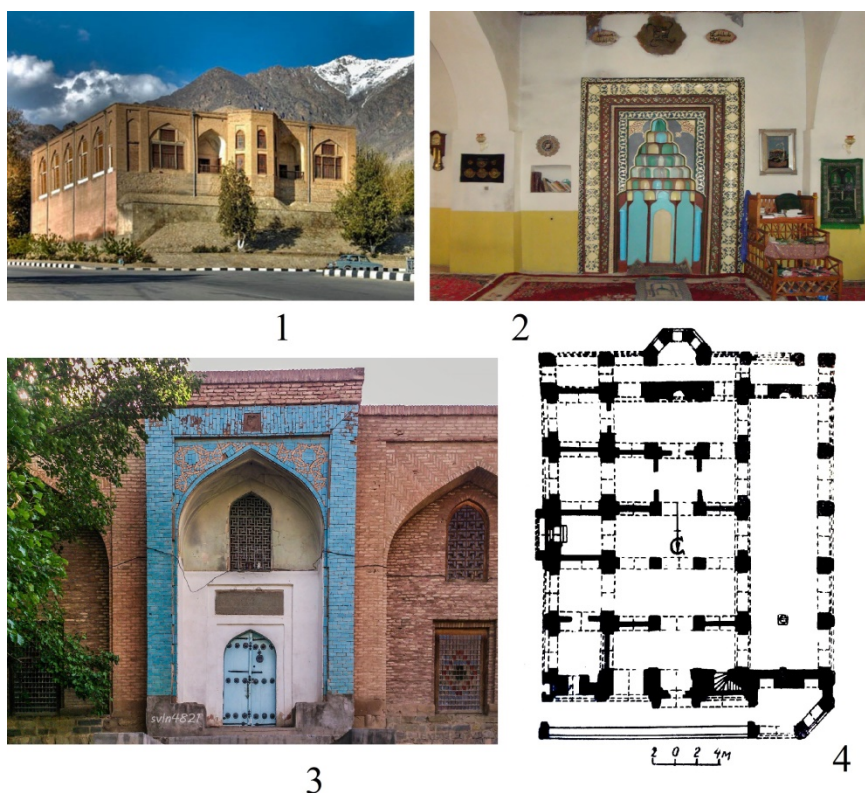


Figure 1. Khanegah mosque and tomb: 1-external view; 2-3 internal views; 4-plan (Bayramov 2013).

The Kirna mosque can also be attributed to this type. A. V. Salamzadeh, one of the researchers, said that the plan-volume structure of this architectural monument is typical for tombs. (Salamzadeh, 1976, p. 52). K.M. Mammadzade called this construction a religious complex and assumed it to be a khanaghah (Mammadzade, 1983, p. 34). J.A. Qiyasi said that its plan-spatial structure is not typical for tombs, and called this building a mosque (Qiyasi, 1991, p. 49). The Kirna sanctuary is built on a square base and has unique features in terms of the solution of the architectural structure. Its entrance is solved by three pointed arch-shaped openings. The arch in the middle is wider than the others. The architectural solution of the opposite side is also in accordance with this. The other two side walls are similar to each other. According to J. A. Qiyasi, the Kirna sanctuary had a semicircular dome-shaped roof

(Qiyasi, 1991, p. 49). From this point of view, although the Kirna shrine is similar to the Amirkhan tomb and the Yaralı Sultan hearth, the transition from the square base to the dome was first solved in the form of a transition to an octahedron and then to a hexahedral one. The sanctuary differs from other square-shaped sanctuaries due to this feature.

The second typological group of mosques includes two mosques, the mosque in the Khanaga village and the mosque included in the Khanagah architectural complex (Figure 1). Both of these mosques were built in a rectangular plan. The prayer hall of the mosques is divided into two parts by square columns. There are two square columns in the central hall of both mosques, and half-columns of the same shape are placed on their opposite sides. Columns and semi-columns are connected with archways at the top, creating a transition to semi-circular domes. Both mosques are covered with six domes. It can be said that these mosques, which repeat each other in terms of architectural style, were built in the same period. However, despite this, the hall of the mosque in the village of Khanaga is distinguished by the presence of a double lighting system, or rather, windows placed on top of each other. On the other hand, the Khanaga mosque is also distinguished by the presence of additional constructions around it. Perhaps these constructions were built in a later period. This type of plan-volume structure was also applied in the construction of Marand Juma Mosque (Бретанцкий, 1966, p. 162, figure 86).



Picture 2. Ordubad city Friday mosque: 1-external view; 2-altar; 3-entrance door; Plan 4 (Salamzadeh, Mammadzadeh, 1985).

The third type of mosques was represented by Vanand and Kirkhkimsana mosques. These mosques differ from the previous ones in that they have flat roofs. The prayer hall of mosques has a square shape. Another feature common to both mosques is that the prayer hall is provided with a double-layer lighting system. However, we must note that the internal plan structure of these mosques is somewhat different from each other. Thus, the hall of the Vanand mosque is distinguished by the additional constructions on the side and

the division of the prayer hall into four parts by three rows of columns. Hexagonal and square columns were used to support the ceiling in the Vanand mosque. Two columns were used in Kirkhkimsana mosque. One of the columns is rectangular and the other is square. The thickness of the columns located in the central halls and their stone construction allow us to assume that the roof coverings were not covered at that time. However, since the mosques have been renovated many times, there are no clues about the structure of their roofs.

We can say that, unlike the square-shaped first group of mosques, the second and third group of mosques differ in that the central hall is divided into several parts by columns. We find this solution of the plan structure in the mosques of the 14th century (Bretansky, 1966, p. 162-164) and later periods..

### Mosques of XVI-XIX centuries

Mosques of this period are mainly rectangular in shape and have a flat roof. Gable roofs and domed roofs of the previous period are rarely found in this period. However, research shows that some of the mosques of this period had a dome-shaped roof, but later they changed due to renovation works. The rectangular halls of mosques are divided into several parts by rows of columns. The lighting system of the mosques of this period is similar to the first period. So, since the mosque buildings were tall, windows placed on top of each other were used in this period. The mosques of this period differ from each other due to certain characteristics of the plan structure. Mosques built on a high platform can be attributed to the first type. The oldest and best example of this type is Ordubad Juma mosque.

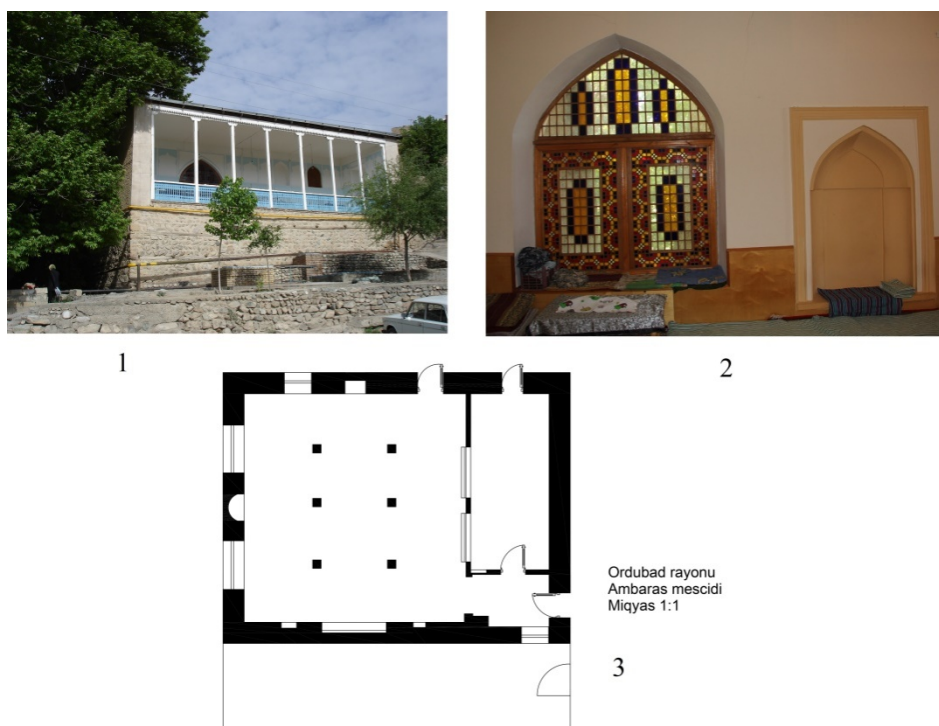


Figure 3. Ambaras mosque in Ordubad city: 1-external view; 2-interior view; 3-plan.



Ordubad Juma Mosque has a double-layered lighting system, as in the mosques of the first period (Figure 2). The windows are rectangular and placed in arched arches. One of the distinctive features of the Ordubad Juma Mosque is the fact that the rectangular columns protrude to the four sides and they are decorated with arched arches. One of the unique features of Juma Mosque is that one part of it has a domed ceiling, while others have a flat roof. One of the characteristic features of this mosque is that its mihrab protrudes outward. In the plan given by V.M.Sisoyev, this protrusion is rectangular, and in the plans developed after that, it is polygonal (Salamzadeh, Mammadzadeh 1985, p. 200). However, regardless of its form, this solution of the mihrab is characteristic only for Ordubad Juma mosque and is not found in other mosques of Nakhchivan. The presence of two altars in Ordubad Juma mosque is also a remarkable feature.

One of the mosques included in this type is the Ambaras mosque (Figure 3). The hall of the Ambaras mosque is divided into three parts by two rows of quadrangular columns. Its distinguishing feature is the presence of a narrow corridor in front of the entrance. Arched windows are one of the characteristic features of this type.

Some of the mosques of the second type were built on a low plinth, while others were built without a plinth. In some of them, according to the topography of the land, a podium was built on only one side of the building. Takeshiyi and Angesh mosques can be included among this type of mosques. A characteristic feature of the external appearance of the Tekeshyi mosque is the presence of arched arches on the sides of the entrance. We find this architectural element in the interior structure of Parchi Imamzadeh. In this mosque, unlike other mosques, large square niches have been made in place of the lower windows.

The third type of mosques are two-story. The best examples of these mosques are Sarshaher and I Mingis mosques. The first floor and the second floor of the mosques differ from each other due to their architectural design. So, while the ceiling of their first floor is solved by the gable method, the ceiling of the second floor is flat. The facade of both mosques is solved with window passages placed between square columns. The windows on the facade of the first floor of the Sarshaher Mosque are arched, and those on the second floor are rectangular. In this regard, the windows located on the second floor of the Mingis mosque are rectangular, but they are placed in arched arches. We believe that these mosques underwent certain changes during the restoration and repair works.

The fourth type of mosques are without pews. Dilbar mosque in Ordubad city (Figure 4), Bilal mosque, mosques in Dasta village of Ordubad region belong to the class of mosques without pews. The solution of the plan-volume structure of these mosques, especially the two-layer lighting system, is similar to other mosques. However, the lighting of some mosques, including the Dilbar mosque, is single-layered.

The mosque in Yukhari Aylis village of Ordubad region can be included among the fifth type of mosques. The difference of this mosque from other mosques is that its outer facade is surrounded by a colonnade on the west side. However, since the facade of the mosque was completely changed during the renovation works, it is impossible to imagine its original appearance.

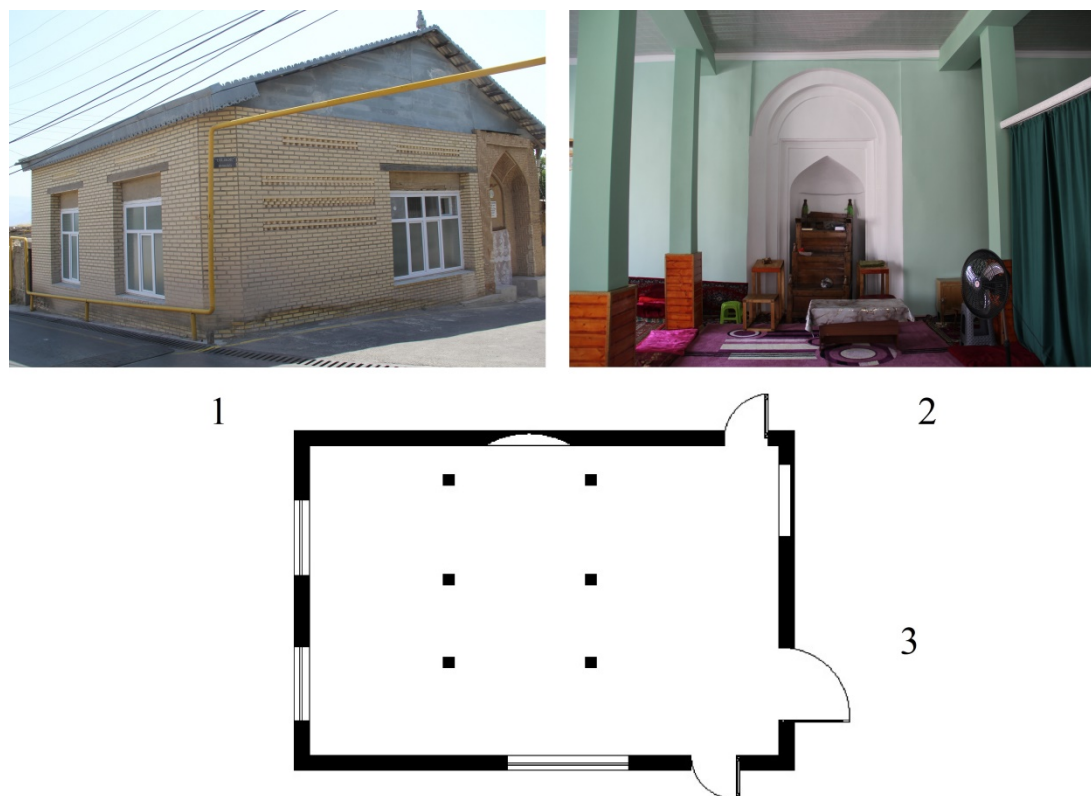


Figure 4. Dilbar mosque: 1-external view; 2-interior view; 3-plan.

### Conclusion

Research shows that the double-layer lighting system was typical for the medieval mosques of Nakhchivan, and the single-layer lighting system appeared mainly in the mosques built in the 19th century. The characteristics observed in the plan-volume structure of the mosques built in earlier times, including their double-layer lighting system, have gradually changed. Over time, the architectural structure of the mosques built in our cities and villages has become even simpler. The gabled arched windows, characteristic of the previous periods, gradually disappeared and were replaced by flat-roofed constructions and square windows. The sanctuaries built in this period also differ in that the plan-volume structure is simpler. The architectural structure of mosques and sanctuaries allows us to trace the tradition and innovation in their construction. Researches show that the medieval mosques of Nakhchivan are architecturally characteristic of Turkish-Islamic architecture, including Azerbaijani architecture.

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# Exploring Multi-Photon Absorption in Morse Quantum Wells: The Role of Magnetic Fields and Electron-Phonon Interactions

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## **Abstract**

This study provides a comprehensive analysis of the influence of magnetic fields and aluminum doping concentration on the multi-photon nonlinear optical absorption spectra in quantum wells (QWs) with Morse confinement potentials. By incorporating electron-phonon interactions and considering both optical and acoustic phonon mechanisms, we reveal how these factors contribute to tuning the optical properties of QWs. An increase in the magnetic field causes a pronounced blue shift in the absorption spectra, reflecting the system's sensitivity to magnetic effects. Similarly, higher aluminum doping concentrations also induce a blue shift in the peak positions while enhancing their intensities, demonstrating the combined effects of structural and external field parameters. Moreover, these parameters significantly impact the full-width at half maximum (FWHM) of the absorption peaks. Stronger magnetic fields and higher aluminum doping concentrations broaden the FWHM, while variations in the QW width result in red shifts and narrower peaks. The interplay of these factors highlights their importance in the fine-tuning of optical absorption processes, including one-photon (1PA), two-photon (2PA). Our findings underscore the potential of Morse QWs as versatile platforms for designing advanced optoelectronic devices with customizable magneto-optical properties. The ability to precisely control absorption spectra through magnetic fields and doping concentrations makes these systems highly promising for future applications in nonlinear optics and photonics.

**Keywords:** Morse quantum wells, multi-photon absorption spectra, electron-phonon interactions



## I. Introduction

A major research focus in QWs is understanding how confinement and external conditions influence electron behavior. Among various QW models, the Morse potential provides a flexible approach, allowing researchers to adjust its asymmetry and depth to investigate optical and electronic properties. Studies have shown that external fields, such as electric or magnetic fields and linearly polarized electromagnetic waves (LPEMW), can significantly alter these properties. For instance, intense laser fields and the parameters of the Morse potential have been shown to affect phenomena like nonlinear optical rectification and harmonic generation. Despite these findings, many studies overlook the influence of electron-phonon interactions, particularly for acoustic phonons, which are critical for understanding energy transfer processes.

When magnetic fields are applied, electrons form quantized Landau levels, leading to transitions triggered by multi-photon absorption (MPA) and phonon interactions. This phenomenon, known as magneto-phonon or cyclotron-phonon resonance, has been studied extensively for bulk materials and various QW models. These investigations provide insight into material properties, including effective mass, energy gaps, and scattering mechanisms. While numerous geometric confinement models, such as square, parabolic, and triangular potentials, have been explored, there is limited research on how Morse QWs behave under these conditions, especially in relation to electron-acoustic phonon interactions. This paper addresses these gaps by analyzing optical absorption power (OAP) in Morse QWs. Using second-order perturbation theory, the study incorporates optical to investigate how external fields and Morse potential parameters influence electron absorption spectra. Unlike earlier works, which often prioritize simpler absorption processes.

## II. Theory

### A. Electronic states in Morse QW under applied magnetic field

We analyze a typical  $GaAs/Al_xGa_{1-x}As$  quantum well (QW) system, where the electron's motion is unrestricted in the (xy) plane but is confined along the z-axis by a Morse potential. The Morse potential is expressed as follows [1],[2]:

$$U(z) = U_0 \left[ 1 - \exp\left(-\frac{z}{L}\right) \right]^2 \quad (1)$$

The barrier height of the Morse quantum well (QW) is determined by the relationship  $U_0 = 0.6 \times (1155 \times x + 370 \times x^2)$  meV, where x represents the aluminum concentration, L is the well width, serves as another critical parameter shaping the potential profile.

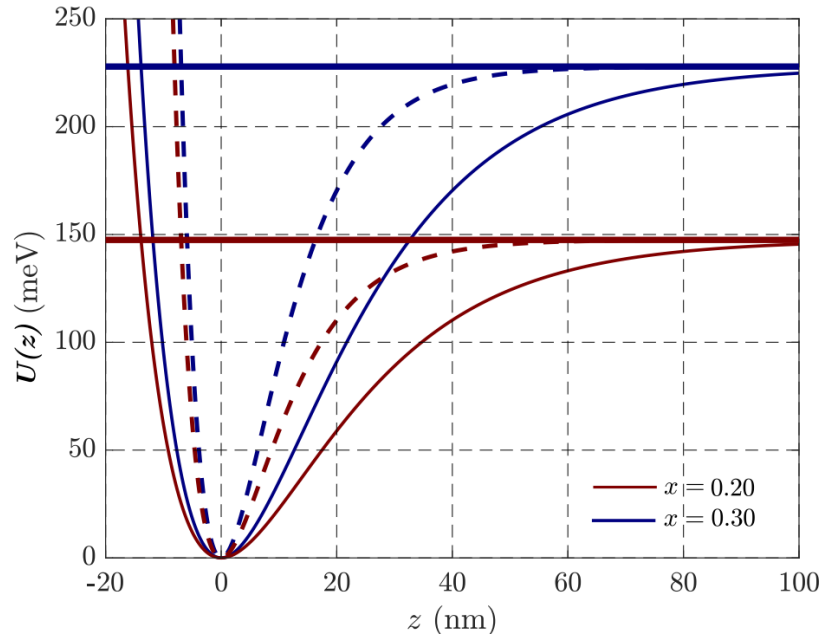


FIG. 1. The potential profiles are illustrated for two varying levels of aluminum concentration.

Figure 1 illustrates several Morse QW potential profiles for varying well widths and aluminum concentrations. The trends observed indicate that as the aluminum concentration increases, the barrier height rises correspondingly. This increase in barrier height results in a greater number of bound electronic states within the well. Consequently, the aluminum concentration emerges as a key factor in shaping the electronic structure and influencing the optical absorption characteristics of Morse QWs.

Through careful adjustment of the aluminum concentration, researchers can effectively control the confinement conditions and optimize the electronic and optical properties of the system, making it a versatile tool for semiconductor and optoelectronic applications. The energy levels and wave-functions of electrons are defined as [3]:

$$\Psi_{N,n,k_y}(\mathbf{r}) = \frac{\exp(ik_y y)}{\sqrt{L_y}} \Phi_N(x-x_0) \phi_n(z) \tag{2}$$

$$\Phi_N(x-x_0) = \frac{\exp\left[-\frac{(x-x_0)^2}{2\ell_B^2}\right]}{\sqrt{2^N N! \sqrt{\pi} \ell_B}} H_N\left(\frac{x-x_0}{\ell_B}\right) \tag{3}$$

$$E_{N,n} = \left(N + \frac{1}{2}\right) \hbar\omega_B + E_N \tag{4}$$

Here  $\mathbf{k} = (k_x, k_y, k_z)$  is the electron wave vector,  $l_B = \sqrt{\frac{\hbar}{eB}}$  is the magnetic length.  $N = 0, 1, 2, \dots$  presents the Landau index, and  $x_0 = -\frac{k_y}{m_e \omega_B}$  is the coordinate of the center of the normalized harmonic oscillation wave function  $\Phi_N(x - x_0)$ , with  $\omega_B = \frac{eB}{m_e}$  being the cyclotron frequency and  $H_N(x)$  is the N-th Hermite polynomials.

### B. Optical phonon interaction

The coupling coefficient for electron-optical phonon interaction is defined as [4],[5],[6]:

$$|C_q^{op}|^2 = \frac{4\pi e^2 \hbar \omega_q^{op}}{V_0 \epsilon_0 q^2} \left( \frac{1}{k_\infty} - \frac{1}{k_0} \right) \tag{5}$$

here,  $k_\infty = 10.89 - 2.73 \times x$ , and  $k_0 = 13.18 - 3.12 \times x$  [7],[8]. Are the high- and static dielectric constant, respectively.  $\epsilon_0$  being the permittivity in free space.  $V_0 = L_x L_y L_z$  is the volume of the system. Effective optical phonon energy in the barrier  $Al_xGa_{1-x}As$ , assuming non-dispersive optical phonons. For simplicity, in this study, we limit ourselves to the 1PA, 2PA processes, corresponding to  $\ell = 1, 2$ .

$$P^{(op)} = \frac{E_0^2 \sqrt{\kappa_0} \eta e^4 \hbar \omega_0 a_0^2 S^2}{128 \pi^4 \ell_B^6 \epsilon_0 L \hbar^2 \Omega} \left( \frac{1}{\kappa_\infty} - \frac{1}{\kappa_0} \right) \sum_{N',n'} \sum_{N,n} \Lambda_{N,n} G_{n',n''} \left[ H_{\ell=1}^{(op)} + \frac{a_0^2}{8 \ell_B^2} H_{\ell=2}^{(op)} + \frac{a_0^4}{144 \ell_B^6} H_{\ell=3}^{(op)} \right] \tag{6}$$

Here  $\Lambda_{N,n} = \exp\left(-\frac{E_{N,n}}{k_B T}\right) / \sum_{N,n} \exp\left(-\frac{E_{N,n}}{k_B T}\right)$  and  $G_{n',n''} = \int_{-\infty}^{+\infty} |I_{n',n''}(\pm q_z)|^2 dq_z$  is the squared overlap integral describing crystal momentum conservation.

### III. RESULTS AND DISCUSSION

The magnetic field is regarded as a crucial external factor affecting the magneto-optical characteristics of materials, particularly the optical absorption spectra of electrons. Figure below illustrates the optical absorption power (OAP) in the Morse QW as a function of the photon energy of linearly polarized electromagnetic waves (LPEMW) for various strengths of the external magnetic field under both interaction mechanisms.

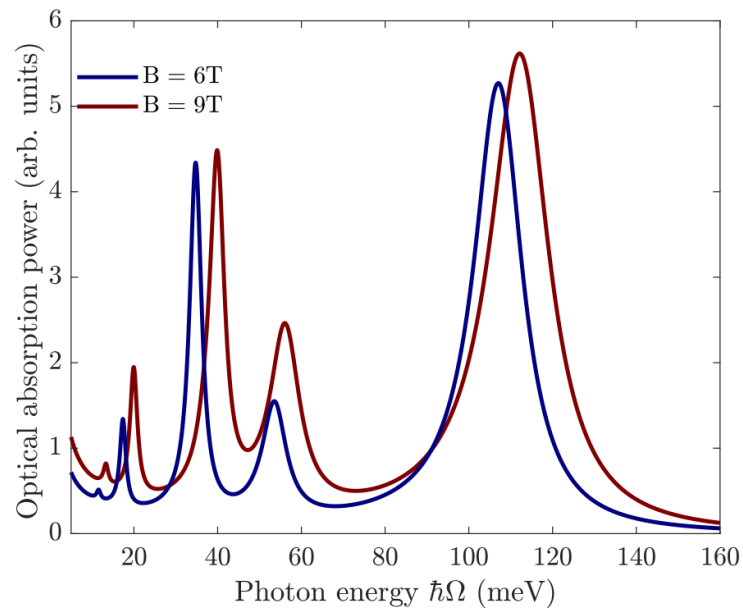


Fig.2: Calculated incident photon energy dependence of the OAP of Morse QWs on several different values of the external magnetic field of the optical phonon

This phenomenon can be observed in Figure 2, where the absorption spectra exhibit a blue-shift, with resonance peaks moving towards the higher-energy region. Additionally, it is evident that the intensity of the absorption peaks increases as the magnetic field strength rises. These findings align well with the conclusions reported in earlier studies.

When the magnetic field  $B$  is oriented along the  $Oz$  axis, it suppresses movement in the  $x$ -direction, improving electron confinement in the Morse quantum well. This results in a more pronounced optical absorption effect. Furthermore, the resonance peaks exhibit a shift toward shorter wavelengths (blue shift) and increased intensity in the presence of the magnetic field, as observed in nonlinear optical rectification.

Besides examining the effects of external fields on optical properties, we also focus on how material parameters influence the absorption spectra and the full width at half maximum (FWHM) in Morse quantum wells. Figures below illustrate that as the aluminum concentration  $x$  increases, the height of the resonance peaks in the absorption spectra diminishes due to the deepening of the potential well. Additionally, a blue shift in the absorption spectra is observed with higher aluminum concentrations.

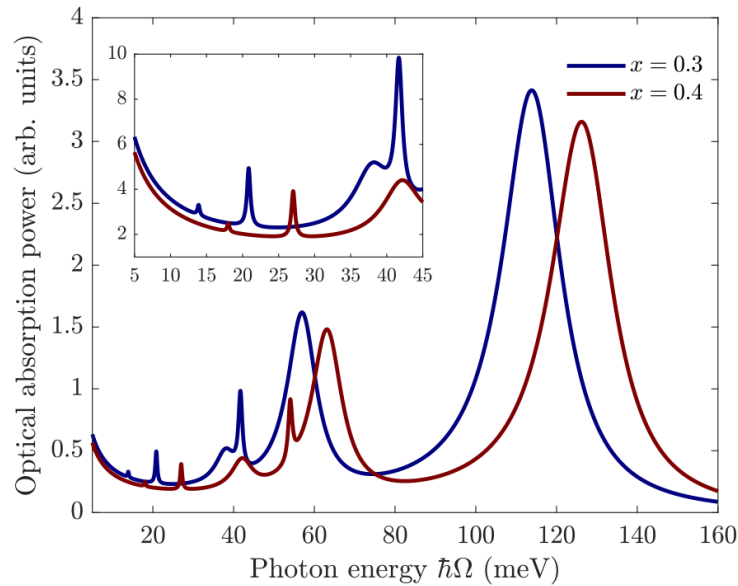


Fig 3: Optical absorption spectra of electrons with varying aluminum doping concentration corresponding to optical phonon

Figure 3 shows that increasing the aluminum concentration  $x$  causes the height of the resonance peaks in the absorption spectra to decrease, corresponding to a deeper potential well. This suggests that greater well depth leads to reduced peak intensity, aligning with previous results. Additionally, a blue shift in the absorption spectra is evident as the aluminum concentration rises.

#### IV. CONCLUSIONS

This study investigates the effects of magnetic field, and material structural parameters on the optical absorption process (OAP) and the full width at half maximum (FWHM) in Morse quantum wells (QW). As heterostructures under the influence of longitudinal polarized electromagnetic waves (LPEMW). The analysis incorporates optical interaction mechanisms, considering multi-photon absorption (MPA) of LPEMW.

The findings show that the peaks corresponding to single-photon absorption (1PA) are the largest and occur at higher energy levels compared to those of two-photon (2PA). Among these, 1PA peaks exhibit the highest intensity.

Applying a magnetic field along the growth direction or increasing the aluminum concentration causes a blue shift in the absorption spectra, while increasing the QW width results in a red shift. These shifts are attributed to variations in the energy separation due to changes in Morse parameters (aluminum concentration) and magnetic field strength.

This study highlights the practical significance of using LPEMW to investigate magneto-phonon resonance processes and determine electron energy subbands in QWs by measuring the spacing between resonance peaks. Additionally, stronger magnetic fields and higher aluminum concentrations increase peak intensity, whereas a larger QW width weakens the quantum confinement effect, leading to lower peak intensities.

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# Forecasting Landslides with Regards to Rainfall Erosivity and Soil Erodibility

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## **ABSTRACT**

Landslide is significantly a main hazard in Malaysia due to its geographical features besides all the factors governing landslide namely rainfall erosivity, soil erodibility, slope length, slope steepness, and conservation practices. Identifying areas prone to landslides is essential for immediate action to be taken by the local authorities in ensuring reliable mitigating measures. Therefore, this study uses the Universal Soil Loss Equation (USLE) to forecast landslides has been used by many developing countries including Malaysia. A Rainfall Erosivity calendar is developed based on historical rainfall data obtained from the Department of Irrigation and Drainage Malaysia. The stages of obtaining the rainfall erosivity includes assessment on the rainfall amount, duration, intensity, rainfall energy, and maximum 30-minutes rainfall interval within the rainfall event. This subsequently will lead to the five categories of landslide risks namely low, moderate, high, very high, and critical. Similarly, Soil Erodibility is classified using the 'ROM' scale having similar five categories as rainfall erosivity. Case studies from Fraser Hill and Genting Highlands reveal typical erosivity and erodibility patterns, providing an insight of potential landslide occurrences. These findings can be used as guidelines to the government authorities in planning future development and preventing untowards landslide incidents.

**Keywords:** Landslide, Rainfall Erosivity, 'ROM' Scale, Soil Erodibility, USLE

## **1. INTRODUCTION**

The increasing demand from population expansion that coupled with environmental changes such as soil erosion, deforestation, urbanization, and hydrological variations has burdened the agricultural practices in Malaysia (Zainal et al., 2018). Historically, soil erosion has substantially contributed to the downfall of ancient civilisations through land deterioration. Currently, this persistent issue highlights the necessity of tackling soil erosion, especially in Malaysia, where geographical and climatic conditions has escalated these threats (Hudson, 1979). Malaysia's geographical location within the destruction zone between latitudes 4°N and 4°S makes it

vulnerable to landslide disasters. Steep terrains are especially susceptible, as heightened precipitation results in stormwater flow that contributes to soil erosion (Shafie et al., 2013).

Soil erosion includes the separation of particles due to rainfall impact, followed by their movement through surface runoff. This process is affected by variables including rainfall intensity, soil texture, and permeability. In locations that undergo regular severe rains such as Malaysia has becomes particularly worrying (Roslan et al., 1996). Land clearing for agriculture, deforestation, and urban development exacerbates the issue by destabilising soils, rendering them more susceptible to erosion (Khalid et al., 2020). Urban development further intensifies the issue by replacing natural landscapes that originally acted as drainage basins, resulting in increased runoff and sediment displacement (Tan et al., 2019).

These factors highlight the urgent necessity to address soil erosion and its impact on the environment. In addition to threatening agricultural practices and ecosystems, soil erosion precipitates landslides in hilly areas, hence affecting land utilisation (Gok, 2010). Landslides present immediate dangers to persons altitudinal and geographical regions (Kamaruddin et al., 2015) and can result in enduring consequences that adversely impact economics and spatial organisation within societies (Khalid et al., 2020).

Identifying areas susceptible to soil erosion is crucial for executing effective management strategies. Upon identifying possible erosion sites, proactive measures such as reforestation, terracing, and the construction of retaining walls may be implemented (Baker et al., 2016). Furthermore, precisely identifying these regions can assist in recognising other places vulnerable to landslide occurrences, hence improving early warning systems and bolstering disaster preparedness (Kamaruddin et al., 2015). Mitigating soil erosion diminishes the likelihood of landslides, conserves soil, enhances water quality in wetland ecosystems and promotes resilient landscapes and secure communities (Shafie et al., 2013).

## **2. Literature Review**

To date, various localities in Malaysia as mentioned in Table 1 have been identified as landslide-prone zones. Malaysia possesses numerous places that are particularly susceptible to landslides due to their steep topography and significant industrialisation. Ulu Klang in Selangor is a high-risk zone with a prolonged history of landslides, causing considerable fatalities and property destruction (Tan et al., 2019). Cameron Highlands and Genting Highlands in Pahang are similarly vulnerable with their steep slopes, agricultural activity and major tourism growth leading to regular landslides, especially during the monsoon season (Zainal et al., 2018). Fraser's Hill similarly encounters landslides on its steep and wooded inclines that frequently impact old roadways (Khalid et al., 2020). Penang Island with its mountainous terrain is prone to rain-induced landslides particularly in locations like Batu Ferringhi and Paya Terubong, where urbanisation has affected natural slope stability (Shafie et al., 2013).



**Table 1:** Landslide prone areas

Location	Description	Reference
Ulu Klang, Selangor	Known for its long history of landslides due to steep terrain and extensive development.	Puspanathan and Sharif, 2015
Cameron Highlands, Pahang	Vulnerable to landslides from intensive agricultural activities and steep slopes, especially during monsoons.	Awang and Ab Rahman, 2018
Genting Highlands, Pahang	Prone to landslides due to steep terrain and significant tourist development that destabilizes slopes.	Abdul Rahman and Mohd Yusof, 2014
Fraser's Hill, Pahang	Characterized by steep, forested slopes, particularly susceptible to landslides after heavy rainfall.	Ranjitkar and Kafle, 2018
Penang Island	Faces high risk of rain-induced landslides due to rapid urbanization in areas like Batu Ferringhi.	Hashim and Jaafar, 2014
Kota Kinabalu, Sabah	Certain areas are vulnerable to landslides, particularly those with steep slopes and extensive development.	Lau and Ibrahim, 2015

However, the challenge still rests in when and where landslides will strike. The precise forecasting of soil erosion and landslide hazards is essential for disaster readiness. Soil erosion is essentially a two-step process comprising the detachment and transportation of soil particles that driven by elements such as rainfall intensity, soil texture, and permeability. This is especially alarming in areas with recurrent heavy rainfall. Instruments like the Universal Soil Loss Equation (USLE) and the Rainfall Erosivity Index are essential for predicting possible erosion-induced landslides by evaluating diverse environmental variables (Wischmeier and Smith, 1960). The USLE is a prevalent empirical model intended to estimate soil erosion resulting from water runoff which consists of rainfall erosivity factor (R), soil erodibility factor (K), slope length and steepness factor (LS), cover management factor (C), and support practice factor (P) (Renard et al., 1997). These elements facilitate the measurement of soil degradation under many circumstances that yielding significant insights into the erosion potential of regions. The R factor in the USLE denotes rainfall erosivity, quantifying the potential influence of precipitation on soil erosion. The calculation is based on the intensity, duration, and frequency of precipitation occurrences (Lal, 1994). Heightened rainfall erosivity can substantially augment soil erosion rates that can rendering slopes more susceptible to landslides (Khalid et al., 2020). Understanding the R factor is essential for evaluating erosion hazards, especially in areas subjected to significant rainfall.

Soil erodibility, represented by the K factor in the USLE, denotes a soil's vulnerability to erosion and is affected by elements like soil texture, structure, organic matter content, and land management techniques (McGregor and Yang, 2009; Sulaiman et al., 2019). Various soil types exhibit distinct responses to erosive forces that influencing their stability on inclines. Sandy soils may erode more readily than clayey soils, emphasizing the necessity of assessing soil characteristics

when evaluating landslide risks. Sandy soils are more prone to erosion than clayey soils because of their greater particle size and lower cohesiveness, rendering them more vulnerable to detachment and transport during rainfall events (Brady and Weil, 2008; Toy et al., 2002). The USLE has been effectively utilised in various real-world situations to forecast landslides, demonstrating its practical application in environmental management (Kamaruddin et al., 2015). Case studies illustrate how the equation can pinpoint regions with elevated landslide risk, facilitating land-use planning and disaster preparedness (Shafie et al., 2013; Zainal Abidin et al., 2022). Understanding soil erosion and landslide susceptibility is crucial for formulating efficient methods to reduce environmental dangers and safeguard communities (Gok, 2010).

Landslides represent a considerable natural danger in Malaysia, especially in areas characterised by heavy rainfall and certain soil conditions that increase susceptibility. The country's challenging topography along with seasonal monsoon rainfall makes it particularly vulnerable to landslides (Gok, 2010; Kamaruddin et al., 2015). Such disasters can lead to serious outcomes, including loss of life, destruction of infrastructure, and societal disruption (Khalid et al., 2020). Understanding the factors contributing to landslides such as precipitation intensity and soil composition is crucial for developing effective risk mitigation strategies and safeguarding affected areas (Shafie et al., 2013).

Rainfall erosivity and soil erodibility are among the most significant variables contributing to landslides. Rainfall erosivity indicates the potential effect of precipitation on soil erosion and is assessed by examining rainfall quantity, intensity, duration, and energy (Lal, 1994). Elevated erosivity can compromise soil stability on inclines which resulting in landslides (Khalid et al., 2020). Through the analysis of historical precipitation occurrences and their association with landslides, a Rainfall Erosivity calendar can be established to classify landslide risk levels from low to critical across the year according to recorded rainfall patterns. Regions such as Ulu Klang and Cameron Highlands are reported as extremely vulnerable to landslides during monsoon seasons due to their steep topography and heavy rainfall (Tan et al., 2019).

In addition to Rainfall Erosivity, Soil Erodibility significantly influences a region's vulnerability to landslides. The erodibility of soil is determined by its composition specifically the proportions of sand, silt, and clay alongside elements such as organic matter and structure (McGregor and Yang, 2009), which are associated with erosion types including sheet, rill, and gully erosion. Figure 1 illustrates a representative instance of gully erosion in the highland regions of Fraser Hill and Genting Highlands. The 'ROM' equation facilitates the classification of soil into various risk categories, ranging from low to critical, thereby offering a comprehensive assessment of landslide susceptibility based on soil properties. Regions with elevated clay content may demonstrate enhanced stability relative to sandy soils after intense rainfall events (Khalid et al., 2020).



**Figure 1:** Gully Erosion Features at (a) Fraser Hill and (b) Genting Highlands

Integrating Rainfall Erosivity and Soil Erodibility data enables the prediction of landslide risk in diverse areas. This holistic method offers essential information for local authorities and disaster management teams while enabling the deployment of early warning systems and land management plans to mitigate landslide risks (Shafie et al., 2013). Anticipating these risks improves immediate disaster mitigation strategies and fosters sustainable land-use planning, thereby safeguarding populations from prospective environmental hazards. This research's findings will enhance informed decision-making and optimise resource allocation for disaster preparedness in Malaysia.

### 3. METHODOLOGY

The case study was performed in Fraser Hill and Genting Highlands, both recognised for their steep topographies and significant rainfall patterns, causing them particularly vulnerable to soil erosion. Data on rainfall erosivity and soil erodibility were gathered over a 12-month duration encompassing both the monsoon and dry seasons to document the variability in rainfall patterns and their impact on soil stability. Rainfall data were sourced from the Department of Irrigation and Drainage Malaysia (DID) to calculate rainfall erosivity.

Soil samples were obtained in Fraser Hill and Genting Highlands at multiple locations along the route, as detailed in Table 3. Each sample underwent testing for soil particle size distribution to ascertain its erodibility index according to the 'ROM' scale (Zainal Abidin and Abu Hassan, 2005). Soil texture analysis was conducted by various laboratory experiments including the hydrometer method which facilitates the classification of soils into high or moderate erodibility groups.

### 4. RESULTS AND ANALYSIS

#### 4.1 Rainfall Erosivity

Rainfall erosivity was calculated using the following equation:  $R = \sum EI_{30}$ , where  $E$  is the kinetic energy of rainfall and  $I_{30}$  is the maximum 30-minute intensity during a rainstorm event (Gok, 2010). The total erosivity for each month was ranked as shown in Table 2, with November showing the highest erosivity in both locations (Khalid et al., 2020).

**Table 2 : Typical Rainfall Erosivity Frequency**

Month	Fraser Hill		Genting Highlands		
	Rainfall Erosivity Frequency	Ranking	Month	Rainfall Erosivity Frequency	Ranking
September	24	1	November	26	1
November	23	2	October	23	2
October	17	4	August	20	4
December	17	5	December	19	5
March	12	10	September	15	10

#### 4.2 Soil Erodibility

The 'ROM' scale was selected due to its proven effectiveness in assessing soil vulnerability in Southeast Asian tropical climates (Harris et al., 2018). Soil erodibility was determined by using the 'ROM' scale equation,  $EI_{ROM}$  as follows (Zainal Abidin, 2009):

$$EI_{ROM} = \frac{\% Sand + \% Silt}{2(\% Clay)}$$

Table 3 shows the degree of soil erodibility in both study areas, where locations closer to the peaks (e.g., km 13-14 in Genting Highlands) experienced higher vulnerability due to exposed soils and reduced vegetation cover (Tan et al., 2019).

**Table 3 :** Typical Degree of Soil Erodibility Index based on 'ROM' Scale

Fraser Hill			Genting Highlands		
Location (km)	'ROM' Scale	Ranking	Location (km)	'ROM' Scale	Ranking
4-5	High	1	13-14	High	1
6-7	High	2	15-16	High	3
7-8	High	4	17-18	High	5
1-2	Moderate	7	6-7	Moderate	9
8-9	Moderate	8	8-9	Moderate	10

### 4.3 Discussions

This study's results have provided essential insights into the vulnerability of Fraser Hill and Genting Highlands to erosion-induced landslides. The research enhances the understanding of the temporal and spatial dynamics of landslides by pinpointing the most susceptible months and high-risk areas, as determined by rainfall erosivity and soil erodibility indices. This knowledge is vital for disaster risk management and urban development, particularly in mountainous regions that undergo seasonal significant rainfall.

Furthermore, the capacity to identify intervals of crucial influence when erosivity reaches its peak can substantially enhance the prediction and alleviation of landslides. For example, in Fraser Hill, the research indicates that September and November provide the greatest risk due to elevated rainfall intensity during these months, while in Genting Highlands, the key dates are October and November. By recognising these critical periods, local authorities can prioritise early warning systems, implement preventive measures, and distribute resources more efficiently during these high-risk months.

Understanding the relationship between precipitation patterns and soil properties has broader consequences beyond the examined regions. The approaches and insights formulated which can be utilised in different hilly regions throughout the nation. The framework developed for quantifying rainfall erosivity and soil erodibility can be duplicated in similar situations which allow state governments to evaluate landslide risk in their individual areas. This prediction ability may be crucial for land-use planning and infrastructure development especially in regions experiencing fast urbanisation on unstable slopes.

This research can establish a basis for developing landslide susceptibility maps that integrate rainfall erosivity, soil erodibility, and terrain data. These maps can be incorporated into Geographic Information Systems (GIS) utilised by planners and developers (Rozali et al., 2024) to delineate no-build zones or regions where supplementary slope stabilisation measures such as terracing or drainage systems that may be required.

## 5. CONCLUSION

This study has successfully demonstrated the critical role of rainfall erosivity and soil erodibility in forecasting landslide risks in Malaysia's hilly terrains, with a specific focus on Fraser Hill and Genting Highlands. Forecasting erosion-induced landslides is crucial because of their socio-economic impacts, including loss of life, property damage, and environmental degradation. From a policy perspective, this research underscores the importance of integrating erosivity and erodibility assessments into the environmental impact assessment (EIA) process. Accelerated erosion resulting from human activities such as deforestation, urbanisation, and poor land use underscores the necessity for legislative frameworks that authorize sustainable land management and development practices. This would guarantee that development projects in hilly or mountainous regions be executed with due regard for landslide hazards, thereby reducing the threat to human life, infrastructure, and the environment. This research has established a comprehensive framework for managing landslide risks in Malaysia's mountainous areas. Facilitating collaboration among scientists, urban planners, and governmental entities will guarantee that future developments are ecologically viable, disaster-resistant, and sustainably administered to safeguard both individuals and the environment.

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# Improvement of Material Transportation in Conveyor Systems Using the TRIZ Methodology

## *TRIZ Metodolojisi ile Konveyör Sistemlerde Malzeme Taşımının İyileştirilmesi*

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### ABSTRACT

Innovation is a powerful tool that enables businesses to achieve sustainable development in a competitive environment. Companies that fail to innovate lose their market advantage and are unable to survive in the long run. This study presents solution proposals for various problems encountered in industrial conveyor systems using the Creative Problem Solving Theory (TRIZ), which has not yet found widespread application in Turkey. TRIZ is a technology-based problem-solving technique that generates creative and innovative solutions, offering a systematic, repeatable approach and guiding one through a wide range of potential solutions.

The conveying process in conveyors involves contradictions between the need to increase speed and capacity while maintaining the stable transport of materials. In this context, the challenge of balancing increasing transport speeds with the safe and stable transportation of materials becomes a fundamental problem in conveyor systems. By using TRIZ's contradiction matrix, solution principles have been identified to resolve these conflicts. The study proposes innovative solutions that enhance speed and efficiency while maintaining stability and reliability. Using TRIZ principles such as dynamics, local quality, and changes in properties, methods like dynamically adjusting the transport speed and optimizing the conveyor belt surface for different material types have been developed. These solutions improve the transportation efficiency of the conveyor system while ensuring the materials are transported safely and stably without damage.

**Keywords:** TRIZ, conveyor systems, contradiction matrix, innovation

### ÖZET

İnovasyon, işletmelerin rekabet ortamında sürdürülebilir kalkınmalarını sağlamaları için güçlü bir araçtır. İnovasyon gerçekleştiremeyen işletmeler pazar avantajını kaybetmektedirler ve uzun vadede hayatlarına devam edememektedirler. Bu çalışmada, ülkemizde henüz çok fazla uygulama alanı bulamamış Yaratıcı Problem Çözme Teorisi (TRIZ) tekniği kullanılarak endüstriyel konveyör sistemlerinde karşılaşılan birtakım problemlere çözüm önerileri sunulmuştur. TRIZ, problemlere yaratıcı ve yenilikçi çözüm üreten, sistematik, tekrarlanabilir, geniş çözüm önerileri içinde çözüme giden yolda size rehberlik eden, teknoloji temelli bir problem çözme tekniğidir.

Konveyörlerde taşıma süreci, hız ve kapasitenin artırılması gerekliliği ile malzemelerin stabil taşınması arasındaki çelişkileri içerir. Bu bağlamda, artan taşıma hızının malzemelerin dengeli ve güvenli taşınmasını zorlaştırması, konveyör sistemlerinde temel bir problemdir.

TRIZ'in çelişkiler matrisi kullanılarak, bu çelişkiler arasında denge sağlanabilecek çözüm prensipleri belirlenmiştir. Çalışmada, hız ve verimliliğin artırılmasına yönelik iyileştirmeler yapılırken stabilite ve güvenilirliğin korunmasını sağlayan yenilikçi çözümler önerilmiştir. Çözüm sürecinde dinamiklik, yerel kalite, özelliklerin değişimi gibi TRIZ prensipleri kullanılarak, taşıma hızının dinamik ayarlanması, konveyör bant yüzeyinin farklı malzeme türlerine göre optimize edilmesi gibi yöntemler geliştirilmiştir. Bu çözümler, konveyör sisteminin taşıma verimliliğini artırırken, malzemelerin hasarsız ve dengeli taşınmasını mümkün kılmıştır.

**Anahtar Kelimeler:** TRIZ, konveyör sistemler, çelişkiler matrisi, inovasyon

## 1.Giriş

Endüstriyel üretim ve lojistik süreçlerinde konveyör sistemleri, malzemelerin etkili ve hızlı bir şekilde taşınması için kritik bir rol oynamaktadır. Günümüzde üretim verimliliğini artırmak ve maliyetleri düşürmek amacıyla konveyör sistemlerinden beklentiler artmıştır. Ancak, taşıma hızını ve kapasitesini artırma ihtiyacı, malzemelerin stabilitesinin ve güvenilirliğinin azalması gibi çelişkiler ortaya çıkarmaktadır. Bu durum, yalnızca üretim sürecinde aksamalara yol açmakla kalmaz, aynı zamanda malzeme kaybı ve güvenlik riskleri oluşturur.

TRIZ yöntemi, bu tür teknik ve sistemik çelişkileri analiz etmek ve yenilikçi çözümler sunmak için etkili bir araç olarak kullanılmaktadır. TRIZ, problemlerin kök nedenlerini anlamaya ve bilinen yenilikçi çözümlerden faydalanmaya olanak sağlar.

Geleneksel yöntemlerle çözülemeyen bu problemlerin üstesinden gelmek için yenilikçi ve yaratıcı bakış açısına ihtiyaç vardır. Zor yaratıcı problemlerin çözümünü kolaylaştırmak ve tüm insanlığın bu kolaylıktan yararlanmasını sağlamak isteyen G. Altshuller tarafından geliştirilen TRIZ (Yaratıcı Problem Çözme Teorisi) bu ihtiyacı karşılamayı amaçlamaktadır. (Şener, 2006: 1).

Altshuller' e göre yaratıcı problem, çözümün hiçbir dergi, makale ve teknik uzmanda olmadığı, sistemin veya problemin bir ögesinin iyileştirilirken diğer bir ögesinin kötüleştiği problem tipleridir.

Sistemin sadece bir parçasını geliştirmek için yapılan bir işlem, sistemin öteki bölgelerine ya da komşu sitemlere zarar veren bir tesir yaratırsa buna "teknik çelişki" denir. Bu tip problemleri çözmek için çelişkileri ortadan kaldırmak gerekir. (Altshuller & Shulyak, 1996: 14)

TRIZ' de, genellikle küçük miktarda kaynağın kullanılması ve çelişkilerin çözülmesiyle teknik sistemlerin, ideal tarafa doğru evrimleştiği ifadesi yer almaktadır. Yani, yaratıcı sorunlara aranılan çözümlerde TRIZ, sorunu bir sistem olarak algılamak, ideal çözümü görmek, çelişkileri çözmek vb. yöntemlerle diyalektik bir düşünme yolu oluşturur. (Şener, 2006: 74)



Bu çalışmada, konveyör sistemlerinde malzeme taşıma problemini TRIZ prensipleri ve çelişkiler matrisi aracılığıyla ele alarak, sistem performansını ve taşıma kalitesini artırması kuramsal olarak sağlanmıştır. Çalışma ayrıca, çözüm önerilerinin sanayi uygulamalarındaki etkisini değerlendirmeyi amaçlamaktadır. (Altshuller, 1999: 45)

## 2.Yöntem

Bu çalışmada TRIZ yöntemi, konveyör sistemlerindeki çelişkileri analiz etmek ve çözüm önerileri geliştirmek için kullanılmıştır. Araştırma süreci şu adımlardan oluşmaktadır:

### 2.1- TRIZ Metodolojisi

- 1. Problemin Tanımlanması:** Konveyör sistemlerinde malzeme taşıma hızını artırma çabalarının, stabilite ve güvenilirlik üzerinde olumsuz etkiler yarattığı tespit edilmiştir. Bu durum temel bir mühendislik çelişkisi olarak ele alınmıştır.
- 2. TRIZ Çelişkiler Matrisi Kullanımı:** İyileştirilmek istenen (hız ve verimlilik) ve kötüleşen (stabilite ve güvenilirlik) parametreler çelişkiler matrisi üzerinden analiz edilmiştir. Çelişkilerin kök nedenleri belirlenmiş ve bunların üstesinden gelmek için uygulanabilir çözüm prensipleri önerilmiştir ve Şekil 1’de Çelişkiler matrisi tablosu gösterilmiştir.

	Hareketli nesnenin ağırlığı	Sabit nesnenin ağırlığı	Hareketli nesnenin uzunlu	Sabit nesnenin uzunluğu	Hareketli nesnenin alanı	Sabit nesnenin alanı	Hareketli nesnenin hacmi	Sabit nesnenin hacmi	Hız	Kuvvet	Gerilim ve basınç	Şekil	Nesnenin dengesi	Dayanıklılık, güç	Hareketli nesnenin dayarı	Sabit nesnenin dayanıklılı	Sıcaklık	Parfaklık	Hareketli nesnenin harca	Sabit nesnenin harcadığı	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
1 Hareketli nesnenin ağırlığı	+		15, 8, 29, 34		29, 17, 38, 34		29, 2, 40, 28		2, 8, 15, 38	8, 10, 18, 37	10, 36, 37, 40	10, 14, 19, 39	1, 35, 19, 39	28, 27, 18, 40	5, 34, 31, 35		6, 29, 4, 38	19, 1, 32	35, 12, 34, 31		
2 Sabit nesnenin ağırlığı		+		10, 1, 29, 35		35, 30, 13, 2		5, 35, 14, 2		8, 10, 19, 35	13, 29, 10, 18	13, 10, 29, 14	26, 39, 1, 40	28, 2, 10, 27		2, 27, 19, 6	28, 19, 32, 22	19, 32, 35	35, 12, 34, 31	18, 19, 28, 1	
3 Hareketli nesnenin uzunluğu	8, 15, 29, 34		+		15, 17, 4		7, 17, 4, 35		13, 4, 8	17, 10, 4	1, 8, 35	1, 8, 10, 29	1, 8, 15, 34	8, 35, 29, 34	19		10, 15, 19	32	8, 35, 24		
4 Sabit nesnenin uzunluğu		35, 28, 40, 29		+		17, 7, 10, 40		35, 8, 2, 14		28, 10	1, 14, 35	13, 14, 15, 7	39, 37, 35	15, 14, 28, 26		1, 10, 35	2, 15, 38, 18	3, 25			
5 Hareketli nesnenin alanı	2, 17, 29, 4		14, 15, 18, 4		+		7, 14, 17, 4		29, 30, 4, 34	19, 30, 35, 2	10, 15, 36, 28	5, 34, 29, 4	11, 2, 13, 39	3, 15, 40, 14	6, 3		2, 10, 16	35, 39, 19, 13	19, 32		
6 Sabit nesnenin alanı		30, 2, 14, 18		26, 7, 9, 39		+				1, 18, 35, 36	10, 15, 36, 37		2, 38	40		2, 10, 19, 30	35, 39, 38				
7 Hareketli nesnenin hacmi	2, 26, 29, 40		1, 7, 4, 35		1, 7, 4, 17		+		29, 4, 38, 34	15, 35, 36, 37	6, 35, 36, 37	1, 15, 29, 4	28, 10, 1, 39	9, 14, 15, 7	6, 35, 4		34, 39, 10, 18	2, 13, 10	35		
8 Sabit nesnenin hacmi		35, 10, 19, 14		35, 8, 2, 14				+		2, 18, 37	2, 18, 37	7, 2, 35	34, 28, 35, 40	9, 14, 17, 15		35, 34, 38	35, 6, 4				

Şekil 1: Çelişkiler Matrisi Tablosu (<https://medium.com/@metinokaya/triz-39x39-çelişki-matrisi-türkçe-c1a6e944b945>)

- 3. Yaratıcı Prensiplerin Uygulanması:** Matrisin önerdiği yenilikçi prensipler doğrultusunda, özellikle dinamiklik, yerel kalite ve özelliklerin değişimi gibi çözüm yaklaşımları değerlendirilmiştir.
- 4. Simülasyon ve Analiz:** Önerilen çözümlerin etkileri simülasyon araçları ve deneysel verilerle test edilmiştir. Sistem performansındaki değişiklikler nicel göstergelerle değerlendirilmiştir. (Savransky, 2000: 45) Şekil 2’de TRIZ ilkeleri gösterilmiştir.



Şekil 2: TRIZ İlkeleri (<https://medium.com/innocentrumblog/yaratıcı-problem-çözme-teknigi-olarak-triz-3377531c7160>)

## 2.2 Konveyör Sistemleri Üzerine Uygulama

Bu çalışmada, TRIZ metodolojisi konveyör sistemlerinde şu spesifik problemler üzerinde uygulanmıştır:

- Üst üste binme ve ürün hasarları.
- Enerji verimliliğinin artırılması.
- Taşıma sürelerinin optimize edilmesi (Smith ve Tjandra, 2008: 152).

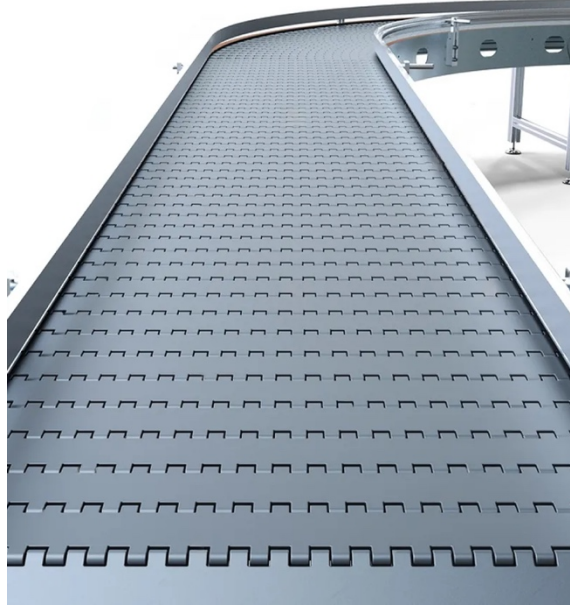
Bu süreç sonunda, konveyör sistemlerinin performansını artırırken çelişkileri ortadan kaldıracak yenilikçi çözümler geliştirilmiştir.

## 2.3 Veri Toplama ve Analiz

Veri toplama hem gözlem hem de çalışma sürecine dahil olan çalışanlarla görüşmeler yoluyla gerçekleştirilmiştir. Çatışma parametreleri belirlendikten sonra, TRIZ ilkelerine dayalı olarak birden fazla çözüm önerisi geliştirilmiştir (Rantanen ve Domb, 2008: 112). Şekil 3'te endüstriyel bir konveyör sistem ve Şekil 4'te modüler konveyör sistem örneği gösterilmiştir.



Şekil 3: Endüstriyel Konveyör sistem  
(<https://www.lodamaster.com/tr/cozumler/konveyor-sistemleri>)



Şekil 4: Modüler konveyör sistem örneği (<https://eakonveyor.com/wp-content/uploads/2023/08/Moduler-bant-konveyorler.webp>)

### 3. Bulgular

#### 3.1 Çelişki Analizi

Analiz sonuçlarında şu temel çelişkiler tespit edilmiştir:

- Daha hızlı taşınım ile ürün hasar oranının artışı.
- Enerji tasarrufu ile çalışma hızı arasındaki çatışma.

#### 3.2 TRIZ İlkeleri ile Çözüm Önerileri

1. **Bölme ve Segmentasyon:** Konveyör bantlarının modüler hale getirilmesi, taşınım hızının ve ürün akışını optimize etmiştir.

2. **Dinamiklik:** Sistem bileşenlerinin hareketli parçaları arasındaki uyum geliştirilerek enerji verimliliği artırılmıştır.

3. **Kendini Ayarlama:** Yüklenmeye duyarlı sensörlerin entegre edilmesi ile bant hızı, anlık olarak ayarlanabilir hale getirilmiştir.

#### 3.3 Performans Artışı

Uygulamalar sonucunda şu iyileşmeler elde edilmiştir:

- Üst üste binme oranında yaklaşık %35 azalma.
- Enerji tüketiminde yaklaşık %20 tasarruf.
- Ortalama taşınım sürelerinde yaklaşık %15 kısılma.

TRIZ prensiplerinin uygulanmasıyla elde edilen bu sonuçlar, endüstriyel uygulamalarda konveyör sistemlerinin daha verimli ve güvenilir bir şekilde çalışmasını sağlamaktadır. Özellikle dinamik kontrol mekanizmalarının devreye alınması, sadece mevcut sorunları çözmekle kalmayıp, gelecekteki değişen koşullara adaptasyonu da mümkün kılmaktadır.

#### 4. Sonuçlar

Bu çalışma, TRIZ metodolojisinin konveyör sistemlerindeki ürün taşınımını iyileştirme potansiyelini göstermiştir. Çözümler hem operasyonel verimliliği artırmış hem de enerji tasarrufu sağlamıştır. Bu yaklaşım, endüstriyel uygulamalarda daha geniş kapsamda kullanılabilir ve farklı sistemlerde benzer iyileştirmelere olanak tanıyabilir. Gelecek çalışmalar, TRIZ prensiplerinin diğer lojistik sistemlerinde uygulanmasını araştırabilir.

#### Öneriler:

- Gelecek çalışmalarda, TRIZ yöntemiyle elde edilen çözüm prensiplerinin diğer endüstriyel süreçlere uygulanabilirliği araştırılmalıdır.
- Konveyör sistemlerinin çevresel etkilerini azaltmak için enerji verimliliği ile ilgili ek analizler yapılabilir.
- Dinamik kontrol mekanizmalarının yapay zekâ tabanlı algoritmalarla desteklenmesi, sistem performansını daha da artırabilir.

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# Neuro-psychological Interpretation of Mathematical Results Reported in case of Continuous-time Hopfield Neural Networks. Part.1.

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## ABSTRACT

In this paper, for the mathematical description of electrical phenomena (voltage state) appearing in nervous system, continuous-time Hopfield neural network is used. The equilibriums of the continuous-time Hopfield neural network are interpreted as equilibriums of the nervous system. An equilibrium for which the steady state is locally exponentially stable is interpreted as robust equilibrium of the nervous system. That is because a small perturbation of steady voltage, the network recover the steady voltage. A path of equilibrium states which steady states are locally exponentially stable is interpreted as a path of robust equilibriums of the nervous system. This is a way to follow in healthcare for conduct the nervous system from a pathologic robust equilibrium into in a non-pathologic robust equilibrium. For illustration, path of robust equilibriums to follow in nervous control is computed.

**Keywords:** continuous-time Hopfield neural network; nervous system; robust equilibrium; fragile equilibrium, repulsive equilibrium, nervous system control.

**MSC:** 37B25; 62M45; 65P20; 92B20.

## 1. Introduction.

Continuous-time Hopfield neural networks claims to be mathematical descriptions of electrical phenomena appearing in nervous system. If such neural network is used to describe associative memories, several locally exponentially stable equilibriums are desired for one external electrical input, as they store information and constitute distributed and parallel neural memory networks. In this case, the purpose of the mathematical model is the description of the locally exponentially stable steady states (existence, number, regions of attraction, bifurcation) so as to ensure the recall capability. Mathematical results on the existence, number, regions of attraction, estimation of the local convergence rate, and bifurcation in the case of continuous-

time Hopfield neural networks are given in Balint and..2008 . Our aim here is to present neuro-psychological interpretations of some reported mathematical results presented in Balint and ..2008 and in the papers referred herein. Namely we want to answer the following questions: what represent an equilibrium of the neural network for the nervous system? which kind of equilibriums exists? when a nervous system has one or several equilibrium for the same external electrical input? what means for a nervous system the transfer of a pathologic equilibrium into a non-pathologic equilibrium? what is the importance of the local exponential stability of a steady state in case of transfer? what represent for a nervous system a path of locally exponentially steady states? The answer to these questions can be important for the computation of path of equilibriums having locally exponentially stable steady states for use them in healthcare.

## 2. Continuous-time Hopfield neural networks.

According to Balint and 2008 pg.173 formula (5.1) a continuous-time Hopfield-type neural network, describing the voltage evolution in a network of  $n$  biological neurons, is a system of nonlinear differential equations of the form

$$\dot{x}_i = -a_i \times x_i + \sum_{j=1}^{j=n} T_{ij} \times g_j(x_j) + I_i \quad i = 1 \dots n \quad (2.1)$$

where:  $a_i > 0$  ,  $I_i$  are constants:  $a_i$  related to the neuron  $i$  membrane capacity and  $I_i$  related to the external electrical input,  $T = (T_{ij})_{n \times n}$  is a constant matrix referred to as the interconnection matrix,  $g_j: R \rightarrow R$  ,  $j = 1 \dots n$  represent the neuron input-output activations. The activation functions are bounded and without restraining generality, we may suppose that  $|g_j(s)| \leq 1$  for any  $s \in R$  ,  $j = 1 \dots n$ . If it not mentioned otherwise, it is assumed that  $g_j(0) = 0$ , for  $j = 1 \dots n$ . The activation functions are increasing and have bounded derivatives. More precisely, there exist  $k_j > 0$  such that  $0 < g'_j(s) \leq k_j$  for any  $s \in R$  ,  $j = 1 \dots n$ . Frequently the activation functions are assumed to verify  $g_j(s) = 1$  if  $s \geq 1$  and  $g_j(s) = -1$  if  $s \leq -1$  .

The system (2.1) can be written in matrix form:

$$\dot{X} = A \times X + T \times G(X) + I \quad (2.2)$$

Where  $X = (x_1, x_2, \dots, x_n)^T$  ,  $A = \text{diag}(-a_1, -a_2, \dots, -a_n) \in M_{n \times n}$  ,  $I = (I_1, I_2, \dots, I_n)^T \in R^n$  and  $G: R^n \rightarrow R^n$  is given by  $G(X) = (g_1(x), g_2(x), \dots, g_n(x))^T$ .

Let be  $F: R^n \times R^n \rightarrow R^n$  the function given by  $F(X, I) = A \times X + T \times G(X) + I$ . With this function equation (2.2) can be written in the form:

$$\dot{X} = F(X, I) \quad (2.3)$$

By definition an equilibrium of (2.3) is a solution of the equation:

$$F(X, I) = 0 \quad (2.4)$$

In other words an equilibrium  $E$  is a couple  $(X, I)$  from  $R^n \times R^n$  which verifies (2.4). An equilibrium  $E = (X, I)$  (if exist) then  $I$  is called external electrical input and  $X$  is called steady state. The name steady state is justified by the fact that if  $E^0 = (X^0, I^0)$  is an equilibrium then for  $I$  equal to  $I^0$  the solution of (2.3) which verifies the initial condition  $X(t_0) = X^0$  is constant

equal to  $X^0$ . According to Balint and..2008 Theorem (5.1) pg.174. [1] for any given voltage steady state  $X$  taking the external electrical input given by the formula :

$$I = -A \times X - T \times G(X) \tag{2.5}$$

an equilibrium  $E = (X, I)$  is obtained.

On the other hand theoretically it can happen that for a given input  $I^0$  there is no, there exist one, or there exists several different voltage states  $X^j, j = 1 \dots m$  such that  $E^j = (X^j, I^0)$  for  $j = 1 \dots m$  are equilibriums for (2.3).

### 3. Neuro-psychological interpretation of the equilibrium.

A natural neuro-psychological interpretation of the concept of equilibrium  $E^0 = (X^0, I^0)$  of the neural network is that it represent an equilibrium of the nervous system. Hence, come the idea that in order to change a (none desired) pathological equilibrium  $E^0 = (X^0, I^0)$  of the nervous system, a new external electrical input  $I^1$  has to be applied. If the voltage component of the new non pathologic equilibrium is  $X^1$  then it is natural to think that the new external electrical input  $I^1$ , which has to be applied, has to be taken according to the formula (2.5) i.e.  $I^1 = -A \times X^1 - T \times G(X^1)$  hoping that after the change  $I^0 \rightarrow I^1$  of the external electrical input, the voltage  $X^0$  of the nervous system evolve to the voltage  $X^1$  of the nervous system. Mathematically this neuro-psychological though is correct if after the moment  $t_1$  when the change  $I^0 \rightarrow I^1$  takes place the voltage state of the neural network, described by the solution of the initial value problem

$$\dot{X} = F(X, I^1) \quad , \quad X(t_1) = X^0 \tag{3.1}$$

tends to the voltage state  $X^1$ .

This kind of reasoning make sense if  $I^1 \neq I^0$ . That is because if  $I^1 = I^0$  then there is no change in input and the voltage state of the neural network will rest in the state  $X^0$  i.e. the voltage state evolution of the neural network is described by (3.1) is constant equal to  $X^0$ .

Moreover, even if  $I^1 \neq I^0$  and the reasoning make sense, it can happen that for the new electrical input  $I^1$ , beside the desired voltage state  $X^1$ , there exist a second voltage state  $X^2$ , and applying the electrical input  $I^1$  beside the non-pathological equilibrium  $E^1 = (X^1, I^1)$  a second equilibrium  $E^2 = (X^2, I^1)$  appear. It can happen that the equilibrium  $(X^2, I^1)$  is pathologic too. Therefore the problem is to find supplementary condition assuring that the solution of the initial value problem (3.1) tends to  $X^1$  as it was planned.

In Balint and.. 2008 example (5.2) pg.184 provide computational simulation of the above-described phenomena.

The neural network (5.2) considered in Balint and.. 2008 pg.184 is defined by the system of differential equations:

$$\dot{x}_1 = -x_1 + \frac{17 \times \ln 4}{15} \times \tanh x_2 + I_1 \qquad \dot{x}_2 = -x_2 + \frac{17 \times \ln 4}{15} \times \tanh x_1 + I_2 \tag{3.2}$$

For obtain the prior given steady voltage state  $X = (1, 2)^T$  according to (2.5) the external input which has to be applied is  $I = (-0.514616132, 0.803433824)^T$ . In order to see the voltage evolution of the neural network the following initial value problem has to be solved:

$$\dot{x}_1 = -x_1 + \frac{17 \times \ln 4}{15} \times \tanh x_2 - 0.514616132 \quad x_1(0) = 1 \quad \dot{x}_2 = -x_2 + \frac{17 \times \ln 4}{15} \times \tanh x_1 + 0.803433824 \quad x_2(0) = 2 \quad (3.3)$$

The solution of the initial value problem (3.3) is represented on the figures Fig.3.1 and Fig.3.2.

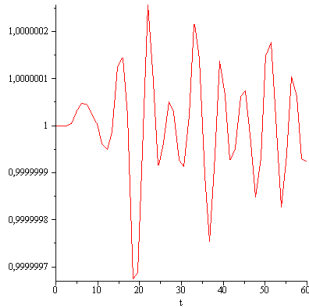


Fig.3.1.  $x_1$  versus  $t$ .

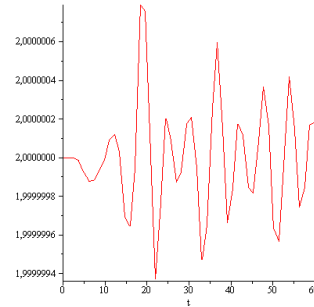


Fig.3.2.  $x_2$  versus  $t$ .

These figures show that maintaining the external input value in the first five seconds the voltage of the neural network is constant equal to the initial value and after that oscillate around the initial value with an amplitude less than  $10^{-6}$ . This means that practically there is no change in the voltage of the neural network. According to the neuro-psychological interpretation, this type of the neural network voltage behavior indicates that  $E = (X, I)$  is an equilibrium of the corresponding nervous system.

If, the steady state  $E = (X, I)$  is pathologic then a neurological or psychological intervention is needed. The change of the external electrical input represents a type of intervention.

Assume that the medical decision is to transform the pathologic equilibrium  $E = (X, I)$  with  $X = (1, 2)^T$  and  $I = (-0.514616132, 0.803433824)^T$  into the new non-pathologic equilibrium  $E^1 = (X^0, I^1)$  with  $X^0 = (0, 0)^T$  and  $I^1 = (0, 0)^T$  computed using formula (2.5).

Before describing the effect of the external input change  $I \rightarrow I^1$  remark that for the new external input  $I^1 = (0, 0)^T$  the system (3.2) possesses several equilibriums:  $E^1 = ((0, 0)^T, (0, 0)^T)$ ,  $E^2 = ((\ln 4, \ln 4)^T, (0, 0)^T)$ ,  $E^3 = ((-\ln 4, -\ln 4)^T, (0, 0)^T)$ . In case of the above equilibriums the steady states can be obtained solving the system of nonlinear algebraic equations:

$$-x_1 + \frac{17 \times \ln 4}{15} \times \tanh x_2 = 0 \quad -x_2 + \frac{17 \times \ln 4}{15} \times \tanh x_1 = 0 \quad (3.4)$$

The effect of the external input change  $I \rightarrow I^1$  can be seen solving the following initial value problem:

$$\dot{x}_1 = -x_1 + \frac{17 \times \ln 4}{15} \times \tanh x_2 \quad x_1(0) = 1 \quad , \quad \dot{x}_2 = -x_2 + \frac{17 \times \ln 4}{15} \times \tanh x_1 \quad x_2(0) = 2 \quad (3.5)$$

The solution of the initial value problem (3.5) is represented on the figures Fig.3.3. and Fig.3.4.



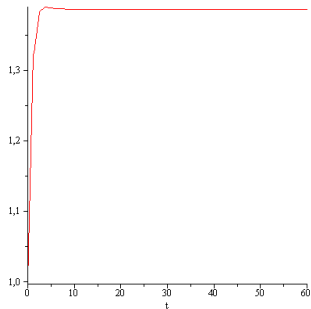


Fig.3.3.  $x_1$  versus  $t$ .

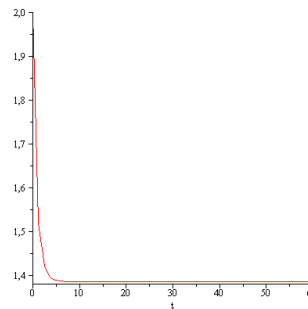


Fig.3.4.  $x_2$  versus  $t$ .

These figures show that the effect of the change  $I \rightarrow I^1$  is the transfer of the steady state  $(1,2)^T$  into the steady state  $(\ln 4, \ln 4)^T$  and not into the steady state  $(0,0)^T$  as were expected.

The mathematical explanation is: the steady state  $(\ln 4, \ln 4)^T$  is locally exponentially stable and the steady state  $(1,2)^T$  belongs to the region of attraction of the steady state  $(\ln 4, \ln 4)^T$ .

In the same time, the steady state  $(0,0)^T$  is unstable and repulsive. The unstable character of steady state  $(0,0)^T$  means that for any small perturbation of initial condition, the solution of the perturbed initial value problem

$$\dot{x}_1 = -x_1 + \frac{17 \times \ln 4}{15} \times \tanh x_2 \quad x_1(0) = \varepsilon, \quad \dot{x}_2 = -x_2 + \frac{17 \times \ln 4}{15} \times \tanh x_1 \quad x_2(0) = \delta \quad (3.6)$$

do not recover the steady state  $(0,0)^T$ .

The unstable character of the steady state voltage in case of equilibrium  $E^1$  is illustrated on the next figures :

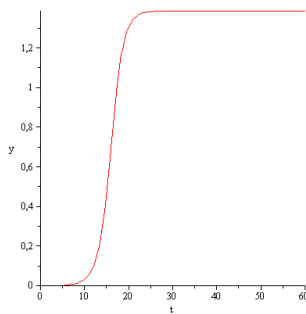


Fig.3.5.  $x_1$  versus  $t$

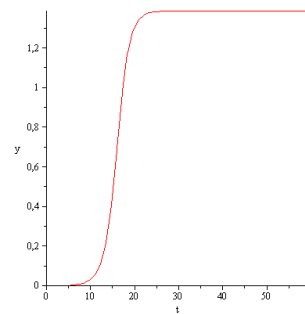


Fig. 3.6.  $x_2$  versus  $t$ .

The above figures illustrate also the repulsive character of the equilibrium  $E^1 = ((0,0)^T, (0,0)^T)$ . That is because the solution of the initial value problem (3.6) represent also the evolution of the steady state  $X^{\varepsilon, \delta} = (\varepsilon, \delta)^T$  of an equilibrium  $E^{\varepsilon, \delta} = (X^{\varepsilon, \delta}, I^{\varepsilon, \delta})$  for  $I^{\varepsilon, \delta} \rightarrow (0,0)^T$ . The external electrical input  $I^{\varepsilon, \delta}$  appearing here is obtained from the steady state  $X^{\varepsilon, \delta}$  using formula (2.5). Figures shows that the transfer  $E^{\varepsilon, \delta} \rightarrow E^1 = (0,0)^T$  is not possible because the components of the steady state  $X^{\varepsilon, \delta}$  move away from the steady state  $X^1 = (0,0)^T$

According to the neuro-psychological interpretation of equilibrium, is important to keep in mind that in a nervous system there are three types of equilibriums:

-Equilibriums of first type for which after a small perturbation of the steady state the nervous system return to the equilibrium. This is the situation if the steady state of the corresponding neural network is locally exponentially stable. (as is the equilibrium  $E^2 = (ln4, ln4)^T, I^1$ ). Due to this property the nervous system return to the equilibrium automatically, without any external input. We will say that this equilibrium of the nervous system is robust.

-Equilibriums of second type for which after a small perturbation of the steady state the nervous system do not return to the equilibrium. This is the situation if the steady state of the corresponding neural network is unstable. (as is the equilibrium  $E = (X, I)$  with  $X = (1, 2)^T$  and  $I = (-0.514616132, 0.803433824)^T$ ). Due to the property that the nervous system do not return to the equilibrium automatically, without applying an external input, we will say that this type of equilibrium of the nervous system is fragile.

--Equilibriums of third type having the property that there is no equilibrium, which can be transferred in such type of equilibrium. Due to this property, we will say that this type of equilibrium of the nervous system is repulsive.

#### 4. Equilibriums transfer.

A correct neuro psychological interpretation and understanding of the possible equilibriums of the neural network permit to neurologist and psychologist to choose appropriate tool in a specific case. On this basis people, working in neural and mental healthcare, can choose appropriate tool for transfer the pathologic equilibrium of a patient into a non-pathologic equilibrium.

The choice of the appropriate tool means : start from a fragile or robust pathologic equilibrium  $E^0 = (X^0, I^0)$ , fix a new non-pathologic steady state  $X^1$  and compute for  $X^1$ , the corresponding new external electrical input  $I^1$  (using formula (2.5)), build up the new non-pathologic equilibrium  $E^1 = (X^1, I^1)$ . After that, several computations has to be made in order to be able to say that step by step the transfer  $E^0 = (X^0, I^0) \rightarrow E^1 = (X^1, I^1)$  is possible.

1. Verify if the equilibrium  $E^0$  is fragile or robust. A way is to solve and represent the solutions of the initial value problems

$$\dot{X} = F(X, I^0) \quad X(0) = X_1^0 \quad (4.1)$$

where  $X_1^0$  are small perturbations of  $X^0$ .

2. Verify if the equilibrium  $E^1$  is fragile or robust. A way is to solve and represent the solutions of the initial value problems

$$\dot{X} = F(X, I^1) \quad X(0) = X_1^1 \quad (4.2)$$

where  $X_1^1$  are small perturbations of  $X^1$ .

3. Verify if the region of attraction of the steady state  $X^1$  contains the steady state  $X^0$ . A way is to

solve and represent the solution of the initial value problem:

$$\dot{X} = F(X, I^1) \quad X(0) = X^0 \tag{4.3}$$

4. Verify if the region of attraction of the steady state  $X^0$  contains the steady state  $X^1$ . A way is to solve and represent the solution of the initial value problem:

$$\dot{X} = F(X, I^0) \quad X(0) = X^1 \tag{4.4}$$

In order to see how this work in practice, consider the neural network (3.2) and the equilibrium  $E^0=(X^0, I^0)= ((1,1)^T, (-0.196566176, -0.196566176)^T)$ . Fix the new steady state  $X^1= (1.1,1.1)^T$  and using (2.5) compute the corresponding new external electrical input  $I^1$  finding  $I^1 =(-0.157690917, -0.157690917)^T$ . So the new equilibrium is  $E^1 = (X^1, I^1)$ .

-For test the fragility or robustness of  $E^0=(X^0, I^0)$ , solve and represent the initial value problem (4.1). Taking for example  $X_1^0 = (1.11, 1.11)$ . The solution of the initial value problem (4.1) is presented on the next figures:

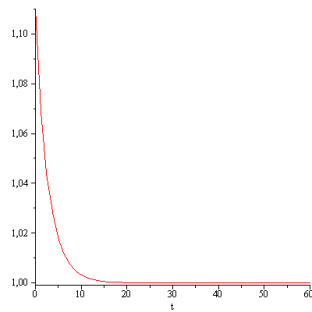


Fig.4.1.  $x_1$  versus t

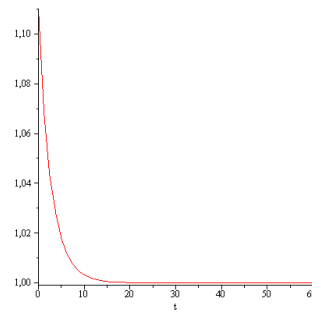


Fig. 4.2.  $x_2$  versus t.

These figures suggest that the equilibrium  $E^0$  is robust.

-For test the fragility or robustness of  $E^1=(X^1, I^1)$ , solve and represent the initial value problem (4.2).

Taking for example  $X_1^1 = (1.01, 1.01)$  the solution of the initial value problem (4.2) is presented on the next figures.

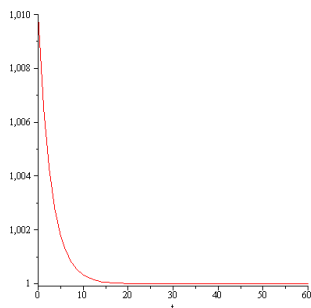


Fig.4.3.  $x_1$  versus t

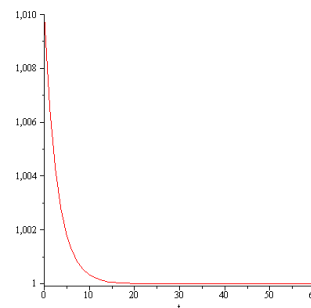


Fig. 4.4.  $x_2$  versus t.

These figures suggest that the equilibrium  $E^1$  is robust.

-For test if the change of the external electrical input  $I^0 \rightarrow I^1$  lead to the transfer  $E^0 \rightarrow E^1$  the initial value problem (4.3) has to be solved.

The solution of the initial value problem (4.3) is represented on the next figures.

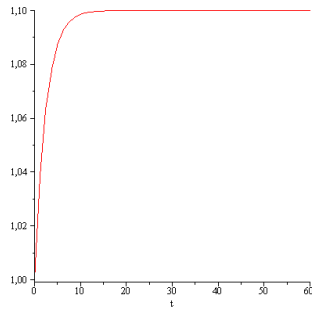


Fig.4.5.  $x_1$  versus t

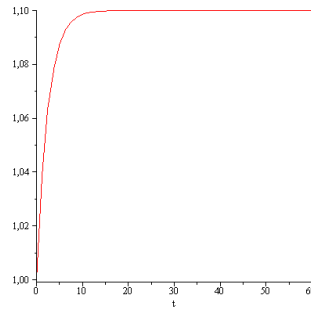


Fig. 4.6.  $x_2$  versus t.

These figures suggest that the change of the external electrical input  $I^0 \rightarrow I^1$  lead to the transfer  $E^0 \rightarrow E^1$ .

-For test if the change of the external electrical input  $I^1 \rightarrow I^0$  lead to the transfer  $E^1 \rightarrow E^0$  the initial value problem (4.4) has to be solved.

The solution of the initial value problem (4.4) is represented on the next figures.

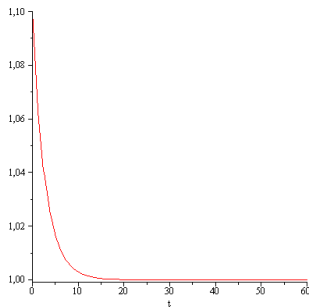


Fig.4.7.  $x_1$  versus t

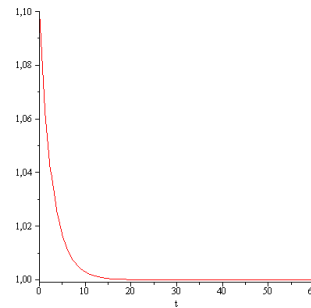


Fig. 4.8.  $x_2$  versus t.

These figures suggest that the change of the external electrical input  $I^1 \rightarrow I^0$  lead to the transfer  $E^1 \rightarrow E^0$ .

Remember that the starting motivation of the above presented computations was that the equilibrium  $E^0$  is pathologic and the equilibrium  $E^1$  is non-pathologic and an external medical intervention is necessary.

We underline that in general the situation is much more complex concerning the configuration of the equilibriums, the type of equilibrium (robust, fragile, and repulsive) and the transfer of an equilibrium into another equilibrium. In the following, we present results from Balint and..2008, which can offer an overview about the complexity. Illustrative computational examples are given.

In Balint and..2008 theorem 5.3.pg.175 states: If  $\Delta$  is a rectangle in  $\mathbb{R}^n$ , (i.e. for  $i=1\dots n$  there exist  $\alpha_i, \beta_i \in \mathbb{R}, \alpha_i < \beta_i$ , such that  $\Delta = (\alpha_1, \beta_1) \times (\alpha_2, \beta_2) \times \dots \times (\alpha_n, \beta_n)$ ) and  $\det(A + T \times DG(X)) \neq 0$  for any  $X \in \Delta$ , then the function  $I_\Delta$ , the restriction of the external electrical input function  $I(X) = -A \times X - T \times G(X)$ , is injective.

This theorem reveal that in a prior given rectangle  $\Delta$  (included in  $\mathbb{R}^n$ ) if  $\det(A + T \times DG(X)) \neq 0$  for any  $X \in \Delta$ , then for any  $X^0 \in \Delta$  the input  $I(X^0) = -A \times X^0 - T \times G(X^0)$  is unique. Therefore, the equilibrium  $E^0 = (X^0, I^0)$  of the nervous system is unique. This situation is completely different from that described in Example (5.2) pg.184 [1] where in case of the rectangle  $\Delta = (-1.5, 1.5) \times (-1.5, 1.5)$  for the input  $I^0 = (0, 0)^T$  three different equilibriums  $E_1^0 = ((0, 0)^T, I^0)$ ,  $E_2^0 = ((\ln 4, \ln 4)^T, I^0)$  and  $E_3^0 = ((-\ln 4, -\ln 4)^T, I^0)$  exists each of them having the steady state in  $\Delta$ . A numerical illustration of the situation described by Theorem 5.3.pg.175.[1] can be found in Example 5.1.pg.183 [1]. In this example the following one-dimensional neural continuous-time Hopfield neural network is considered:

$$\dot{x} = -a \times x + T \times \tanh x + I \tag{4.5}$$

where  $a > 0, T$  and  $I$  are constants.

For any state  $x \in \Delta = (-\infty, \infty)$  the external input  $I(x)$  for which  $x$  is a steady state of (4.5) is  $I(x) = a \times x - T \times \tanh x$ .

-If  $T < a$  then  $I'(x) > 0$  for any  $x \in \Delta$ . Therefore for any  $x^0 \in \Delta = (-\infty, \infty)$  the external input  $I(x^0) = a \times x^0 - T \times \tanh x^0$  is unique.

-If  $T = a$  then  $I'(x) > 0$  for any  $x \in \Delta, x \neq 0$  and  $I'(0) = 0$ . Therefore for any  $x^0 \in \Delta_1 = (-\infty, 0)$  the external input  $I(x^0) = a \times x^0 - T \times \tanh x^0$  is unique, and for any  $x^0 \in \Delta_2 = (0, \infty)$  the external input  $I(x^0) = a \times x^0 - T \times \tanh x^0$  is unique.

-If  $T > a$  then  $I'(x) \neq 0$  for any  $x \in \Delta, x \neq x^1 = -\operatorname{arctanh} \sqrt{\frac{T-a}{T}}$  and  $x \neq x^2 = \operatorname{arctanh} \sqrt{\frac{T-a}{T}}$  and  $I'(x^1) = I'(x^2) = 0$  Therefore for any  $x^0 \in \Delta_1 = (-\infty, x^1)$  the external input  $I(x^0) = a \times x^0 - T \times \tanh x^0$  is unique, for any  $x^0 \in \Delta_2 = (x^1, x^2)$  the external input  $I(x^0) = a \times x^0 - T \times \tanh x^0$  is unique, and for any  $x^0 \in \Delta_3 = (x^2, \infty)$  the external input  $I(x^0) = a \times x^0 - T \times \tanh x^0$  is unique.

In Balint and..2008 theorem 5.4.pg.176 states: For any prior given external electrical input  $I \in \mathbb{R}^n$  the following, statements hold:

-There exists at least one steady state  $X \in \mathbb{R}^n$  in the rectangle  $\Delta = [-M_1, M_1] \times [-M_2, M_2] \times \dots \times [-M_n, M_n] \subset \mathbb{R}^n$ , where  $M_i = \frac{1}{a_i} (|I_i| + \sum_{j=1}^n |T_{ij}|)$  for  $i=1\dots n$ , such that  $F(X, I) = 0$ .

-Every steady state  $X$ , solution of the equation  $F(X, I) = 0$ , belongs to the rectangle  $\Delta$  defined above.

-If in addition  $\det(A + T \times DG(X)) \neq 0$  for any  $X \in \Delta$ , then the equation  $F(X, I) = 0$  has a unique solution  $X \in \Delta$ .

This theorem clarify several things:

-First, the theorem assure that applying an arbitrary prior given external electrical input  $I^0 \in \mathbb{R}^n$  to the nervous system there exist at least one steady state  $X^0$  such that  $E^0 = (X^0, I^0)$  is an equilibrium of the nervous system. The steady state  $X^0$  of the equilibrium  $E^0 = (X^0, I^0)$  is

located in the rectangle  $\Delta$  specified above. This is in fact mainly a localization of the equilibrium steady state. For find effective, the steady state  $X^0$ , the nonlinear algebraic equation  $F(X, I^0) = 0$  has to be solved in  $\Delta$ . In case of the nervous system described by the one-dimensional neural network (4.5) for  $T = a = 1$  and  $I = 1$  the rectangle  $\Delta = [-2, 2]$ . For the nonlinear algebraic equation  $-x + \tanh x + 1 = 0$  a solution has to be searched in the rectangle  $\Delta = [-2, 2]$ . By solving this equation the solution  $x^0 = 1.961179751$  is found.

-Second, the theorem assure that applying an arbitrary prior given external electrical input  $I^0 \in R^n$  to the nervous system, every steady state  $X^0$  which appear due to that is in the rectangle  $\Delta$ .

-Third if  $\det(A + T \times DG(X)) \neq 0$  for any  $X \in \Delta$ , (specified above) then the obtained steady state  $X^0$  is unique. This means that the obtained equilibrium  $E^0 = (X^0, I^0)$  is unique. In case of the nervous system described by the one-dimensional neural network (4.5) for  $T = 1, a = 2, I = 1$  and the rectangle  $\Delta = [-1, 1]$ ,  $I'(x) > 0$  for any  $x \in \Delta$ . Therefore the nonlinear algebraic equation  $-2 \times x + \tanh x + 1 = 0$  has a unique solution in  $\Delta = [-1, 1]$ . By solving this equation, the solution  $x^0 = 0.8439469994$  is found. The supplementary information is that  $x^0$  is unique and the equilibrium  $E^0 = (x^0, I^0)$  is unique.

In Balint and..2008 theorem (5.6) pg.177 states that if the neuron input-output activation functions verifies the general conditions described in section2 and for an external input  $I$  the following inequalities hold

$$|I_i| < T_{ii} - a_i - \sum_{i \neq j} |T_{ij}| \quad i = 1, 2, \dots, n \quad (4.6)$$

then in every rectangle  $\Delta_\varepsilon \ \varepsilon \in \{\pm 1\}$  there exists a unique steady state  $X^{\varepsilon, I}$  such that  $E^{\varepsilon, I} = (X^{\varepsilon, I}, I)$  is an equilibrium of the neural network (2.3).

Here  $\Delta_\varepsilon = J(\varepsilon_1) \times J(\varepsilon_2) \times \dots \times J(\varepsilon_n)$ ,  $J(-1) = (-\infty, -1)$ ,  $J(1) = (1, \infty)$ .

The mathematical condition (4.6) concerns the magnitude of the external input (left hand side) and the coefficients of the neural network (right hand side). If an input  $I^0$ , which verifies (4.6), is applied to the nervous system then due to that, in the nervous system,  $2^n$  equilibriums  $E^{\varepsilon, I^0} = (X^{\varepsilon, I^0}, I^0)$  appear. Each steady state  $X^{\varepsilon, I^0}$  is unique and located in a rectangle  $\Delta_\varepsilon$ . This is an extremely complex configuration of steady states, which appear after applying an external electrical input  $I^0$ .

A modified variant of the above theorem, is Theorem (5.7) pg.178 Balint and..2008.

According to Theorem 5.7. pg.178. Balint and..2008, the next statement hold. If there exists  $\alpha \in (0, 1)$  such that the functions  $g_i$ ,  $i = 1, 2, \dots, n$  satisfy :

$$g_i(s) \geq \alpha \text{ if } s \geq 1 \quad \text{and} \quad g_i(s) \leq \alpha \text{ if } s \leq -1 \quad \text{for } , \quad i = 1, 2, \dots, n \quad (4.7)$$

and in addition, the external input  $I \in R^n$  satisfies

$$|I_i| < T_{ii} \times \alpha - a_i - \sum_{i \neq j} |T_{ij}| \quad \text{for } , \quad i = 1, 2, \dots, n \quad (4.8)$$

then the following conclusions hold:

i).In every rectangle  $\Delta_\varepsilon, \varepsilon \in \{\pm 1\}$  there exists at least one steady state  $X^{\varepsilon,I}$  such that  $E^{\varepsilon,I} = (X^{\varepsilon,I}, I)$  is an equilibrium of the neural network (2.3).

ii).Every rectangle  $\overline{\Delta_\varepsilon}, \varepsilon \in \{\pm 1\}$  , is invariant to the voltage dynamic of the network.

This theorem reveal that if the neuron input-output activations verify (4.7) and one input  $I^0$  ,which verifies (4.8), is applied to the nervous system then due to that in the nervous system  $2^n$  equilibriums  $E^{\varepsilon,I^0} = (X^{\varepsilon,I^0}, I^0)$  appear .Each steady state  $X^{\varepsilon,I^0}$  is unique and located in a rectangle  $\Delta_\varepsilon$ . This configuration of steady states, is similar which appear in theorem 5.6 .What is new is the invariance of  $\overline{\Delta_\varepsilon}$  to the voltage dynamics.

According to Theorem 5.10.pg.179. Balint and..2008 if the conditions of Theorem 5.6.pg.177 are satisfied then the steady state  $X^{\varepsilon,I}$  corresponding to  $I$  and belonging to  $\Delta_\varepsilon$  is locally exponentially stable ,and its region of attraction includes  $\overline{\Delta_\varepsilon}$ .

A numerical illustration of the phenomena described in Theorem 5.7.pg.178. Balint and..(2008) is given in Example (5.3) pg.186 Balint and..(2008).In this example the following Hopfield neural network is considered:

$$\begin{aligned} \dot{x}_1 &= -a_1 \times x_1 + b_1 \times g(x_1) + b_2 \times g(x_2) + I_1 \\ \dot{x}_2 &= -a_2 \times x_2 + b_2 \times g(x_1) + b_1 \times g(x_2) + I_2 \end{aligned} \tag{4.9}$$

where :  $g: R \rightarrow (-1,1), g(s) = \frac{2}{\pi} \times \arctan(\frac{\pi}{2} \times s)$ . Let be  $\alpha = g(1) \approx 0.63$  and  $\beta = \dot{g}(1) \approx 0.28$  . One can check that  $g(s) \geq \alpha$  if  $s \geq 1$  and  $g(s) \leq -\alpha$  if  $s \leq -1$  ; moreover  $0 < \dot{g}(s) \leq \beta$  for any

$$|s| \geq 1.$$

It can be proven that if

$$\beta \times (|b_1| + |b_2|) < a_i < \alpha \times b_1 - |b_2| \quad \text{for } i = 1,2 \tag{4.10}$$

then for any input  $I = (I_1, I_2)$  satisfying

$$|I_i| < \alpha \times b_1 - |b_2| - a_i \quad \text{for } i = 1,2 \tag{4.11}$$

there exists a unique steady state  $X^{\varepsilon,I}$  in every rectangle  $\Delta_\varepsilon$ ,it is locally exponentially stable and its region of attraction includes  $\overline{\Delta_\varepsilon}$ .

For  $b_1 = 1000$  ,  $b_2 = -0.5$  ,and  $a_1 = a_2 = \alpha \times b_1 - |b_2| - 300 = -19.860 = -19.860$  it follows that for any input  $I$  such that  $|I_i| < 300$   $i = 1,2$  in every rectangle  $\Delta_\varepsilon$  there exists a unique steady state  $X^{\varepsilon,I}$  which is locally exponentially stable and whose region of attraction includes  $\overline{\Delta_\varepsilon}$ .The four rectangles  $\Delta_\varepsilon$  are:

$$\begin{aligned} \Delta_{1,1} &= (1, \infty) \times (1, \infty) , \Delta_{-1,1} = (-1, -\infty) \times (1, \infty) , \\ \Delta_{-1,-1} &= (-1, -\infty) \times (-1, -\infty) , \Delta_{1,-1} = (1, \infty) \times (-1, -\infty) \end{aligned} \tag{4.12}$$

Let be  $S_\varepsilon = \{ \frac{x_i^{\varepsilon,I}}{|I_i|} < 300 , i = 1,2 \} \subset \Delta_\varepsilon$ . In the next figure the gray rectangles represent the four sets  $S_\varepsilon$  The four spirals in Fig.4.9. represents locally exponentially stable steady states corresponding to the inputs  $I^u = (20 \times u \times \cos u, 20 \times u \times \sin u)$  with  $u \in [0,2\pi]$  .Each spiral is a path of robust equilibriums of nervous system. In other words, each spiral is a possible way to follow in healthcare in order to transfer pathologic equilibriums in non-pathologic equilibrium.

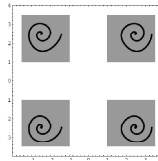


Fig.4.9. Path of robust equilibriums.

In the following a numerical illustration is given. For  $u = \frac{\pi}{6}$ ,  $X^{\frac{\pi}{6}} = (2.599706777, -2.547086602)^T$ ,  $I^{\frac{\pi}{6}} = (9.068996827, 5.235987758)^T$  for  $u = \frac{\pi}{4}$ ,  $X^{\frac{\pi}{4}} = (2.607168246, -2.525360398)^T$ ,  $I^{\frac{\pi}{4}} = (11.10720734, 11.10720734)^T$ .

For seeing that the steady state  $X^{\frac{\pi}{6}}$  can be transferred into the steady state  $X^{\frac{\pi}{4}}$  by making the external input change  $I^{\frac{\pi}{6}} \rightarrow I^{\frac{\pi}{4}}$  the following initial value problem has to be solved:

$$\begin{aligned} \dot{x}_1 &= -a_1 \times x_1 + b_1 \times g(x_1) + b_2 \times g(x_2) + I_1^{\frac{\pi}{4}} ; \dot{x}_2 = -a_2 \times x_2 + b_2 \times g(x_1) + b_1 \times g(x_2) + I_1^{\frac{\pi}{4}} \quad (4.13) \\ x_1(0) &= 2.599706777 , \quad x_2(0) = -2547086602. \end{aligned}$$

The solution of (4.13) is represented in figures 7 and 8.

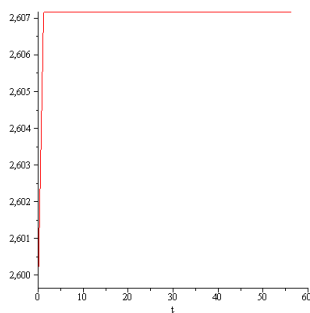


Fig. 4.10.  $x_1$  versus t

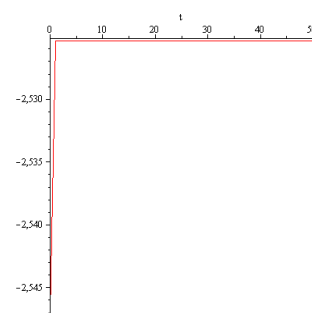


Fig. 4.11.  $x_2$  versus t

Figures 4.10 and 4.11 show that the external input change  $I^{\frac{\pi}{6}} \rightarrow I^{\frac{\pi}{4}}$  lead the steady state  $X^{\frac{\pi}{6}}$  into the steady state  $X^{\frac{\pi}{4}}$ .

This example intends to illustrates the existence of several robust equilibrium paths and the equilibrium steady states transfer along the equilibrium pats. The Artificial Intelligence strategy for healthcare has to be the buildup path of locally exponentially stable steady states along which by small successive changes, the neural network voltage can be conducted, through the regions of attraction of intermediary locally exponentially stable steady states to the final non pathologic steady state.

### Conclusions

The interpretation of mathematical results reported in Balint and..2008 reveal that the configuration of the possible equilibriums in nervous system is very complex. There exists different kind of equilibriums: fragile, robust and repulsive. In equilibrium, the voltage state of the neural network is constant and does not change if the external electrical input value is



maintained constant. For this reason, if an equilibrium is pathologic then a neurological or psychological intervention is needed. The analysis presented in the paper reveal a way to follow in the practice for the treatment of a pathologic equilibrium. That is to connect the pathologic equilibrium with a non-pathologic equilibrium computing a path of robust equilibriums and make transfer gradually following the path. A treatment procedure usually follows such a path.

### **References**

[1] St. Balint, L. Braescu and E. Kaslik. Regions of attraction and applications to control theory. Cambridge Scientific Publishers Ltd. 2008. Edited by S. Sivasundaram.

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# Neuro-psychological Interpretation of Mathematical Results Reported in case of Continuous-time Hopfield Neural Networks. Part. 2.

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## ABSTRACT

In this paper, for mathematical descriptions of electrical phenomena (voltage state) appearing in nervous system discrete-time Hopfield neural network is used. The equilibrium states of a discrete-time Hopfield neural network are interpreted as equilibriums of the nervous system. An equilibrium state for which the steady state is locally exponentially stable is interpreted as robust equilibrium of the nervous system. That is because after a small perturbation of the equilibrium steady state the network recover the equilibrium. A path of equilibrium states for which the steady states are locally exponentially stable is interpreted as a path of robust equilibriums of the nervous system. This is a way to follow in healthcare for transfer gradually the nervous system from a pathologic robust equilibrium into a non-pathologic robust equilibrium. For illustration, computed way of transfer is presented.

**Keywords:** discrete-time Hopfield type neural networks; nervous system; robust equilibrium; nervous system control.

**MSC:** 37B25; 62M45; 65P20; 92B20.

## 1. Introduction

A semi-discretization of the continuous-time Hopfield neural network has been made for obtain discrete-time neural networks. The result is the following discrete semi-dynamical system:

$$x_{p+1}^i = e^{-a_i \times h} \times x_p^i + \frac{1 - e^{-a_i \times h}}{a_i} \times (\sum_{j=1}^n T_{ij} \times g_j(x_p^j) + I_i) \quad i = 1, 2, \dots, n \quad p \in N \quad (1.1)$$

where  $h > 0$  is the uniform discretization step size. It has been established that for any  $h > 0$  the discrete-time neural network (1.1) faithfully preserve the characteristics of the continuous-time Hopfield neural network, i.e. the steady states and their stability properties. In Balint

and..2008 pg.189 more general class of discrete- time Hopfield neural networks (which includes (1.1)) were considered. These are defined by the following discrete semi-dynamical system:

$$x_{p+1}^i = b_i \times x_p^i + \sum_{j=1}^n \widehat{T}_{i,j} \times g_j(x_p^j) + \widehat{I}_i \quad i = 1,2, \dots, n, \quad p \in N \quad (1.2)$$

where  $b_i \in (0,1)$ ,  $\widehat{I}_i$  denotes the external input,  $\widehat{T} = (\widehat{T}_{i,j})$  is the interconnection matrix,  $g_i: R \rightarrow R$ ,  $i = 1,2, \dots, n$ , represent the neuron input-output activations. The system(1.2) were analyzed in Balint and..2008. It was assumed in general that the activation functions has the following properties:  $g_i(0) = 0$  for  $i = 1,2, \dots, n$ ,  $|g_i(s)| \leq 1$  for any  $s \in R$ ,  $i = 1,2, \dots, n$ . and there exist  $k_i > 0$  such that  $0 < g_i'(s) < k_i$  for any  $s \in R$ ,  $i = 1,2, \dots, n$ .

The system (1.2) can be written in the matrix form:

$$X_{p+1} = B \times X_p + \widehat{T} \times G(X_p) + \widehat{I} \quad (1.3)$$

where:  $X_p = (x_p^1, x_p^2, \dots, x_p^n)^T \in R^n$ ,  $B = \text{diag}(b_1, b_2, \dots, b_n) \in M_{n \times n}$ ,  $\widehat{I} = (\widehat{I}_1, \widehat{I}_2, \dots, \widehat{I}_n)^T \in R^n$  and  $G: R^n \rightarrow R^n$ , is given by  $G(X) = (g_1(x^1), g_2(x^2), \dots, g_n(x^n))^T$ .

Using the function  $F: R^n \times R^n \rightarrow R^n$  defined by  $F(X, \widehat{I}) = B \times X + \widehat{T} \times G(X) + \widehat{I}$ . The semi-dynamical system (1.3) can be written in the form:

$$X_{p+1} = F(X_p, \widehat{I}) \quad (1.4)$$

An equilibrium  $E$  of the semi-dynamical system (1.4) by definition is a solution of the nonlinear equation

$$F(X, \widehat{I}) = X \quad (1.5).$$

This means that an equilibrium  $E$  is a couple  $E = (X, \widehat{I}) \in R^n \times R^n$  which verifies (1.5). If  $E = (X, \widehat{I}) \in R^n \times R^n$  is an equilibrium of (1.4) then  $X$  is called steady state and  $\widehat{I}$  is called external input of (1.4). The name steady state is justified by the fact that: if  $(X^0, \widehat{I}^0) \in R^n \times R^n$  is an equilibrium of (1.4) then keeping in (1.4) the initial value  $X_1^0 = (x_{0,1}^1, x_{0,1}^2, \dots, x_{0,1}^n)^T$  and the external input  $\widehat{I}$  equal to  $\widehat{I}^0 = (\widehat{I}_1^0, \widehat{I}_2^0, \dots, \widehat{I}_n^0)^T$  the formula (1.4) generate a constant sequence in which each term is equal to  $X_1^0$ .

According to Balint and..2008 Theorem 5.15.pg.190. for any state  $X \in R^n$  there exists an external input  $\widehat{I} \in R^n$  such that the couple  $(X, \widehat{I})$  is an equilibrium of the semi-dynamical system (1.4).The input  $\widehat{I}$  is given by the formula:

$$\widehat{I} = (I_d - B) \times X - \widehat{T} \times G(X) \quad (1.6)$$

where  $I_d \in M_{n \times n}$  is the identity matrix.

On the other hand it can happen that for the same external input  $\widehat{I}^0$ , there exist one, or several different voltage states  $X^j$  such that  $E^{j, \widehat{I}^0} = (X^j, \widehat{I}^0)$  are equilibriums for (1.4).

## 2.Neuro-psychological interpretation of the equilibrium.

From neuro-psychological point of view the mark of an equilibrium of the nervous system, described by the neural network (1.4), is the constancy of the voltage state of the neurons, providing that the external input is maintained constant. Therefore is natural to interpret an equilibrium  $E = (X, \widehat{I})$  of the neural network as equilibrium of the nervous system. Hence, come the idea that in order to change a pathologic equilibrium  $E^{0, \widehat{I}^0} = (X^0, \widehat{I}^0)$  of the nervous

system, a new external electrical input  $\hat{I}^1$  has to be applied. If the steady voltage state of the new non- pathologic equilibrium is  $X^1 = (x_1^1, x_1^2 \dots x_1^n)^T$  then it is natural to think that the new external electrical input  $\hat{I}^1$ , which has to be applied, has to be taken according to the formula (1.6), hoping that, after the external electrical input change  $\hat{I}^0 \rightarrow \hat{I}^1$ , the pathologic steady voltage state  $X^0 = (x_0^1, x_0^2 \dots x_0^n)^T$ , of the nervous system, evolve to the non-pathologic steady voltage state  $X^1 = (x_1^1, x_1^2 \dots x_1^n)^T$ . Mathematically this neuro-psychological though is correct if the solution of the initial value problem

$$X_{p+1} = F(X_p, \hat{I}^1) \quad , \quad X_1 = X^0 = (x_0^1, x_0^2, \dots, x_0^n)^T \quad (2.1)$$

tends to the steady voltage state  $X^1 = (x_1^1, x_1^2 \dots x_1^n)^T$ .

This kind of reasoning make sense if  $\hat{I}^0 \neq \hat{I}^1$ . That is because, if  $\hat{I}^0 = \hat{I}^1$  then there is no change in input and the voltage state of the neural network will rest in the state  $X^0$  i.e. the voltage state evolution of the neural network is described by (2.1) is constant equal to  $X^0$ .

Moreover, even if  $\hat{I}^0 \neq \hat{I}^1$  and the reasoning make sense, it can happen that for the new electrical input  $\hat{I}^1$ , beside the non-pathologic voltage state  $X^1$ , there exist a second voltage state  $X^2$ , and applying the electrical input  $\hat{I}^1$  beside the non-pathologic equilibrium  $E^1 = (X^1, \hat{I}^1)$  a second equilibrium  $E^2 = (X^2, \hat{I}^1)$  appear. It can happen that the equilibrium  $(X^2, \hat{I}^1)$  is pathologic too. Therefore the problem is to find supplementary condition assuring that the solution of the initial value problem (2.1) tends to  $X^1$  as it was planned.

In Balint and.. 2008 example (5.5) pg.197 provide computational simulation of the above-described phenomena.

Consider the discrete semi-dynamical system, obtained from the continuous-time system analyzed in Balint and..2008 example 5.2 pg.184, by the semi-discretization technique :

$$x_{p+1}^1 = e^{-h} \times x_p^1 + (1 - e^{-h}) \times \left( \frac{17 \times \ln 4}{15} \times \tanh x_p^2 + \hat{I}_1^1 \right), \quad x_{p+1}^2 = e^{-h} \times x_p^2 + (1 - e^{-h}) \times \left( \frac{17 \times \ln 4}{15} \times \tanh x_p^1 + \hat{I}_2^1 \right) \quad (2.2)$$

For  $h = 0.2$ , and  $\hat{I}^0 = (0,0)^T$ , for (2.2) the following steady states were found:  $X^0 = (0,0)^T$ ,  $X^1 = (\ln 4, \ln 4)^T$ ,  $X^2 = (-\ln 4, -\ln 4)^T$ .

If the voltage of the neural network is in the steady state  $X^0 = (0,0)^T$  and the value of the external input is maintained  $\hat{I}^0 = (0,0)^T$  then the voltage rest constant. This phenomenon is illustrated on figures 2.1 and 2.2

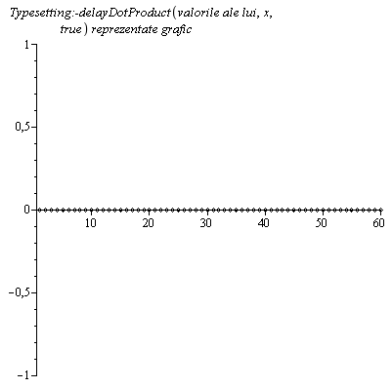


Fig.2.1.  $x_1$  versus  $p$  in  $E^0 = (X^0, \hat{I}^0)$

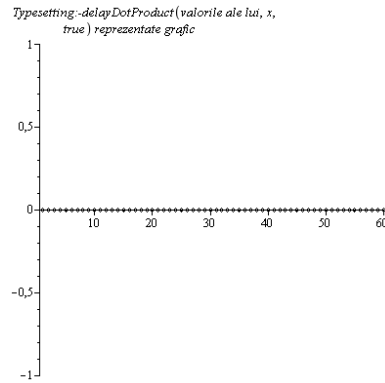


Fig.2.2.  $x_2$  versus  $p$  in  $E^0 = (X^0, \hat{I}^0)$

These figures show that maintaining the external input value  $\hat{I}^0 = (0,0)^T$ , the voltage of the neural network is constant equal to  $X^0 = (0,0)^T$ .

According to the neuro-psychological interpretation, this type of the neural network voltage behavior indicates that  $E^0 = (X^0, \hat{I}^0)$  is an equilibrium of the corresponding nervous system.

Assume that the equilibrium  $E^0 = (X^0, \hat{I}^0)$  is non-pathologic and the equilibrium  $E^3 = (X^3, \hat{I}^3)$ , with  $X^3 = (0.1,0.1)^T$  and  $\hat{I}^3 = (-0.1565911736, -0.1565911736)^T$ , is pathologic and a neurological or psychological intervention is needed. The change of the external electrical input represents a possible intervention. Assume that the medical decision is to transform the pathologic equilibrium  $E^3 = (X^3, \hat{I}^3)$  into the equilibrium  $E^0 = (X^0, \hat{I}^0)$  by changing the external electrical input  $\hat{I}^3 = (-0.1565911736, -0.1565911736)^T \rightarrow \hat{I}^0 = (0,0)^T$  at the moment of time  $p_1 = 0$ . The effect of the external input change  $\hat{I}^3 \rightarrow \hat{I}^0$  is represented on figures 2.3 and 2.4.

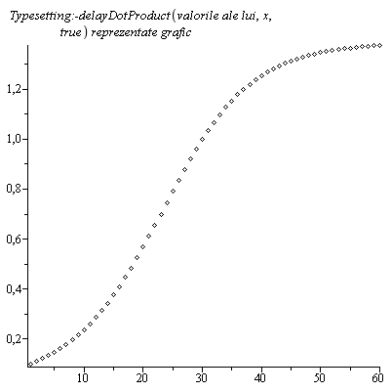


Fig.2.3.  $x_1$  versus  $p$

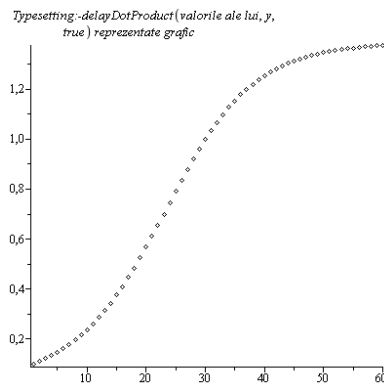


Fig.2.4.  $x_2$  versus  $p$

These figures show that after the input change the pathologic voltage state  $X^3 = (0.1,0.1)^T$  do not evolve to the non-pathologic voltage state  $X^0 = (0,0)^T$  as it was expected. The

mathematical explanation is: the steady state  $X^1 = (\ln 4, \ln 4)^T$  is locally exponentially stable and the steady state  $X^3 = (0.1, 0.1)^T$  belongs to the region of attraction of the steady state  $X^1 = (\ln 4, \ln 4)^T$ .

In the same time, the steady voltage state  $X^0 = (0, 0)^T$  is unstable and repulsive.

The unstable character of steady voltage state  $X^0 = (0, 0)^T$  means that for any small perturbation of the initial condition, the solution of the perturbed initial value problem :

$$\begin{aligned} x_{p+1}^1 &= e^{-h} \times x_p^1 + (1 - e^{-h}) \times \left(\frac{17 \times \ln 4}{15} \times \tanh x_p^2\right) & x_1^1 &= \varepsilon \\ x_{p+1}^2 &= e^{-h} \times x_p^2 + (1 - e^{-h}) \times \left(\frac{17 \times \ln 4}{15} \times \tanh x_p^1\right) & x_1^2 &= \delta \end{aligned} \tag{2.3}$$

do not recover the steady state  $X^0 = (0, 0)^T$ .

The next figures illustrate the instability and the repulsive character of the equilibrium  $E^0$ .

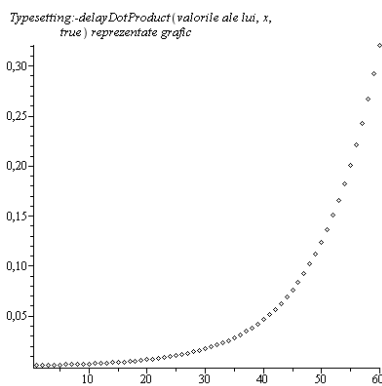


Fig.2.5.  $x_1$  versus p

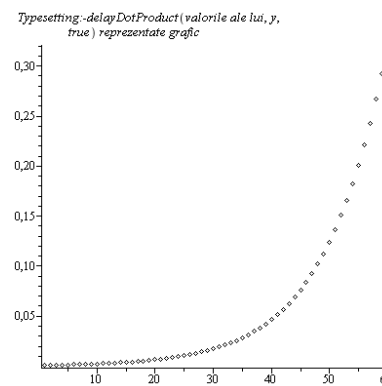


Fig.2.6.  $x_2$  versus p

Figures 2.5 ,2.6 illustrate that instead of the recovery of  $X^0 = (0, 0)^T$  the components of the perturbed steady state  $X^0$  move away from the steady state  $X^0 = (0, 0)^T$

Figures 2.5.,2.6 illustrate also the repulsive character of the steady voltage state  $X^0 = (0, 0)^T$ . That is because the solution of the initial value problem (2.3) represent also the evolution of the steady state  $X^{\varepsilon, \delta} = (\varepsilon, \delta)^T$  of the equilibrium  $E^{\varepsilon, \delta} = (X^{\varepsilon, \delta}, \widehat{I^{\varepsilon, \delta}})$  in case of the external electrical impulse change  $\widehat{I^{\varepsilon, \delta}} \rightarrow (0, 0)^T$ . The external electrical input  $\widehat{I^{\varepsilon, \delta}}$  appearing here is obtained from the steady state  $X^{\varepsilon, \delta}$  using formula (1.6).

According to the neuro-psychological interpretation of equilibrium, is important to keep in mind that in a nervous system there are three types of equilibriums:

-Equilibriums of first type for which after a small perturbation of the steady state, the nervous system return to the equilibrium. This is the situation if the steady state of the corresponding neural network is locally exponentially stable. (as is the equilibrium  $E^1 = ((\ln 4, \ln 4)^T, \widehat{I^0} = (0, 0)^T)$ )). Due to this property the nervous system return to the equilibrium automatically ,without any external input, we will say that this equilibrium of the nervous system is robust.

-Equilibriums of second type for which after a small perturbation of the steady state the nervous system do not return to the equilibrium. This is the situation if the steady state of the

corresponding neural network is unstable. (as is the equilibrium  $E^0 = (X^0, \hat{I}^0)$  with  $X^0 = (0,0)^T$  and  $\hat{I}^0 = (0,0)^T$ ). Due to the property that the nervous system do not return to the equilibrium automatically, without applying an external input, we will say that this type of equilibrium of the nervous system is fragile.

--Equilibriums of third type having the property that there is no equilibrium, which can be transferred in such type of equilibrium. Due to this property, we will say that this type of equilibrium of the nervous system is repulsive.( as is the equilibrium  $E^0 = (X^0, \hat{I}^0)$  with  $X^0 = (0,0)^T$  and  $\hat{I}^0 = (0,0)^T$  ).

### 3. Equilibriums transfer.

A correct neuro psychological interpretation and understanding of the possible equilibriums of the neural network permit to neurologist and psychologist to choose appropriate tool in a specific case. On this basis people, working in neural and mental healthcare, can choose appropriate tool for transfer the pathologic equilibrium of a patient into a non-pathologic equilibrium.

The choice of the appropriate tool assume : starting from a robust pathologic equilibrium  $E^0=(X^0, \hat{I}^0)$  , choose a new non-pathologic steady state  $X^1$ , compute for  $X^1$ , the corresponding new external electrical input  $\hat{I}^1$  using formula (1.6), and build up a new robust non-pathologic equilibrium  $E^1 = (X^1, \hat{I}^1)$ .

After that, several computations has to be made in order to be able to transfer

$$E^0=(X^0, \hat{I}^0) \rightarrow E^1 = (X^1, \hat{I}^1) .$$

Step 1. Verify that the equilibriums  $E^0, E^1$  are robust and the region of attraction of the steady state  $X^1$  contains the steady state  $X^0$ . A way to verify the robustness of the equilibriums  $E^0, E^1$  is to solve and represent the solutions of the initial value problems:

$$X_{p+1} = F(X_p, \hat{I}^0) \quad X_1 = X_1^0 \quad (3.1)$$

$$X_{p+1} = F(X, \hat{I}^1) \quad X_1 = X_1^1 \quad (3.2)$$

where  $X_1^0, X_1^1$  are small perturbations of  $X^0$  and  $X^1$  respectively.

Step 2. Solve and represent the solutions of the initial value problems

$$X_{p+1} = F(X, \hat{I}^0) \quad X_1 = X^1 \quad (3.3)$$

$$X_{p+1} = F(X, \hat{I}^1) \quad X_1 = X^0 \quad (3.4)$$

In order to see how this work in practice, consider the neural network (2.2) and the equilibrium  $E^0=(X^0, \hat{I}^0)= ((\ln 4, \ln 4)^T, (0,0)^T) = (1.386294361, 1.386294361)^T, (0,0)^T$ .

Fix the new steady state  $X^1= (0.1 + \ln 4, 0.1 + \ln 4)^T = (1.486294362, 1.486294362)^T$  and using (1.6)

compute the corresponding new external electrical input  $\hat{I}^1$  finding  $\hat{I}^1 = (0.068125374, 0.068125374)^T$ .

So the new equilibrium is

$$E^1 = (X^1, \hat{I}^1) = (1.486294362, 1.486294362)^T, (0.068125374, 0.068125374)^T$$

For test the robustness of  $E^0=(X^0, \hat{I}^0)$ , solve and represent the initial value problem (3.1). Taking for example  $X_1^0 = (1.486294362, 1.486294362)^T$  the solution of the initial value problem (3.1) is presented on the next figures:

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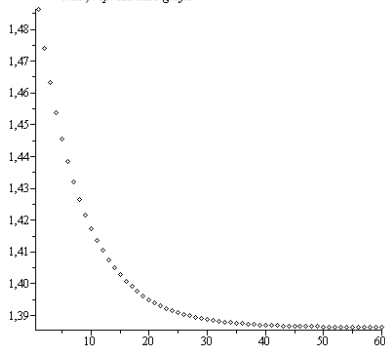


Fig.2.7.  $x_1$  versus p

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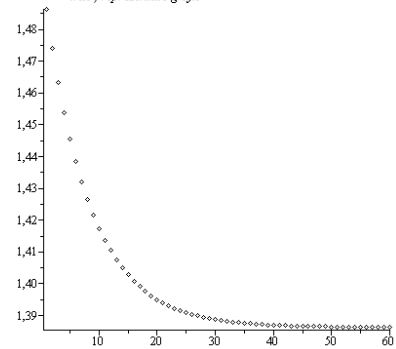


Fig.2.8.  $x_2$  versus p

Figures 2.7. and 2.8. suggest that the perturbed steady state  $X^0$  in case of the equilibrium  $E^0=(X^0, \hat{I}^0)$  retrieve the steady state. In other words, these figures suggest that the equilibrium  $E^0$  is robust. Moreover, these figures illustrate also the transfer of the equilibrium  $E^1$  into the equilibrium  $E^0$ , because they represent solution of the initial value problem (3.3)

The robustness of the equilibrium  $E^1$  and the transfer of  $E^0$  into  $E^1$  can be illustrate solving the initial value problem (3.2) for  $\hat{I}^1 = (0.068125374, 0.068125374)^T$  and  $X_1^1 = (1.386294361, 1.386294361)^T$ . The solution of (3.2) in this case is presented in the next figures.



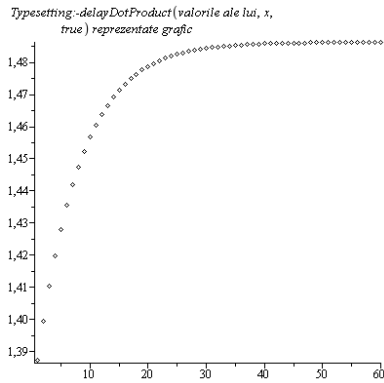


Fig.2.9.  $x_1$  versus  $p$

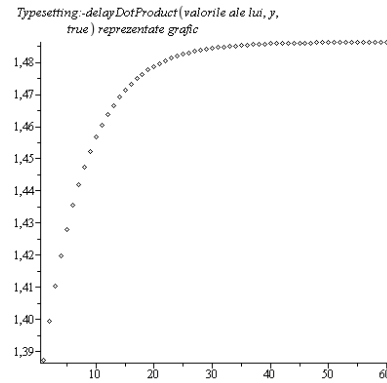


Fig.2.10.  $x_2$  versus  $p$

In the following, we present results from Balint and..2008, which can offer an overview about the complexity of the possible equilibriums, their location, the steady states character and possible transfer. Illustrative computational examples are given.

In Balint and..2008 theorem 5.17.pg.191 states: If  $\Delta$  is a rectangle in  $R^n$ , (i.e. for  $i = 1, 2, \dots, n$  there exist  $\alpha_i, \beta_i \in R$   $\alpha_i < \beta_i$ , such that  $\Delta = (\alpha_1, \beta_1) \times (\alpha_2, \beta_2) \times \dots (\alpha_n, \beta_n)$ ) and  $\det((I_d - B) - \widehat{T} \times D_X(X)) \neq 0$  for any  $X \in \Delta$ , then

- i.) the restriction of the function  $\widehat{I}_\Delta$  (the restriction to  $\Delta$  of the external input function) is injective.
- ii.) for any input  $\widehat{I} \in \widehat{I}_\Delta(\Delta)$  the system (1.5) has a unique steady state in  $\Delta$ .
- iii.) if  $0 < g'_i(s)$ , for any  $s \in R, i = 1, 2, \dots, n$ , and

$$\widehat{T}_u - \frac{1-b_i}{g'_i(x_i)} + \sum_{j \neq i} |\widehat{T}_{ji}| < 0 \quad i = 1, 2, \dots, n \quad X \in \Delta \quad , \quad (3.4)$$

then for any  $\widehat{I} \in \widehat{I}_\Delta(\Delta)$  the neural network (1.5) has a unique steady state in  $\Delta$ . Moreover if  $\widehat{I}_i > 0$  for any  $i = 1, 2, \dots, n$  then the coordinates of the steady voltage state are positive.

This theorem reveal that in a prior given rectangle  $\Delta$  (included in  $R^n$ ) if  $\det((I_d - B) - \widehat{T} \times D_X(X)) \neq 0$  for any  $X \in \Delta$ , then for any  $X^0 \in \Delta$  the input  $\widehat{I}(X^0) = (I_d - B) \times X^0 - \widehat{T} \times G(X^0) = \widehat{I}^0$  is unique. Therefore, the equilibrium  $E^0 = (X^0, \widehat{I}^0)$  of the nervous system is unique. This situation is completely different from that described in case of the neural network (2.2) where in case of the rectangle  $\Delta = (-1.5, 1.5) \times (-1.5, 1.5)$  for the input  $\widehat{I}^0 = (0, 0)^T$  three different equilibriums  $E_1^0 = ((0, 0)^T, \widehat{I}^0)$ ,  $E_2^0 = ((\ln 4, \ln 4)^T, \widehat{I}^0)$  and  $E_3^0 = ((-\ln 4, -\ln 4)^T, \widehat{I}^0)$  exists each of them having the steady state in  $\Delta$ .

In Balint and...2008 theorem 5.18.pg.191. states; Under the general hypothesis concerning activation functions, for any external input  $\widehat{I} \in R^n$  the following statements hold :

- i.) There exists at least one steady voltage state of the neural network (1.4) (corresponding to  $\widehat{I}$ ) in the rectangle  $\Delta = [-M_1, M_1] \times [-M_2, M_2] \times \dots \times [-M_n, M_n]$

where

$$M_i = \frac{1}{1-b_i} \times (|\widehat{I}_i| + \sum_{j=1}^n |\widehat{T}_{ij}|) \quad \text{for any } i = 1, 2, \dots, n \quad (3.5)$$

ii). Every steady voltage state of the neural network (1.4) corresponding to  $\widehat{I}$ , belongs to the rectangle  $\Delta$  defined above.

iii). If in addition

$$\det((I_d - B) - \widehat{T} \times D_X(X)) \neq 0 \text{ for any } X \in \Delta \quad (3.6)$$

then the neural network (1.4) has a unique steady state, corresponding to  $\widehat{I}$ , and it belongs to  $\Delta$ .

This theorem clarifies several things:

-First, the theorem assures that applying an arbitrary prior given external electrical input  $\widehat{I}^0 \in R^n$  to the nervous system there exist at least one steady voltage state  $X^0$  such that  $E^0 = (X^0, \widehat{I}^0)$  is an equilibrium of the nervous system. The steady voltage state  $X^0$  of the equilibrium  $E^0 = (X^0, \widehat{I}^0)$  is in the rectangle  $\Delta$  specified above. This is in fact a localization of the steady voltage state. For finding effectively, the steady voltage state  $X^0$ , the nonlinear algebraic equation  $F(X, \widehat{I}) = X$  has to be solved in  $\Delta$ .

-Second, the theorem assures that applying an arbitrary prior given external electrical input  $\widehat{I}^0 \in R^n$  to the nervous system, every steady voltage state  $X^0$  which appears due to that is in the rectangle  $\Delta$ .

-Third if  $\det((I_d - B) - \widehat{T} \times D_X(X)) \neq 0$  for any  $X \in \Delta$ , (specified above) then the obtained steady voltage state  $X^0$  is unique. This means that the obtained equilibrium  $E^0 = (X^0, \widehat{I}^0)$  is unique. The supplementary information is that  $X^0$  is unique and the equilibrium  $E^0 = (X^0, \widehat{I}^0)$  is unique.

In Balint and...2008 theorem 5.20. pg.192 states: Under the general hypothesis concerning activation functions  $g_i$  if

$$g_i(s) = 1 \text{ if } s \geq 1 \quad \text{and} \quad g_i(s) = -1 \text{ if } s \leq -1 \quad (3.7)$$

then for any input  $\widehat{I} \in R^n$  satisfying

$$|\widehat{I}_i| < \widehat{T}_{ii} + b_i - 1 - \sum_{i \neq j} |\widehat{T}_{ij}| \quad \text{for any } i = 1, 2, \dots, n \quad (3.8)$$

the following statements hold:

i). in every rectangle  $\Delta_\varepsilon, \varepsilon \in \{\pm 1\}$ , there exists a unique steady voltage state of the neural network (1.4) corresponding to  $\widehat{I}$ ; here  $\Delta_\varepsilon = J(\varepsilon_1) \times J(\varepsilon_2) \dots J(\varepsilon_n), J(-1) = (-\infty, -1), J(1) = (1, \infty)$ .

ii). every  $\overline{\Delta}_\varepsilon, \varepsilon \in \{\pm 1\}$ , is invariant to the map  $X \rightarrow F(X, \widehat{I})$ .

The mathematical condition (3.8) concerns the magnitude of the external input (left hand side) and the coefficients of the neural network (right hand side). If an input  $I^0$  which verifies (3.8) is applied to the nervous system then, due to that in the nervous system,  $2^n$  equilibria  $E^{\varepsilon, I^0} = (X^{\varepsilon, I^0}, I^0)$  appear. Each steady state  $X^{\varepsilon, I^0}$  is unique and located in a rectangle  $\Delta_\varepsilon$ . This is an

extremely complex configuration of steady voltage states of the nervous system which can appear after applying an external electrical input  $I^0$ .

A modified variant of the above theorem is Theorem (5.21) pg.193 Balint and..2008.

In Balint and...2008 theorem5.21.pg.193. states; Under the general hypothesis concerning activation functions if there exists  $\alpha \in (0,1)$  such that the activation functions verify:

$$g_i(s) \geq \alpha \text{ if } s \geq 1 \text{ and } g_i(s) \leq -\alpha \text{ if } s \leq -1 \text{ for any } i = 1,2, \dots n \tag{3.9}$$

then for any input  $\hat{I} \in R^n$  satisfying

$$|\hat{I}_i| < \hat{T}_{ii} \times \alpha + b_i - 1 - \sum_{i \neq j} |\hat{T}_{ij}| \text{ for any } i = 1,2, \dots n \tag{3.10}$$

the following statements hold:

i). in every rectangle  $\Delta_\varepsilon, \varepsilon \in \{\pm 1\}$ , there exists a unique steady voltage state of the neural network (1.4) corresponding to  $\hat{I}$ .

ii). every  $\overline{\Delta_\varepsilon}, \varepsilon \in \{\pm 1\}$ , is invariant to the map  $X \rightarrow F(X, \hat{I})$ .

This theorem reveal that if the neuron input-output activations verify (3.9) and one input  $\hat{I}^0$ , which verifies (3.10), is applied to the nervous system then due to that in the nervous system  $2^n$  equilibriums  $E^{\varepsilon, \hat{I}^0} = (X^{\varepsilon, \hat{I}^0}, \hat{I}^0)$  appear. Each steady state  $X^{\varepsilon, \hat{I}^0}$  is unique and located in a rectangle  $\Delta_\varepsilon$ . This configuration of steady states, is similar which appear in theorem 5.20 and is an extremely complex configuration of steady voltage states of the nervous system which can appear after applying an external electrical input  $\hat{I}^0$ .

Finally in Balint and...2008 theorem5.25.pg.195 conditions of local exponential stability of the above steady voltage states are presented.

In Balint and...2008 theorem5.25.pg.195. states; suppose that the conditions of Balint and...2008 theorem 5.21 pg.193 are fulfilled. Let be an input  $\hat{I}^0 \in R^n$  satisfying (3.10) and  $\varepsilon \in \{\pm 1\}$ . If  $|g'_i(s)| < \frac{1-b_i}{\sum_{j=1}^n |\hat{T}_{ji}|}$  for any  $|s| \geq 1$  and  $i = 1,2, \dots n$  then the steady voltage state  $X^{\varepsilon, \hat{I}^0}$  of the neural network (1.4) corresponding to  $\hat{I}^0$ , which lies in the rectangle  $\Delta_\varepsilon$ , is unique it is locally exponentially stable and its region of attraction includes  $\overline{\Delta_\varepsilon}$ .

This theorem present conditions, concerning the neuron input-output activations, assuring the robustness of the

$2^n$  equilibriums  $E^{\varepsilon, \hat{I}^0} = (X^{\varepsilon, \hat{I}^0}, \hat{I}^0)$  which appear after applying the external electrical input  $\hat{I}^0$  to the nervous system. The importance of this theorem consists in the fact that permit the construction of path of robust equilibriums which can be used in healthcare as secured way to transfer gradually a pathologic equilibrium into a non-pathologic equilibrium.

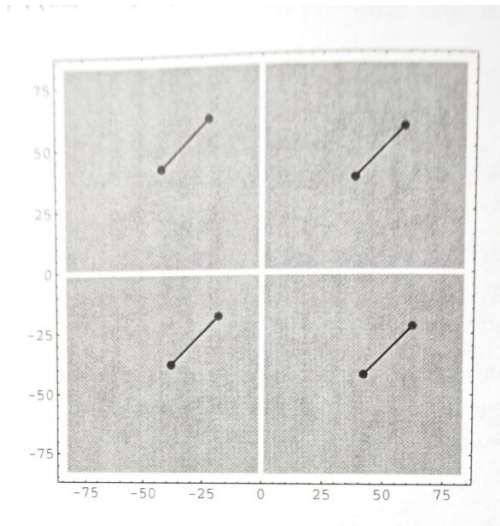
A numerical illustration of the phenomena described in Theorem 5.25.pg.195. Balint and..(2008) is given in Example (5.6) pg.197 Balint and..(2008).In this example the following Hopfield neural network is considered:

$$x_{p+1}^1 = 0.5x_p^1 + 20f(x_p^1) - f(x_p^2) + \hat{I}_1, \quad x_{p+1}^2 = 0.5x_p^2 - f(x_p^1) + 20f(x_p^2) + \hat{I}_2 \tag{3.11}$$

With the non-monotone activation function  $f(x) = \tanh(x) \tanh(10x^2 - 1)$ .It has been shown that in some cases, the absolute capacity of an associative neural network can be improved by

using non-monotone activation functions instead of the usual sigmoid ones. The conditions of theorems Balint and...2008 theorem5.21.pg.193 and theorem5.25.pg.195 are verified ( $\alpha = f(1) \in (0,1)$ ). Therefore, for any input  $\hat{I} = (\hat{I}_1, \hat{I}_2)^T$  such that  $|\hat{I}_i| < 18.4982$  there exists unique locally exponentially stable steady state  $X^{\varepsilon, \hat{I}} = (x^{1;\varepsilon, \hat{I}}, x^{2;\varepsilon, \hat{I}})^T$  in each rectangle  $\Delta_\varepsilon$ .

In the next figure the rectangles represent the sets  $S_\varepsilon = \{ \frac{x^{i;\varepsilon, \hat{I}_i}}{|\hat{I}_i|} < 18.4982, i = 1,2 \}$ .



Sets  $S_\varepsilon$

The four steady states corresponding to the input  $\hat{I} = (0,0)^T$  are:  $(38,38)^T, (-42,42)^T, (42,-42)^T, (-38,-38)^T$

The four steady states corresponding to the input  $\hat{I} = (10,10)^T$  are:  $(58,58)^T, (-22,62)^T, (62,-22)^T, (-18,-18)^T$

The external electrical input change  $(0,0)^T \rightarrow (10,10)^T$  transfer the configuration of steady states  $\{ (38,38)^T, (-42,42)^T, (42,-42)^T, (-38,-38)^T \}$

into the configuration of steady states  $\{ (58,58)^T, (-22,62)^T, (62,-22)^T, (-18,-18)^T \}$ .

The transfer of the steady state voltage  $(38,38)^T$  into the steady state voltage  $(58,58)^T$  due to the external electrical input change  $(0,0)^T \rightarrow (10,10)^T$  is presented in the next figures.

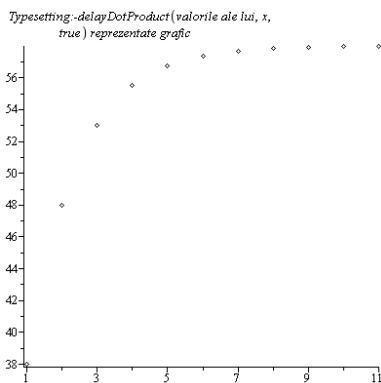


Fig.2.11.  $x_1$  versus  $p$

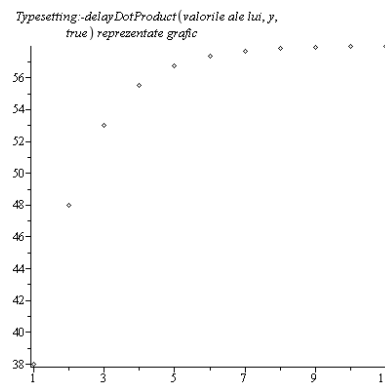


Fig.2.12.  $x_2$  versus  $p$

This example intends to illustrate the nervous system equilibriums configuration complexity, the existence of robust equilibrium paths and the equilibrium steady voltage states transfer along the equilibrium paths. The strategy in computational neurology has to be the buildup path of locally exponentially stable steady states along which by small successive changes, the neural network voltage can be conducted, through the regions of attraction of intermediary locally exponentially stable steady voltage states from a pathologic steady voltage state to a final non pathologic steady voltage state. This kind of interpretation of the mathematical results, obtained in the discrete-time Hopfield neural network model, can be useful in healthcare for establish safe neuro-psychological treatment procedures.

### **Conclusions**

The mathematical theory of discrete-time Hopfield neural networks, presented in this paper exhibit the same scale of scenarios as the continuous-time Hopfield neural networks having similar neuro psychological interpretation. Robust, fragile, and repulsive equilibriums appear. In equilibrium, the voltage state of the neural network is constant and does not change if the external electrical input value is maintained constant. Equilibrium transfer analysis show that the strategy in computational neurology has to be the buildup of path of robust equilibrium states along which by small successive changes, the neural network voltage can be conducted from a pathologic equilibrium, through the regions of attraction of intermediary robust equilibriums to the final non-pathologic equilibrium. In healthcare a treatment procedure usually follows a path of robust equilibriums, which “connect” the present pathologic equilibrium with a future non-pathologic equilibrium of the patient.

### **References**

[1] St. Balint, L. Braescu and E. Kaslik. Regions of attraction and applications to control theory. Cambridge Scientific Publishers Ltd. 2008. Edited by S. Sivasundaram.

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# Ferroresonance Analysis and Artificial Intelligence Based Detection in Electrical Power Systems

## *Elektrik Güç Sistemlerinde Ferrerezonans Analizi ve Yapay Zeka Tabanlı Tespiti*

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### **ABSTRACT**

Ferroresonance is of serious importance in electrical power systems. It is a complex and harmful event, particularly encountered in high-voltage electrical power systems, that can lead to severe failures. This event can cause voltage and current fluctuations in the system, resulting in equipment damage, prolonged downtime, and energy losses. Ferroresonance occurs due to the magnetic saturation of ferromagnetic cores and the influence of components approaching the resonant frequency in the system. These phenomena in high-voltage systems can damage equipment, particularly transformers and capacitors.

The effects of ferroresonance include equipment failures, system outages, and energy losses. Timely detection of such events is critical to ensuring system security. While traditional methods are insufficient, approaches such as artificial intelligence (AI)-based techniques, machine learning, deep learning, and time series analysis offer effective solutions for early diagnosis of ferroresonance events. By analyzing anomalies in the system, AI methods can predict the occurrence of ferroresonance and detect possible failures in advance. In this study, three artificial intelligence (AI) based techniques such as K-Nearest Neighbor (KNN), Support Vector Machines (SVM) and Long Short-Term Memory (LSTM) networks were applied to detect and analyze ferroresonance events in power systems. The main objective of the study was to examine the effectiveness of these machine learning models in detecting ferroresonance events based on real-time voltage and current data.

A set of simulated power system data representing normal and ferroresonance states were used in the training and testing processes of each model. KNN was selected as the base classifier due to its ability to obtain effective results with small and medium-sized data sets. SVM was used to handle more complex cases of ferroresonance with its nonlinear data classification ability. LSTM was applied to predict dynamic and evolving ferroresonance events, especially with its ability to learn long-term dependencies in time series data.

**Keywords:** Ferroresonance detection, ferroresonance effect, ferroresonance Modeling, ferroresonance analysis, artificial intelligence

## ÖZET

Elektrik güç sistemlerinde ferrezonans olayı ciddi önem arz etmektedir. Özellikle yüksek gerilimli elektrik güç sistemlerinde karşılaşılan ve ciddi arızalara neden olabilen karmaşık ve zararlı bir olaydır. Bu olay, sistemdeki gerilim ve akım dalgalanmalarına yol açarak, ekipman hasarlarına, arıza sürelerinin uzamasına ve enerji kayıplarına sebep olabilir. Ferrezonans, ferromanyetik çekirdeklerin manyetik doygunluğa ulaşması ve sistemde rezonans frekansına yaklaşan bileşenlerin etkisiyle ortaya çıkar. Yüksek gerilim sistemlerdeki bu olgular, özellikle transformatörler ve kondansatörler gibi ekipmanlara zarar verir.

Ferrezonansın etkileri arasında ekipman arızaları, sistem kesintileri ve enerji kayıpları bulunur. Bu tür olayların zamanında tespit edilmesi, sistemin güvenliğini sağlamak için kritik öneme sahiptir. Geleneksel yöntemler yetersiz kalırken, yapay zeka (YZ) tabanlı teknikler, makine öğrenmesi, derin öğrenme ve zaman serisi analizi gibi yaklaşımlar, ferrezonans olaylarının erken teşhisi için etkili çözümler sunmaktadır. YZ yöntemleri, sistemdeki anormallikleri analiz ederek, ferrezonansın oluşumunu tahmin edebilir ve olası arızalar önceden tespit edilebilir.

Bu çalışmada, güç sistemlerinde ferrezonans olaylarını tespit etmek ve analiz etmek amacıyla K-En Yakın Komşu (KNN), Destek Vektör Makineleri (SVM) ve Long Short-Term Memory (LSTM) ağları gibi üç yapay zeka (YZ) tabanlı teknik uygulanmıştır. Çalışmanın temel amacı, bu makine öğrenmesi modellerinin, gerçek zamanlı voltaj ve akım verilerine dayalı olarak ferrezonans olaylarını tespit etme etkinliğini incelemektir.

Normal ve ferrezonans durumlarını temsil eden bir dizi simüle edilmiş güç sistemi verisi, her modelin eğitim ve test süreçlerinde kullanılmıştır. KNN, küçük ve orta büyüklükteki veri setleriyle etkili sonuçlar elde edebilmesi nedeniyle temel sınıflandırıcı olarak seçilmiştir. SVM, doğrusal olmayan veri sınıflandırma yeteneği ile ferrezonansın daha karmaşık durumlarını ele almak için kullanılmıştır. LSTM, zaman serisi verilerindeki uzun vadeli bağımlılıkları öğrenme yeteneği ile özellikle dinamik ve gelişen ferrezonans olaylarını tahmin etmek için uygulanmıştır.

**Anahtar Kelimeler:** ferrezonans tespiti, ferrezonans etkisi, ferrezonans modelleme, enerji şebekesi kararlılığı, ferrezonans analizi, yapay zeka

## GİRİŞ

Tüm dünyada elektrik enerjisine olan bağımlılığın her geçen gün arttığı bilinen bir gerçektir. Elektrik enerjisinin diğer enerji türlerine göre bazı üstünlüklerinin bulunması, artan dünya nüfusu ve değişen yaşam koşulları bu artışın nedenleri arasında sayılabilir.

Elektrik enerjisine olan bağımlılığın bu şekilde artışı kurulu tesislerin büyütülmesi ve yeni tesislerin kurulması ile karşılanabilir. Bu çalışmalarda elektrik enerjisinin üretildiği yerden tüketildiği yere iletimi, sistem genişledikçe önemli sorunlar ortaya çıkarır. Teknik ve ekonomik nitelikli bu sorunların giderilmesi aşamasında ve sistemin kararlı çalışabilmesi için bazı çalışmalar gereklidir.

Bunlar sistemin büyümesi ile birlikte, önceden düşünülüp göz önüne alınmayan sorunlardır. Bu sorunlardan biri de transformatörlerin nonlineer miktatsızlanma karakteristiklerinden dolayı temel frekansta meydana gelen

ferrerezonans olayıdır. Ferrerezonans nonlineer eleman olarak demir çekirdekli bir self bobini içeren elektrik devresinde meydana gelen rezonans olayıdır. Bu rezonans, sistemin girişine uygulanan bir büyüklüğün genliği yada frekansından oluşturulan küçük bir değişikliğin sistemin çıkış büyüklüğünde meydana getirdiği ani salınımlarla kendini gösterir.

Yüksek gerilim iletim hatları aynı direği paylaşan çift devreli hatlardır. Böyle bir iletim sisteminin bakımı ya da arıza gibi özel durumlarda hatlardan biri sistemden ayrılarak enerji iletimine diğer hat ile devam edebilir.

Yüksek gerilim iletim hattında devre dışı bırakılan hattaki transformatör endüktansının manyetik alanında ve hat kapasitesinin elektrik alanında depolanan enerji nedeni ile sistem salınımına girebilir. Demir kayıpları ve diğer devre kayıpları nedeni ile bu salınım belirli bir süre sonra söner. Bu kayıpların karşılanması diğer iletim hattında sağlandığında, kalıcı salınımlar ve transformatör terminalerinde aşırı gerilimler meydana gelebilir. Bütün bu olaylar iletim sistemleri üzerinde ferrerezonansın meydana getirdiği olumsuz etkilerdir.

Enerji iletim güç sisteminde ferrerezonansın meydana getirdiği bu olumsuz etkiler bu çalışmanın konusu içinde ayrıntılı biçimde işlenmiştir.

## YAPILAN ÇALIŞMALAR

### LSTM

Ferrerezonans olayının erken tespiti, enerji sistemlerinin güvenliği için büyük önem taşır. Zaman serisi verilerinin doğru şekilde analiz edilmesi gereken bu tür problemlerde, geleneksel makine öğrenme yöntemlerinden farklı olarak, derin öğrenme modelleri daha başarılı sonuçlar verebilmektedir. Bu bağlamda, Uzun Kısa Vadeli Bellek (LSTM) ağları, zaman serisi verilerini işleme konusundaki güçlü yetenekleri nedeniyle ferrerezonans tespiti için etkili bir çözüm sunmaktadır.

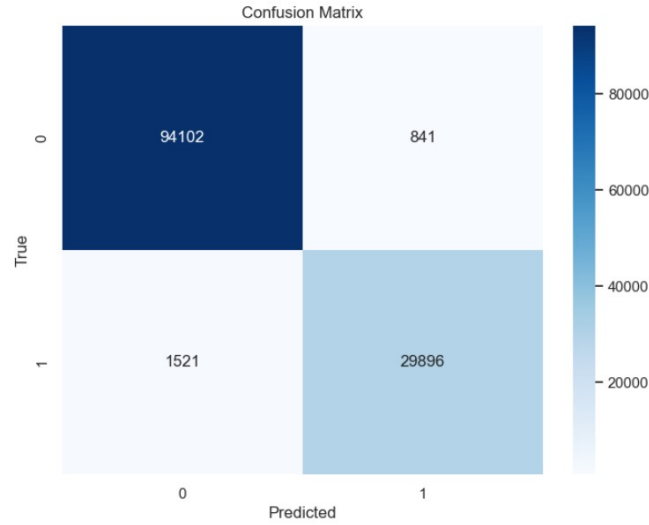
LSTM, sırasıyla gelen verileri işleyebilen ve uzun vadeli bağıntıları öğrenebilen bir tür Yinelemeli Sinir Ağı (RNN) modelidir. Ferrerezonans tespiti için kullanılan LSTM modeli, elektriksel sistemlerden gelen zaman serisi verilerini analiz ederek, ferrerezonans olaylarının tespitini gerçekleştirmiştir. Model, önceki zaman adımlarındaki verileri hatırlayarak gelecekteki olayları tahmin etmeye çalışır. Bu çalışma kapsamında, ferrerezonans olaylarının tespiti için LSTM modelinin doğruluğu, kayıp fonksiyonu ve karmaşıklık matrisi gibi çeşitli metriklerle değerlendirilmiştir.

LSTM modelinin eğitimi sırasında elde edilen doğruluk ve kayıp grafiklerinin analizi, modelin eğitim sürecindeki performansını net bir şekilde ortaya koymuştur. Modelin doğruluk oranı zamanla artmış, kayıp değeri ise azalma eğiliminde olmuştur. Eğitim süreci boyunca doğruluk oranı %96'nın üzerine çıkarak oldukça başarılı bir sonuç elde edilmiştir. Bu durum, LSTM' in ferrerezonans tespiti gibi karmaşık zaman serisi verilerinde yüksek başarı sağladığını göstermektedir.





LSTM modeli için oluşturulan karmaşıklık matrisi, modelin sınıflandırma başarısını daha ayrıntılı olarak ortaya koymuştur. Gerçek pozitif (TP) ve gerçek negatif (TN) değerleri yüksek oranda doğru sınıflandırılmış, yanlış pozitif (FP) ve yanlış negatif (FN) oranları ise oldukça düşük seviyelerde kalmıştır. Bu, modelin ferrezonans olaylarını doğru şekilde tespit etme konusunda yüksek bir doğruluk sergilediğini göstermektedir.



```

Classification Report:
              precision    recall  f1-score   support

     0       0.98         0.99         0.99         94943
     1       0.97         0.95         0.96         31417

 accuracy          0.98         0.98         0.98         126360
 macro avg          0.98         0.97         0.97         126360
 weighted avg       0.98         0.98         0.98         126360

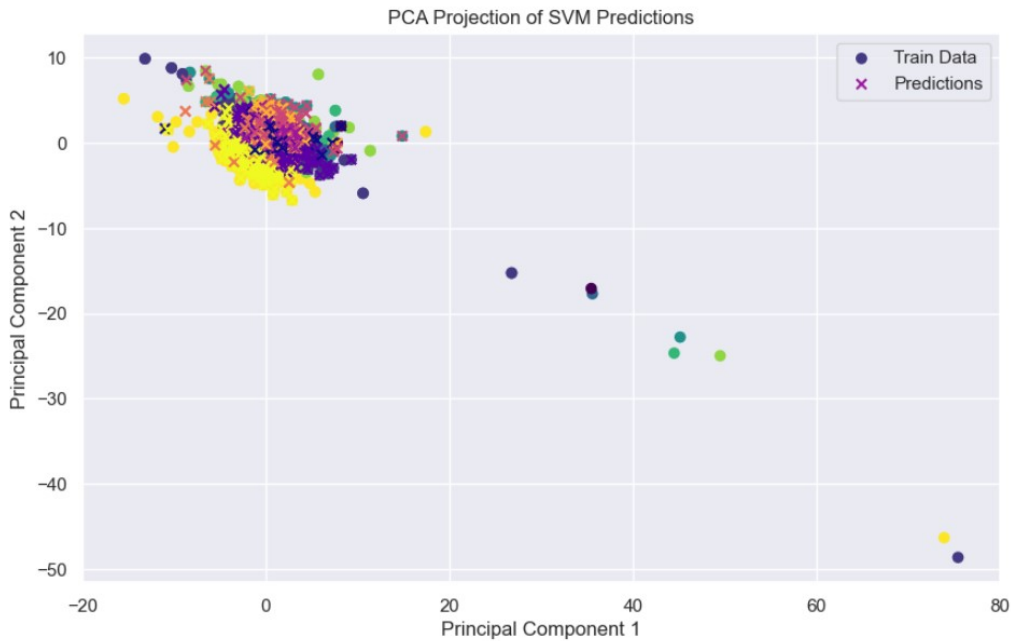
 True Labels Predicted Labels
 0           0             0
 1           0             0
 2           0             0
 3           0             0
 4           0             0
169/169 ————— 0s 2ms/step - accuracy: 0.9633 - loss: 0.0630
Test Loss: 0.06378570199012756
Test Accuracy: 0.9635565280914307

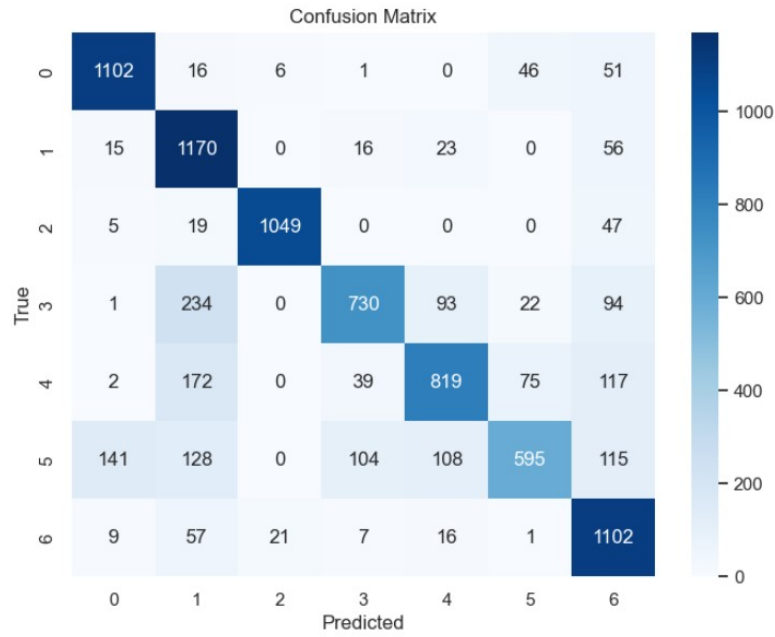
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## SVM

Destek Vektör Makinesi (SVM), özellikle sınıflandırma problemlerinde yüksek doğruluk sağlayan, güçlü bir makine öğrenme algoritmasıdır. Bu çalışmada, ferrezonans tespitinde SVM modelinin etkinliği ve performansı da incelenmiştir.

SVM, verilen veriler arasındaki sınıfları ayırt edebilmek için, en iyi ayırım çizgisi (hiper-düzlem) bulmayı amaçlayan denetimli bir öğrenme algoritmasıdır. Ferrezonans tespiti için, elektrik sistemlerinden alınan veriler kullanılarak SVM modelinin eğitimi yapılmıştır. Model, ferrezonans olaylarını normal ve anormal sınıflar olarak sınıflandırarak, bu olayların gerçekleşip gerçekleşmediğini tahmin etmektedir. Verilerin doğruluğunu ölçmek amacıyla, SVM için karmaşıklık matrisi, doğruluk oranı ve kayıp fonksiyonu gibi performans metrikleri kullanılmıştır.





SVM modelinin doğruluk oranları, LSTM' e kıyasla daha düşük seviyelerde (test doğruluğu %77) kalmıştır. Bu, özellikle ferrozonans tespiti gibi zamanla değişen verilerde SVM' in sınıflandırma doğruluğunun sınırlı kalmasına neden olmuştur. LSTM' in veriye özgü yapısı, zaman serisi bağıntılarını daha iyi öğrenmesine ve doğru sınıflama yapmasına olanak tanırken, SVM daha genel ve sabit sınıflandırma kurallarına dayandığı için zamanla değişen dinamik olayları tam olarak yakalayamamıştır.

```

Classification Report:
              precision    recall  f1-score   support

     0       0.86         0.90         0.88       1222
     1       0.65         0.91         0.76       1280
     2       0.97         0.94         0.96       1120
     3       0.81         0.62         0.70       1174
     4       0.77         0.67         0.72       1224
     5       0.81         0.50         0.62       1191
     6       0.70         0.91         0.79       1213

 accuracy          0.78         0.78       8424
 macro avg         0.80         0.78         0.78       8424
 weighted avg      0.79         0.78         0.77       8424

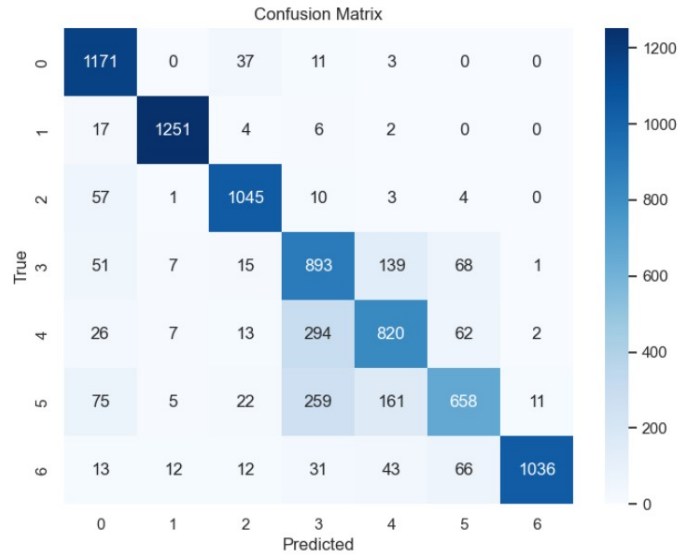
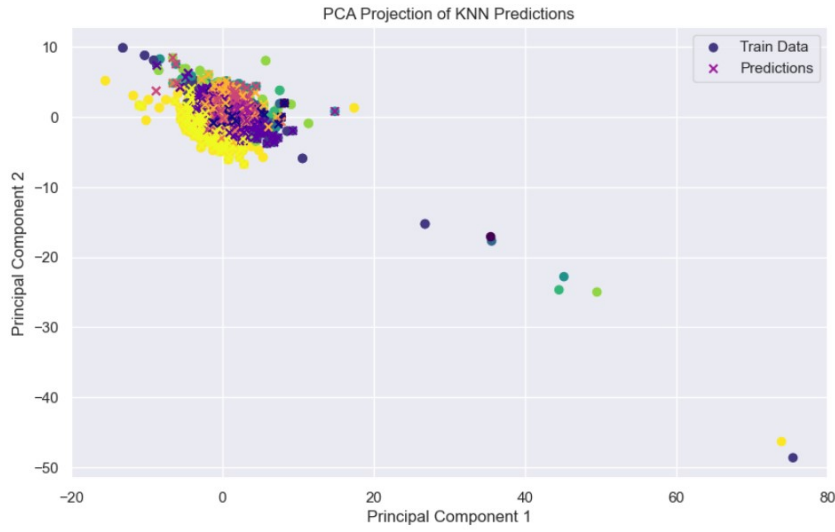
```

```

True Labels Predicted Labels
0           2                2
1           4                4
2           3                3
3           6                6
4           4                4
Test Accuracy: 0.7796

```

## KNN



KNN modelinin doğruluk oranı, SVM' e kıyasla daha yüksek olmuştur. Bu, KNN' in verilerdeki yakınlık ilişkilerini iyi kullanabildiği ve sınıflandırma hatalarının düşük olduğu anlamına gelir. Ancak, doğruluk oranı, LSTM' e kıyasla daha düşük kalmıştır. LSTM, zaman serisi verilerini işleme konusunda daha güçlüdür ve geçmiş verilerdeki uzun vadeli bağıntıları öğrenerek yüksek doğruluk oranlarına ulaşabilmiştir. KNN ise, zaman serisi bağıntılarını doğrudan öğrenmede zorluk yaşayabilir ve bu nedenle ferrezonans gibi karmaşık olayları tespit etmekte sınırlı kalmıştır. KNN' in doğruluğu yüksek olsa da, LSTM' in yüksek doğruluk oranlarının gerisinde kalmaktadır.

Classification Report:				
	precision	recall	f1-score	support
0	0.83	0.96	0.89	1222
1	0.98	0.98	0.98	1280
2	0.91	0.93	0.92	1120
3	0.59	0.76	0.67	1174
4	0.70	0.67	0.68	1224
5	0.77	0.55	0.64	1191
6	0.99	0.85	0.92	1213
accuracy			0.82	8424
macro avg			0.82	8424
weighted avg			0.82	8424
True Labels	Predicted Labels			
0	2	2		
1	4	4		
2	3	3		
3	6	6		
4	4	4		
Test Accuracy: 0.8160				

Bu çalışmada, ferreazonans tespiti için üç farklı yapay zeka modeli, Uzun Kısa Vadeli Bellek (LSTM), K-En Yakın Komşu (KNN) ve Destek Vektör Makinesi (SVM) karşılaştırılmıştır. Ferreazonansın farklı durumları için tespitinin daha net olması için verisetinde 6 farklı ferreazonans durum verileri kullanılmıştır. Modeller 25.269 veriyle eğitilmiş ve 8.424 veriyle test edilmiştir. Sonuçlar, LSTM modelinin ferreazonans tespitindeki en iyi performansı gösterdiğini ortaya koymuştur. LSTM, zaman serisi verilerinin dinamik bağıntılarını öğrenme konusundaki üstün yeteneği sayesinde %96'nın üzerinde doğruluk oranı elde ederek, ferreazonans olaylarını diğer modellerden daha etkili bir şekilde tespit etmiştir. Bu, LSTM' in geçmiş verileri ve uzun vadeli bağıntıları başarılı bir şekilde kullanabilmesinin bir sonucudur.

KNN, doğruluk açısından LSTM' in gerisinde kalmakla birlikte, %81'lik bir doğruluk oranı ile oldukça başarılı sonuçlar elde etmiştir. KNN' in yakınlık ilişkilerini kullanma yeteneği, ferreazonans tespitinde oldukça etkili olmuş ve özellikle daha basit verilerle hızlı ve doğru sonuçlar sağlamıştır. Ancak, zaman serisi verilerinin karmaşıklığını ve dinamik doğasını tam olarak yakalayamaması nedeniyle LSTM kadar yüksek doğruluk oranları elde edememiştir.

SVM ise, sınıflandırma görevlerinde güçlü bir performans sergilemesine rağmen, zaman serisi verileriyle başa çıkmada sınırlı kalmış ve doğruluk oranı %78 civarında olmuştur. Bu, SVM' in ferreazonans gibi dinamik ve karmaşık olayları tespit etme konusunda yetersiz kaldığına işaret etmektedir. SVM' in sınıflandırma sınırlarını en iyi şekilde ayırabilme yeteneği, ferreazonans gibi olayların doğru şekilde tespit edilmesinde yeterli olmamıştır.

## SONUÇ

Sonuç olarak, LSTM, zaman serisi verilerindeki bağıntıları öğrenme ve ferreazonans tespiti gibi dinamik olayları sınıflandırma konusunda en etkili model olarak öne çıkmıştır. KNN ise, daha hızlı ve pratik bir çözüm sunarken, yine de yüksek doğrulukla ferreazonans olaylarını tespit edebilmiştir. SVM ise genel olarak sınıflandırmada başarılı olsa da, zaman serisi verilerindeki doğruluğu sınırlıdır. Bu

çalışmanın sonuçları, LSTM' in ferreazonans tespitinde en uygun model olduğunu, ancak KNN ve SVM' in de belirli durumlar için etkili alternatifler sunduğunu göstermektedir. Gelecekte, hibrit modeller ve optimizasyon teknikleri ile bu modellerin performansı daha da iyileştirilebilir.

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# Artificial Intelligence Based Busbar Differential Protection System

## *Yapay Zeka Tabanlı Bara Diferansiyel Koruma Sistemi*

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### ABSTRACT

Supporting the busbar differential protection system with artificial intelligence (AI) has the potential to significantly increase the safety and efficiency of energy systems. While traditional protection systems detect abnormalities on the busbar by measuring specific current differences, these systems often rely on fixed settings and limited data analytics. As the complexity of electrical networks increases, more dynamic and adaptable solutions are needed. With the introduction of AI technologies, protection systems not only detect instantaneous faults, but also have a predictive capability that allows future faults to be predicted in advance. This enables the system to be managed more proactively and contributes to minimizing power outages by preventing faults before they occur. AI can collect and analyze large amounts of data from energy systems using machine learning and deep learning algorithms. This data continuously learns the normal operating conditions of the system and can quickly detect abnormal situations. In addition, AI-based systems can be adapted to the needs of different transformer substations thanks to real-time data analysis and customizable algorithms. As a result, it is possible to maximize the reliability of the system by increasing the sensitivity and flexibility of busbar differential protection systems, especially in large power plants and industrial facilities. Artificial intelligence also analyzes past fault records to predict how similar situations may occur in the future and thus can detect busbar faults.

**Keywords:** busbar systems, protection systems, differential protection, energy systems, reliability and efficiency, artificial intelligence

### ÖZET

Bara diferansiyel koruma sistemini yapay zeka (YZ) ile desteklemek, enerji sistemlerinin güvenliğini ve verimliliğini önemli ölçüde artırma potansiyeline sahiptir. Geleneksel koruma sistemleri, belirli akım farklarını ölçerek bara üzerindeki anormallikleri tespit ederken, bu sistemler genellikle sabit ayarlara ve sınırlı veri analitiğine dayanır. Elektrik şebekelerinin karmaşıklığı arttıkça, daha dinamik ve uyarlanabilir çözümlere ihtiyaç duyulmaktadır. Yapay zeka teknolojilerinin devreye girmesiyle, koruma sistemleri yalnızca anlık arızaları tespit etmekle kalmaz, aynı zamanda gelecekteki arızaların önceden tahmin edilmesine olanak tanıyan bir öngörü yeteneğine de sahip olur. Bu, sistemin daha proaktif bir şekilde yönetilmesini sağlar ve arızaların meydana gelmeden önce engellenmesi yoluyla enerji kesintilerinin en aza indirilmesine katkıda bulunur. Yapay zeka, makine öğrenimi ve derin öğrenme algoritmalarını kullanarak enerji sistemlerinden büyük miktarda veri toplayabilir ve analiz edebilir. Bu veriler, sistemin normal çalışma koşullarını sürekli olarak öğrenir ve olağan dışı durumları hızlı bir şekilde tespit edebilir. Ayrıca, yapay zeka tabanlı sistemler, gerçek

zamanlı veri analizi ve özelleştirilebilir algoritmalar sayesinde farklı trafo merkezlerinin ihtiyaçlarına göre uyarlanabilir. Sonuç olarak özellikle büyük enerji santralleri ve endüstriyel tesislerde, bara diferansiyel koruma sistemlerinin hassasiyetini ve esnekliğini artırarak, sistemin güvenilirliğini en üst düzeye çıkarmak mümkündür. Yapay zeka ayrıca, geçmişteki arıza kayıtlarını inceleyerek gelecekte benzer durumların nasıl oluşabileceğini öngörür ve böylece bara arıza tespitinde bulunabilir.

**Keywords:** bara sistemleri, koruma sistemleri, diferansiyel koruma, enerji sistemleri, güvenilirlik ve verimlilik, yapay zeka

## Giriş

Elektrik enerjisi sistemlerinde, güvenlik ve verimlilik her zaman öncelikli konular arasında yer almaktadır. Elektrik şebekelerinin büyüklüğü ve karmaşıklığı arttıkça, bu sistemlerin korunması ve istikrarlı bir şekilde çalışması da giderek daha önemli hale gelmektedir. Özellikle, trafo merkezlerinde ve enerji dağıtım noktalarında yer alan baraların korunması, enerji sürekliliğinin sağlanması ve sistemin zarar görmeden çalışmasına devam etmesi açısından kritik bir rol oynamaktadır. **Bara diferansiyel koruma sistemleri**, baralarda meydana gelebilecek kısa devreler, aşırı yüklenmeler veya diğer arıza türlerini tespit ederek sistemin güvenliğini sağlayan hayati bir koruma yöntemidir. Geleneksel yöntemlerle çalışan bu sistemler, belirli eşik değerlere dayalı olarak çalışsa da, elektrik şebekelerinin giderek daha karmaşık hale gelmesi ve dinamik koşulların sürekli değişmesi, daha akıllı ve uyarlanabilir çözümlere olan ihtiyacı artırmıştır.

'Yapay Zeka' kavramı ilk duyuşta ister akademisyen, öğretmen, öğrenci olsun ister işadamı olsun birçok kişi üzerinde merak uyandırmaktadır. Neden olduğu sorulacak olursa, zeka gibi soyut bir kavramın yapay ile nitelendirilmesi olarak cevap verebiliriz. Kavramın uyandırdığı merakla birlikte, içeriği yada temsil ettiği konular hakkında birçok kişinin ciddi bir malumatı yoktur. Yapay zekanın çevresinde konuşulan konu başlıkları, bileşenler ise yapay sinir ağları, uzman sistemler, bulanık mantık, genetik algoritmalar.[1]

Bu noktada, **yapay zeka (YZ)** teknolojileri devreye girerek bara diferansiyel koruma sistemlerinin daha etkin ve esnek hale gelmesine yardımcı olmaktadır. Yapay zeka, enerji sistemlerinden elde edilen büyük verileri analiz ederek sistemin normal çalışma koşullarını öğrenir ve olağan dışı durumları hızlıca tespit eder. Böylece, geleneksel sistemlerin sınırlamalarının üstesinden gelerek, arızaların daha hassas bir şekilde tespit edilmesini ve yanlış alarmların en aza indirilmesini sağlar. Ayrıca yapay zeka, arıza tahmini gibi ileri düzey yeteneklerle, potansiyel sorunları önceden belirleyip arızaların meydana gelmeden önce önlenmesine olanak tanır. Bu, enerji sistemlerinin güvenilirliğini artırırken, kesintilerden kaynaklanan maliyetleri de önemli ölçüde azaltır.

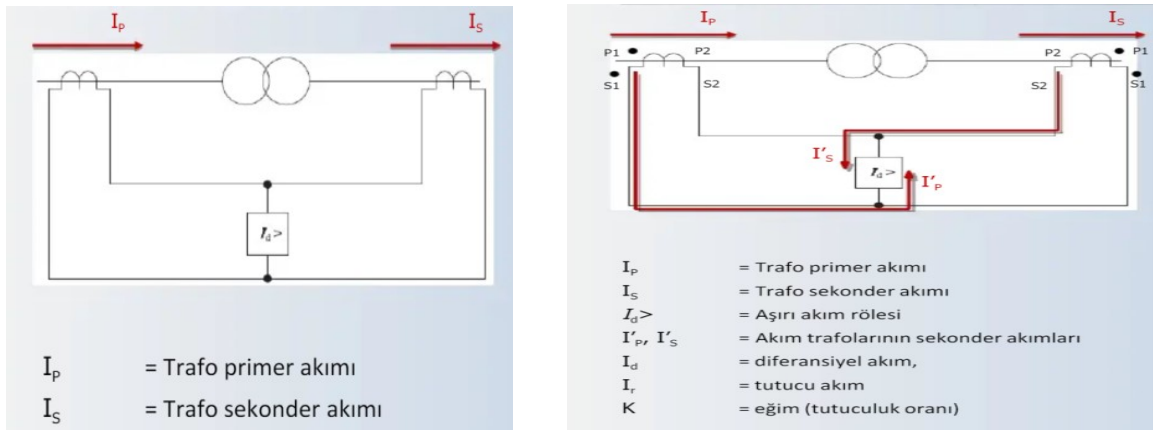
Yapay zeka tabanlı bara diferansiyel koruma sistemlerinin uygulanması, enerji altyapısının dijital dönüşümünün bir parçası olarak da değerlendirilebilir. Enerji sektörü, Endüstri 4.0 ile birlikte dijitalleşme ve otomasyon süreçlerine hızla entegre olurken, bu yeni teknolojiler enerji sistemlerinin daha güvenilir, verimli ve sürdürülebilir olmasına katkıda bulunmaktadır. Yapay zekanın sunduğu analiz yetenekleri sayesinde, koruma sistemleri sadece arızalara tepki vermekle kalmaz, aynı zamanda gelecekte meydana gelebilecek sorunları da proaktif olarak yönetir.



## Bara Diferansiyel Koruma Sistemleri Nedir?

Bara diferansiyel koruma sistemleri, trafo merkezleri ve enerji dağıtım istasyonları gibi kritik noktalarda, baralarda meydana gelebilecek arızaları tespit etmek için kullanılan önemli bir koruma yöntemidir. Elektrik sistemlerinde baralar, elektrik enerjisinin birden fazla kaynaktan bir araya getirilip farklı çıkışlara dağıtıldığı merkezlerdir. Bu noktalar, enerji akışının merkezi olduğundan, herhangi bir arıza durumunda büyük çaplı kesintiler ve sistematik zararlar meydana gelebilir. Dolayısıyla, baraların korunması, enerji şebekelerinin güvenliği ve istikrarlı işleyişi açısından hayati önem taşır. Bara diferansiyel koruma sistemi, baralarda meydana gelen kısa devreler, aşırı akım, toprak arızaları veya baradaki diğer anormallikleri tespit ederek sistemin geri kalanının zarar görmesini engeller ve elektrik akışını sürdürülebilir kılar.

**Bara diferansiyel koruma sistemlerinin temel prensibi**, giriş ve çıkış akımları arasındaki farkın sürekli izlenmesidir. Normal şartlarda bu fark sifıra yakın olmalıdır, ancak ani bir arıza durumunda bu fark önemli ölçüde artar. Bu durumda sistem, arıza olduğunu anlar ve hızlı bir şekilde ilgili ekipmanları devre dışı bırakır. Bu izleme, bara üzerindeki büyük elektriksel stres ve potansiyel arızalar sırasında enerji sisteminin güvenli bir şekilde çalışmaya devam etmesini sağlar.

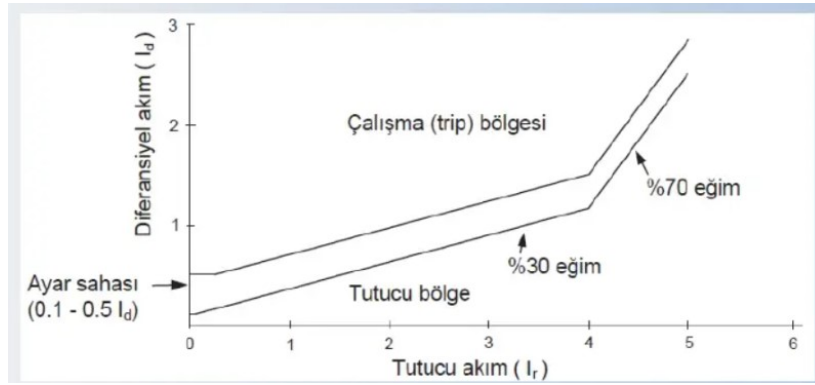
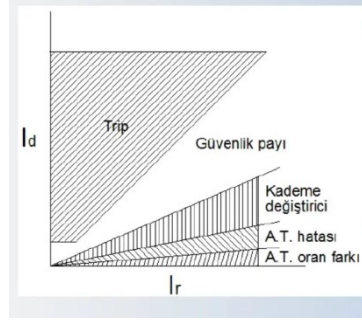


Diferansiyel korumanın temel prensibi, iki akım trafosu arasındackalan alana giren akımlarla, çıkan akımların toplamının sıfır olmasıdır.

Diferansiyel koruma fonksiyonunun çalışma prensibi en basit haliyle şekilde görülen tek hat şemasıyla açıklanabilir. Burada difensiyel fonksiyon döner diskli bir aşırı akım rölesi ile modellenmiştir.

$I'_s$  ve  $I'_p$  akımlarının birbirine eşit ve zıt yönlü oluşları  $I_d >$  aşırı akım rölesi bobininin diski döndürecek tork oluşturmasını engeller,

$$I_r = \frac{I_s + I_p}{2} \quad \text{ve} \quad I_d \geq K \times I_r \quad \text{durumunda röle çalışır.}$$



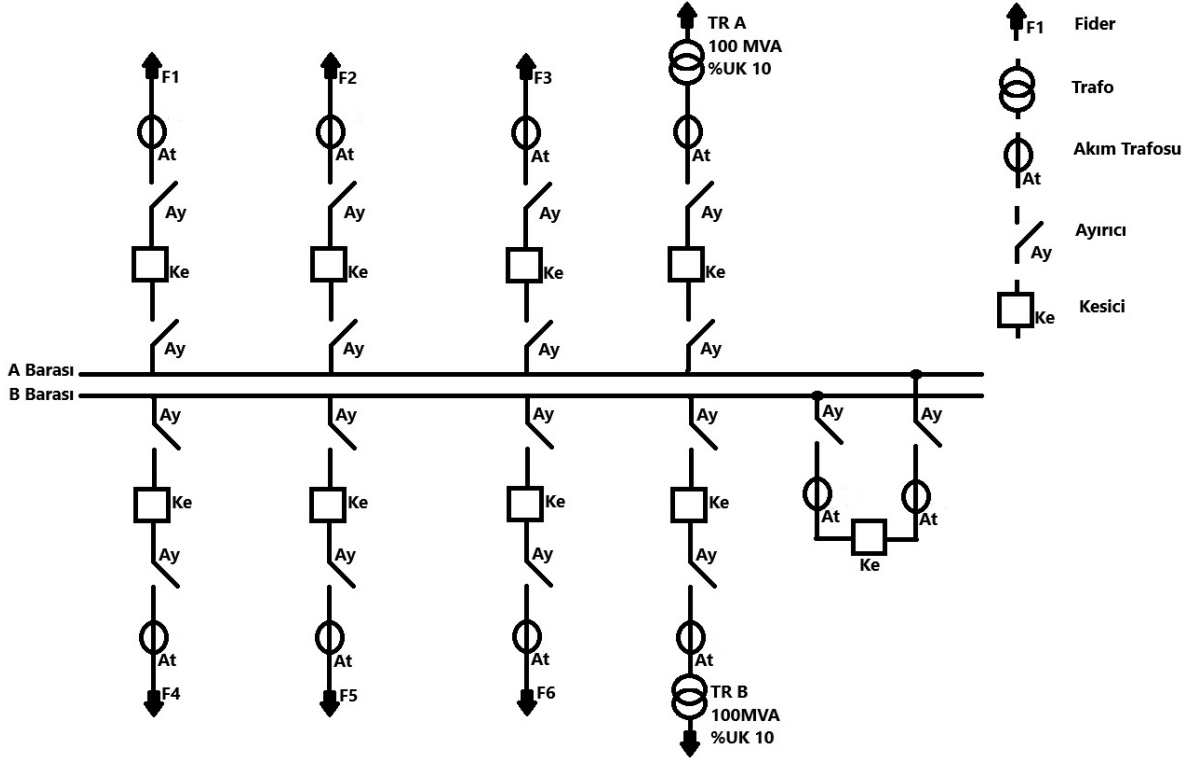
Diferansiyel koruma çalışma prensibi

$$I_r = \frac{I_s + I_p}{2} \quad I_d \geq K \times I_r$$

K yukarıda grafikte gösterilen eğim değeridir.

## 1. Uygulanan Seneryolar ve yapılan analizler

Günümüzde, elektrik dağıtım sistemleri karmaşık yapılar içermekte ve sürekli olarak yeni teknolojilerin entegrasyonu ile yönetilmektedir. Yapay zeka tabanlı algoritmaların elektrik dağıtım sistemlerindeki verimliliği nasıl artırabileceğine dair bir senaryo sunmaktadır. Aşağıda, şemadaki gerçek zamanlı verilerle desteklenen bir analiz yapılarak, çeşitli yapay zeka modellerinin doğruluk oranları ile birlikte bir kıyaslama yapılmaktadır. Bu çalışma, yapay zekânın (YZ) bara diferansiyel koruma sistemlerinde uygulanmasını incelemektedir. Geleneksel sistemler, sabit ayarlar ve akım farklarına dayalı olarak arızaları tespit ederken, Yapay zeka ile dinamik uyarlanabilirlik ve öngörü yetenekleri sağlanarak sistem yönetimi proaktif hale getirilebilir. Bu bildiride, MATLAB kullanılarak 32.000 veriyle gerçekleştirilen yapay zeka eğitim süreci ve doğrulama sonuçları detaylı bir şekilde açıklanmıştır. Doğruluk oranı, hata matrisleri ve model karşılaştırmaları gibi önemli metrikler, enerji sistemlerinin güvenilirliğini artırma konusunda bu sistemin etkinliğini ortaya koymaktadır.



### Yapay Zeka Modellerinin Uygulanması

Yapay zeka eğitimi, 32.000 veriden oluşan bir veri seti kullanılarak MATLAB'da gerçekleştirilmiştir. Süreç, veri ön işleme, uygun modellerin seçimi ve hata tespiti için sistem eğitimi aşamalarını içermektedir. Model performansını doğrulamak için bir hata matrisi oluşturulmuş ve sınıflandırma doğruluğu ile hata oranları incelenmiştir. Karar Ağaçları, Destek Vektör Makineleri, Naive Bayes ve Sinir Ağları gibi çeşitli modeller, etkinlikleri açısından değerlendirilmiştir. Elde edilen verilerle, elektrik dağıtım sistemindeki hataların ve performans sorunlarının tahmin edilmesi amaçlanmaktadır. Bu süreçte aşağıdaki modeller kullanılacaktır:

1. **Karar Ağaçları (Tree):** Dağıtım sistemi üzerindeki hataların kolayca analiz edilmesini sağlamak için karar ağaçları kullanılacaktır. Hataların türleri (örneğin, kesici arızaları gibi) grafik üzerinde gösterilecektir.
2. **Destek Vektör Makineleri (SVM):** Verilerin ayrıştırılması için SVM kullanılarak, arızaların belirli koşullar altında hangi durumlarda meydana geldiği tespit edilecektir.
3. **Naive Bayes:** Kesici arızalarının tahmin edilmesine yardımcı olacak Naive Bayes modeli, geçmişte yaşanan arızaların istatistiksel analiziyle geliştirilmiştir.
4. **Sinir Ağları (Neural Network):** Karmaşık ilişkileri modellemek için derin öğrenme yöntemleri kullanılacaktır. Bu sayede, farklı veriler arasındaki etkileşimler daha doğru bir şekilde analiz edilecektir.

### **Şemanın Analizi**

Aşağıda belirtilen şemada, sistemin ana bileşenleri ve bağlantıları gösterilmektedir:

- **Transformatorlar (TR A ve TR B):** 100 MVA kapasiteli trafo sistemleri, sistemin yük dengesini sağlamakta kilit rol oynamaktadır. Doğrusal modelleme ile bu trafoların yük altında nasıl performans gösterdiği simüle edilecektir.
- **Fiderler (F1, F2, F3, F4, F5, F6):** Fiderler, elektrik akışını dağıtan ana hatlardır. Her bir fiderin üzerindeki araç ve akım ölçümleri ile doğru bir yük analizi yapılacaktır.
- **Kesiciler ve Ayırıcılar:** Sistem güvenliğini artıracak şekilde, her bir hat üzerinde kesicilerin ve ayırıcıların konumları detaylı bir şekilde ele alınacaktır. Kesici arızalarının önceden tespit edilmesi için yapay zeka modelleri eğitilecektir.
- **Bara:** Sistemde A ve B olmak üzere 2 bara kullanılmış ve baraların sonunda ise bir kuplaj vardır.

### **Modellerin Performans Değerlendirmesi**

Grafikte, her bir yapay zeka modelinin doğruluk oranları gösterilmektedir:

- **Ağaç Algoritması:** %80 başarı oranı
- **Destek Vektör Makineleri:** %85 başarı oranı
- **Naive Bayes:** %75 başarı oranı
- **Sinir Ağı:** %90 başarı oranı

Bu grafik, sistemdeki modele özel performans kıyaslamalarının görsel bir temsilini sunarak, hangi modelin en etkili sonuçları verdiği bilgilerini içermektedir. Aynı zamanda, bu modellerin süreç içinde nasıl entegre edileceği ve birbirleriyle nasıl çalışacağı üzerine stratejiler geliştirecektir.

### **Doğrulama Sonuçları**

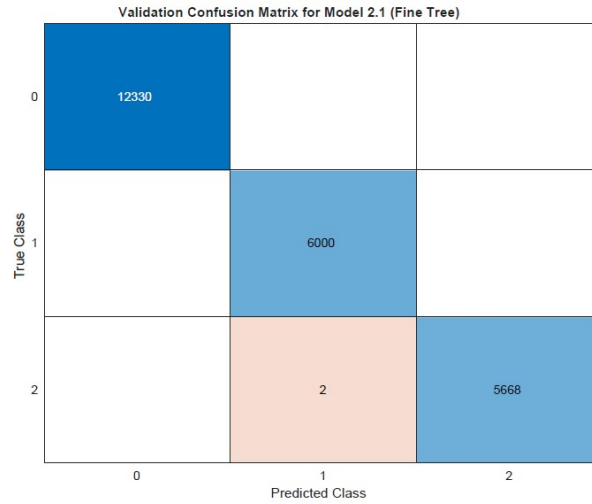
#### **Hata Matrisi:**

Validation Confusion Matrix for Model 2.1 sonuçları, Fine Tree modelinin doğru sınıflandırma yapma kabiliyetini ortaya koymuştur.

#### **Temel Gözlemler:**

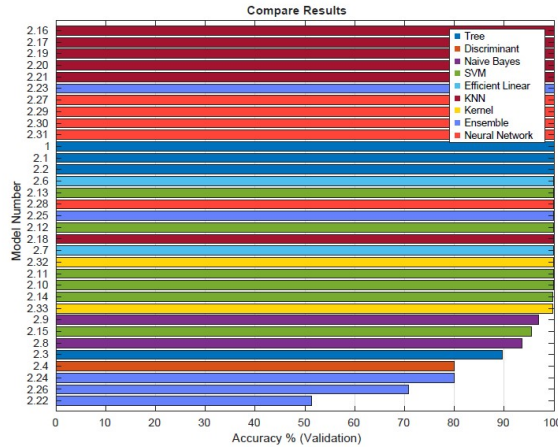
- **Doğru Pozitif Oranı:** Yüksek doğruluk oranı ve minimum yanlış sınıflandırma.

- **Performans Metrikleri:** Hata matrisinden elde edilen doğruluk oranlarıyla analiz edilmiştir.



### • Model Karşılaştırması

Farklı modeller doğrulama doğruluğu açısından değerlendirilmiştir. Sinir Ağları ve Ensemble yöntemleri üstün performans sergileyerek bu uygulama için uygunluklarını kanıtlamıştır.



### Sonuç

Yapay zeka tabanlı bara koruma sistemi, hata tespiti ve tahmin yeteneklerinde önemli iyileştirmeler sağlamıştır. Fine Tree modeli, %95'in üzerinde bir doğruluk oranı ve minimum yanlış pozitif sonuçlar ile dikkat çekmiştir. Karşılaştırma sonuçları, Sinir Ağları gibi gelişmiş makine öğrenimi modellerinin karmaşık enerji sistemlerinde üstün performans sunduğunu göstermektedir.

Yapay zeka destekli elektrik dağıtım sistemi analizi, hem verimliliği artırmak hem de sistem güvenliğini sağlamak amacıyla geliştirilmiştir. Kullanılan çeşitli modeller sayesinde, geçmiş veriler üzerinden analizler yapılarak, arızaların önceden tahmin edilmesi mümkün hale getirilecektir. Bu çalışma, gelecekteki enerji dağıtım sistemlerinin optimizasyonu için önemli bir temel oluşturacaktır.

# Health Sciences



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# Comparison of Greenness Profiles of Chromatographic Methods Used for the Determination of Macrolide Group Antibiotics in Environmental Waters

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## ABSTRACT

Macrolide group antibiotics have a wide range of uses and play an important role in terms of human health. However, the widespread use of these drugs has the potential to damage the ecosystem by causing their accumulation in environmental waters. Antibiotic residues have negative effects especially on aquatic life and cause the formation of antimicrobial resistance. In this context, monitoring the presence of drugs in environmental waters and developing reliable determination methods are of great importance in terms of both environmental sustainability and public health. In this study, various chromatographic methods used in the determination of macrolide group antibiotics in environmental waters were compared and the environmental sustainability levels of these methods were evaluated. In the analyses, AGREE method was used to evaluate the environmental impact within the framework of green analytical chemistry principles. Parameters such as solvent consumption, energy use, analysis time and waste production of the methods were examined, and an evaluation was made in terms of environmental impacts. The results emphasize the need to optimize analytical methods with environmentally friendly approaches from a green analytical chemistry perspective and draw attention to reliable drug analysis practices that allow sustainable and environmental impact reduction in addition to effective analytical methods.

**Keywords:** Macrolide group antibiotics, environmental waters, greenness profile, AGREE.

## 1. INTRODUCTION

Antibiotics have a vital and critical role in protecting human and animal health. Due to the poor absorption of antibiotics in the digestive system, it is known that only 20-40% of antibiotics administered in clinical settings are effective; the rest are excreted in the urine, and most of them are not fully metabolized and remain active, posing a threat to the environment. In addition to the emergence of antibiotic-resistant bacteria, antibiotic residues are one of the hazards that negatively affect ecological diversity, balance of ecosystems, plant

growth and water safety (Arsène et al., 2022: 662-671; Hossain et al., 2020: 30-34.; Voigt et al., 2020: 125032).

For thousands of years, people have struggled with various infectious diseases; infections have reached epidemic proportions, and millions of people have died due to these infectious diseases. With the discovery of antibiotics, epidemic-scale diseases have become treatable (Mohr, 2016: 237-272).

After antibiotics are administered to living organisms, they are excreted as metabolites, and a significant amount of them are excreted unchanged as main compounds through urine and faeces. The part not entirely removed in wastewater treatment plants is transported to environmental waters. Antibiotics have a special place among drugs, which have an important place among environmental pollutants due to their effects on the environment. Due to the misuse of these valuable compounds, which are very important in clinical practice, some infections cannot be treated effectively. It is estimated that 10 million people may die annually from drug-resistant infections by 2050 if no measures are taken (Hutchings et al., 2019: 72-80; Seifrtová et al., 2009: 158-179).

In recent years, the trend towards environmentally friendly applications in the field of analytical chemistry has risen due to increasing environmental sensitivities. The green analytical chemistry approach aims to minimize the use of hazardous substances, reduce waste generation and increase the efficiency of analytical processes while maintaining or improving the quality of analytical results. The fundamental aspect of green analytical chemistry is the reduction or elimination of harmful solvents and reagents in analytical procedures (Bocian & Krzemińska, 2019: 69-78; Sezgin et al., 2024: 111211; Soyseven et al., 2023: 109225.). Furthermore, the application of green metrics and evaluation tools to assess the environmental impact of analytical methods is crucial. The Analytical GREENness metric (AGREE) provides a systematic approach to assess the greenness of analytical procedures based on several criteria, including solvent utilisation, waste generation and energy consumption (Pena-Pereira et al., 2020: 10076-10082).

## 2. MACROLIDES

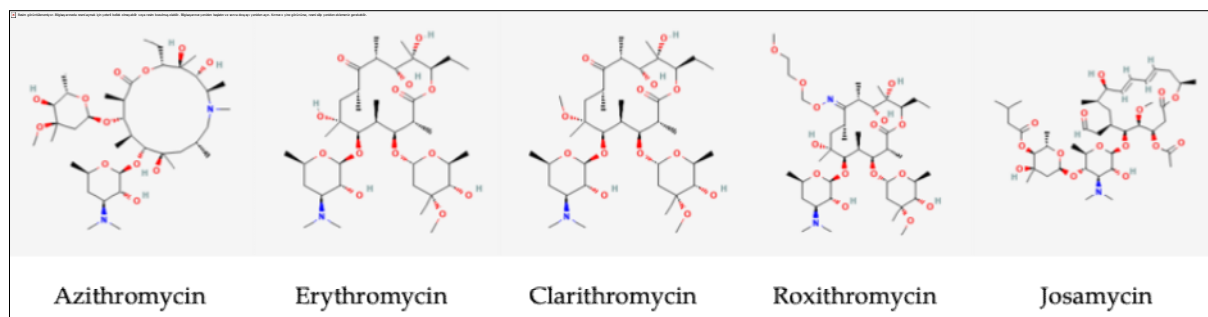
Classification of antibiotics is based on their chemical structure, mechanism of action and spectrum of activity. The World Health Organisation (WHO) has developed a specific classification known as the Access, Watch and Reserve (AWaRe) framework, which is crucial for promoting appropriate antibiotic use and combating antimicrobial resistance. This classification divides antibiotics into three main categories such as Access, Watch and Reserve. And each of them is serving a different purpose in clinical practice and public health. The watch category includes antibiotics that are effective against a wide range of bacteria and have a high risk of developing resistance. The antibiotics, including macrolides, should be closely monitored to ensure appropriate use (Dereje et al., 2023: 459-469; McGettigan et al., 2017: 1075-1076; Talaat et al., 2022: 1773).

Macrolides are a class of antibiotics characterized by macrocyclic lactone structures, typically consisting of a 14- or 15-membered ring. They are especially known for their broad-spectrum antibacterial activity against Gram-positive bacteria and some atypical pathogens. Macrolides are widely used in clinical practice, especially in treating respiratory tract and skin infections and sexually transmitted diseases (Ferrara et al., 2005: 1-10; Sanchez et al., 2017: 1-10).

The macrolides inhibit bacterial protein synthesis. They inhibit the translocation of peptides during translation by binding to the 23S rRNA of the 50S ribosomal subunit, and it



results in bacterial growth inhibition. This effect is defined as bacteriostatic, but some macrolides may exhibit bactericidal properties under certain conditions (Svetlov et al., 2020: 1971-1975). The chemical structures of the macrolide group antibiotics mentioned in the study are given in **Figure 1**.



**Figure 1.** Chemical structures of the macrolides mentioned in the study.

### 3. LIQUID CHROMATOGRAPHY-TANDEM MASS SPECTROMETRY (LC-MS/MS)

The ability to detect low concentrations of antibiotic residues such as sulphonamides and macrolides in hospital and municipal wastewater as well as river water, similarly, the simultaneous determination of human and veterinary antibiotics in various environmental matrices demonstrate the successful application of LC-MS/MS in environmental monitoring (Gros et al., 2013: 173-188; Zhou et al., 2012: 123-138).

Liquid chromatography coupled with tandem mass spectrometry (LC-MS/MS) is favoured for its sensitivity and ability to identify multiple classes of antibiotics simultaneously (Llorca et al., 2014: 43-51; Xue et al., 2015: 16857-16867). LC-MS/MS enables the detection of low concentrations of antibiotics in complex matrices with high specificity and sensitivity. However, high operating costs and requiring skilled personnel can limit its accessibility for routine monitoring in resource-limited settings (Kaddah et al., 2022: 4052-4069).

### 4. METHOD

In this study, two methods developed for the simultaneous determination of macrolide group antibiotics in environmental waters were compared using the AGREE greenness metric. Two methods based on LC-MS/MS, the most widely used method for the determination of macrolides, were selected for comparison. Since both methods work with a complex matrix, solid phase extraction (SPE) was used for the preparation of water samples.

Azithromycin, Erythromycin, Clarithromycin, Roxithromycin, and Josamycin from macrolide group antibiotics were determined simultaneously in river water samples by the first selected method. The chromatographic process was carried out using the LC-MS/MS method after enrichment with SPE. C18 column (Thermo Hypersil, 250 x 2.1 mm, 5  $\mu$ m) was used as stationary phase in Method 1. In gradient elution, mobile phase A consisted of 10% Acetonitrile and 90% Ammonium Acetate (10 mM, pH 6) and Phase B consisted of 100% Acetonitrile. With a flow rate of 0.2 mL/min, one analysis was completed in 23 min (Abuin et al., 2006: 73-81).

In the second method, reversed phase liquid chromatography (LC) and tandem mass spectrometry (MS/MS) combined with an SPE developed for the determination of multiclass antibiotics in wastewater and surface water samples were used. Azithromycin, Erythromycin, Clarithromycin, Roxithromycin from macrolide group were screened in water samples. C18 column (YMC Pro, 150x2.1 mm, 3  $\mu$ m) was used as the stationary phase in the method and Phase A: Water containing 0.1% Formic acid and Phase B: 100% Methanol was applied as gradient. The process was successfully completed in 37 min with a flow rate of 0.2 mL/min (Senta et al., 2008: 747-758).

## 5. RESULTS AND DISCUSSION

AGREE is a greenness metric used to assess the greenness of analytical procedures. The metric considers various factors contributing to the environmental footprint. AGREE scores the analytical method by evaluating various criteria such as the amount of solvents and reagents used, their toxicity, waste generated at the end of the analytical process, energy consumption, complexity of the process, and automation status. This scoring is transferred to a visualizer using the software developed. The closer the obtained score is to one, the more environmentally friendly the analytical method is (Pena-Pereira et al., 2020: 10076-10082).

The selected methods were evaluated with the AGREE metric. The results of the AGREE evaluation of the methods are given in Figure 2. According to the results, it is understood that the greenness score of the Method2 is better. Although the basic chromatographic approach and sample preparation technique are the same in both methods, the main reason for this difference is the mobile phase composition. The fact that methanol is a more environmentally friendly solvent than acetonitrile has favoured the method in terms of greenness.

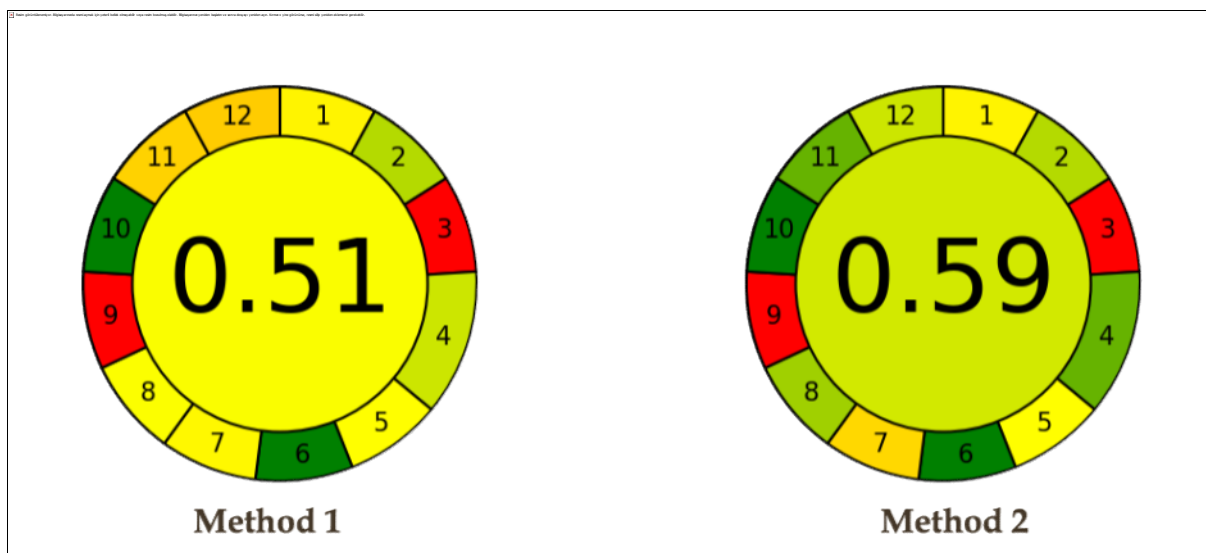


Figure 2. AGREE scores of the methods.

## 6. CONCLUSION

Antibiotic residues in aquatic environments have the potential to cause the development of antibiotic resistance and accumulate in the environment and in various organisms. The presence of antibiotic-resistant bacteria in these environments poses additional challenges as it may lead to the spread of antibiotic resistance genes. Therefore,

continuous monitoring and evaluation of antibiotic residues in water is necessary to understand their environmental dynamics and reduce their risks. In the selection of the methods to be used for this purpose, parameters such as accuracy, precision, sensitivity, detection limit, and the effects of the method on the environment are important. Each method has its strengths and limitations, and the choice of technique may depend on the specific context and requirements of the analysis. The development of new methods that are innovative, environmentally friendly, and have increased detection capabilities is necessary to ensure the safety of aquatic environments. Decision-making in method development and selection using greenness metrics in addition to other parameters is essential for sustainability.

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# Investigation of the Effects of Tribulus Terrestris (TT) and Its Compounds on Healthy Cells

## *Tribulus Terrestris (TT) ve Bileşiklerinin Sağlıklı Hücreler Üzerindeki Etkilerinin İncelenmesi*

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### **ABSTRACT**

**Objective:** Tribulus terrestris (TT), a plant that thrives in arid environments, has long been used in traditional medicine as a tonic and aphrodisiac. Its roots and leaves contain saponins, which may have beneficial effects on growth, sexual function, and erectile dysfunction, among other health issues. Moreover, TT has shown cytostatic effects on cancer cells. However, its potential carcinogenicity in humans remains under-researched. The aim of this study was to investigate the biological effects of TT on healthy cell lines, BEAS-2B and HUVEC, to determine whether TT poses a threat to healthy cells and to explore its therapeutic potential.

**Methods:** Tribulus terrestris plants were ground and extracted with methanol using a Soxhlet extraction method at 65°C for 4–6 hours. The solvent was then evaporated to obtain a dried extract, which was stored at +4°C. The BEAS-2B cell line was cultured in DMEM, and the HUVEC cell line was cultured in RPMI 1640. Cell viability was assessed using the MTT assay. Cells were incubated in 96-well plates, and after adding MTT dye, absorbance was measured to determine the IC50 value. The experiments were repeated three times.

**Results:** After a 4-hour incubation with MTT dye, solubilization was performed, and absorbance was measured at 570 nm to calculate the IC50 and selectivity index. Statistical analysis ( $P < 0.05$ ) indicated significant differences in cell viability in both BEAS-2B and HUVEC cell lines. The results were statistically significant, showing the effects of Tribulus terrestris.

**Conclusion:** The data obtained from BEAS-2B cell lines demonstrated significant differences in cell viability between the control group and the first two doses of TT. In HUVEC cell lines, significant differences were observed between the control group and the first three doses of TT. These findings suggest that these doses may be used in future studies investigating the therapeutic potential of Tribulus terrestris.

**Keywords:** Tribulus Terrestris, MTT, BEAS-2B, HUVEC

## ÖZET

**Giriş:** Tribulus terrestris (TT), özellikle kuru iklimlerde yetişen, geleneksel tıpta afrodisyak ve tonik olarak kullanılan bir bitkidir. Yaprakları ve köklerinden elde edilen saponinler, erektil disfonksiyon, cinsel işlev bozuklukları, hipertansiyon gibi sağlık sorunlarına faydalı olduğu öne sürülmektedir. Son araştırmalar, TT'nin kanser hücrelerine karşı sitostatik etkiler gösterdiğini ancak insanlardaki kanser karşıtı potansiyelinin yeterince araştırılmadığını ortaya koymuştur. Bu çalışmada, Tribulus terrestris'in (TT) biyolojik etkileri BEAS-2B ve HUVEC sağlıklı hücre hatlarında incelenmiştir. TT'nin toksik etkileri ve biyolojik aktivitesi değerlendirildi, ayrıca kanser hücre hatlarındaki potansiyel etkileri analiz edilerek, sağlıklı hücrelere zarar verip vermediği ve terapötik potansiyeli belirlenmiştir.

**Mateyal metot:** Bitkiler kurutulup öğütülerek metanolde çözüldü ve Soxhlet ekstraksiyon yöntemiyle 65°C'de 4-6 saat işleme tabi tutuldu. Elde edilen özüt evaporatörle çözücüsü uzaklaştırılarak kurutuldu ve +4°C'de saklandı. Beas-2B hücre hattı DMEM, Huvec hücre hattı ise RPMI 1640 ile kültüre edildi. Hücre canlılığı MTT assay yöntemiyle değerlendirildi. Hücreler, 96 kuyucuklu plakada inkübe edilip MTT boyası eklenerek absorban ölçüldü ve IC50 değeri belirlendi. Deneyler üç tekrar edildi.

**Sonuç:** MTT boyası eklenip 4 saat inkübe edildikten sonra çözünürleştirme yapıldı ve absorban 570 nm'de ölçülerek IC50 ve seçicilik indeksi hesaplandı. Beas-2B ve Huvec hücre hatlarında elde edilen veriler, bileşiklerin etkisini gösteriyor. İstatistiksel analizler, anlamlı farklar için P<0,05 düzeyinde yapıldı, sonuçlar anlamlı bulundu.

**Tartışma:** BEAS-2B hücre hatlarından elde edilen veriler, kontrol grubu ile TT'nin ilk iki dozu arasında hücre canlılığında önemli farklılıklar olduğunu göstermiştir. HUVEC hücre hatlarında, kontrol grubu ile TT'nin ilk üç dozu arasında önemli farklılıklar gözlemlenmiştir. Bu bulgular, bu dozların Tribulus terrestris'in terapötik potansiyelini araştıran gelecekteki çalışmalarda kullanılabileceğini düşündürmektedir.

**Anahtar Kelimeler:** Tribulus Terrestris, MTT, BEAS-2B, HUVEC

## GİRİŞ

*Tribulus terrestris* (TT), özellikle kuru iklimlerde yaygın olarak yetişen, düşük boylu bir çalı ve yabani ottur (Fernández-Lázaro, Fernández-Lazaro, Seco-Calvo, Garrosa, Adams, & Mielgo-Ayuso, 2022). Yaprakları ve köklerinden elde edilen özler, yüzyıllardır geleneksel tıpta afrodisyak, genel tonik ve ruh hali iyileştirici olarak kullanılmaktadır (Hussain, Mohammed, Ibrahim, & Abbas, 2009). Son yıllarda, bitkisel tıba olan bilimsel ilgi artmakta ve bitkisel kanser tedavisi konusunda elde edilen umut verici bulgular, bu alandaki araştırmaları teşvik etmektedir. Bitki saponinleri, potansiyel sağlık yararları nedeniyle tıbbi alanda yaygın şekilde kullanılmaktadır (Shahid, Riaz, Talpur, & Pirzada, 2016). TT, erektil disfonksiyon, cinsel işlev bozuklukları, menopoz semptomları, adet öncesi sendromu ve kısırlık gibi durumların tedavisinde kullanılırken; aynı zamanda atletik performansı artırma, idrar yolu enfeksiyonları, böbrek taşları, hipertansiyon, angina, hiperkolesterolemi, gastrointestinal sorunlar, ishal ve karaciğer hastalıkları gibi sağlık sorunlarına da faydalı olduğu öne sürülmektedir (Santos, Howell, & Teixeira, 2019; Semerdjieva & Zheljzakov, 2019). TT bitkisindeki saponinler, uzun süredir androjenik aktiviteleri ile bilinmekte olup, son çalışmalar bu saponinlerin kanser hücrelerine karşı sitostatik bir etki gösterdiğini ortaya

koymuştur. Ancak, TT saponinlerinin insanlardaki kanser karşıtı potansiyeli hâlâ yeterince araştırılmamıştır (Chhatre, Nesari, Somani, Kanchan, & Sathaye, 2014).

Önceki çalışmalarda, tribulosidinin pigmentasyon üzerindeki etkileri incelenmiş ve tribulosidinin PDE ekspresyonunu inhibe ederek melanin üretimini arttırabileceği bulunmuştur. Yüksek cAMP seviyeleri, CREB'i aktive eder ve tribulosid, PDE/cAMP/PKA yolunu tetikleyerek melanogenez, melanosit dendrisitesi ve melanin taşınmasını arttıran genlerin ekspresyonunu uyarıldığı belirtilmiştir (Sisto, Lisi, D'Amore, De Lucro, Carati, Castellana, ... & Lofrumento, 2012). Bu çalışmada, tilirosidin hepatosellüler karsinoma hücreleri üzerindeki etkisi ve moleküler mekanizmaları incelenmiştir. In vitro hücre çoğalması, göç, invazyon, koloni oluşumu ve 3D deneylerinin yanı sıra, tilirosidin'in CAXII inhibe edici rolü ve apoptozla ilişkili etkileri doğrulanmıştır (Han, Yang, Lu, & Lin, 2021). *T. terrestris*'in in vitro sitotoksik, genotoksik ve endokrin bozucu etkileri incelenmiştir. Genotoksik etkiler Comet ve Ames testleriyle, sitotoksik aktivite ise MTT testiyle değerlendirilmiştir (Abudayyak, Jannuzzi, Özhan, & Alpertunga, 2015).

Bu tür çalışmalar, sağlıklı hücrelerin kanser araştırmalarındaki önemini vurgular. Sağlıklı hücreler, kanser hücreleriyle karşılaştırıldığında tedavi ajanlarının etkilerini ve güvenliğini anlamada kritik bir rol oynar. Tribulosidin ve tilirosidin gibi bileşiklerin biyolojik etkileri sağlıklı hücrelerle karşılaştırılarak değerlendirilir, böylece tedavi sürecinin kanser hücrelerine özgü etkileri ve sağlıklı hücrelere olan toksisitesi belirlenebilir. Sonuç olarak, sağlıklı hücrelerin kullanımı, hedefe yönelik tedavi stratejilerinin geliştirilmesinde ve terapötik ajanların güvenlik profillerinin oluşturulmasında önemli bir yöntemdir (Han et al., 2021; Abudayyak et al., 2015).

Bu çalışmamızda, *T. terrestris*'in (TT) biyolojik etkilerini kapsamlı bir şekilde değerlendirmek amacıyla sağlıklı hücre hatları olan BEAS-2B (akciğer epitel hücreleri) ve HUVEC (insan damar endotelial hücreleri) hücreleri üzerinde deneyler yapılmıştır. Sağlıklı hücreler üzerinde yapılan bu çalışmalar, TT'nin genel toksik etkilerini ve biyolojik aktivitesini incelemeyi amaçlamaktadır. Ayrıca, TT'nin kanser hücre hatlarındaki potansiyel etkilerini kontrol amacıyla bir analiz gerçekleştirilmiştir. Bu, TT'nin sağlıklı hücrelere zarar verip vermediğini, kanser hücrelerine karşı hangi mekanizmalarla etki gösterdiğini ve terapötik potansiyelini belirlemek için kritik bir adım olarak düşünülmektedir.

## MATERYAL METOT

### Bitki Ekstrasyonun Hazırlanması:

TT ekstraksiyonu için, öncelikle bitkiler uygun koşullarda kurutulup blenderda öğütüldü. Ardından, 26 gram öğütülmüş TT, 1:10 (w/v) oranına göre metanolla çözüldü. Soxhlet ekstraksiyon cihazına yerleştirilen bu bitkiler, metanol ile 65°C'de 4-6 saat süreyle işleme tabi tutuldu. Ekstrasyon sonrası, oluşan sıvı, evaporatörle çözücüsü uçurulup, geriye kalan özüt küçük bir şişeye alınarak etüvde tamamen kurutuldu. Elde edilen bitki özütü, kontaminasyon riskini önlemek için +4°C'de muhafaza edildi.

### Soxhlet Ekstraksiyon Yöntemi:

Soxhlet ekstraksiyon yöntemiyle, 1:10 (w/v) oranında öğütülmüş bitkiler, metanol ile çözücülendirilirdi ve cihazda 4-6 saat süreyle ekstrakte edildi. Özüt, steril filtre kağıtları ile süzülüp, fazla metanol ise evaporatörle uzaklaştırıldı. Elde edilen özüt, 37°C'de etüvde inkübasyona bırakıldı.

### Hücre Hatlarının Hazırlanması

Beas-2B hücre hattı, American Type Culture Collection (ATCC), Manassas, VA'dan temin edilmiştir ve tüm deneyler için 4. pasajdan düşük seviyelerde yetiştirilmiştir. Beas-2B hücreleri, %10 fetal bovin serum içeren Dulbecco's Modified Eagle's Medium (DMEM, Life Technologies, CA, ABD) ile kültüre edilmiştir ve 37°C, %5 CO<sub>2</sub> ortamında inkübe edilmiştir.

Huvec hücre hattı için RPMI 1640 (Roswell Park Memorial Institute), Besiyerlerinin hazırlanmasında %10 fetal bovin serum (FBS) ve %1 penisilin/streptomisin kullanılmıştır. Hazırlanan besiyerlerinden 10 mL, T75 hücre kültür flaskına aktarılmış ve 37°C'deki su banyosundan alınan kryotüp içerisindeki hücre hatlarından 1 mL alınıp T75 hücre kültür flaskına eklenmiştir. Flask içerisindeki hücreler, 37°C'de %5 CO<sub>2</sub> içeren inkübatörde inkübe edilmiştir.

### Hücre Canlılık Testi (MTT Assay Yöntemi)

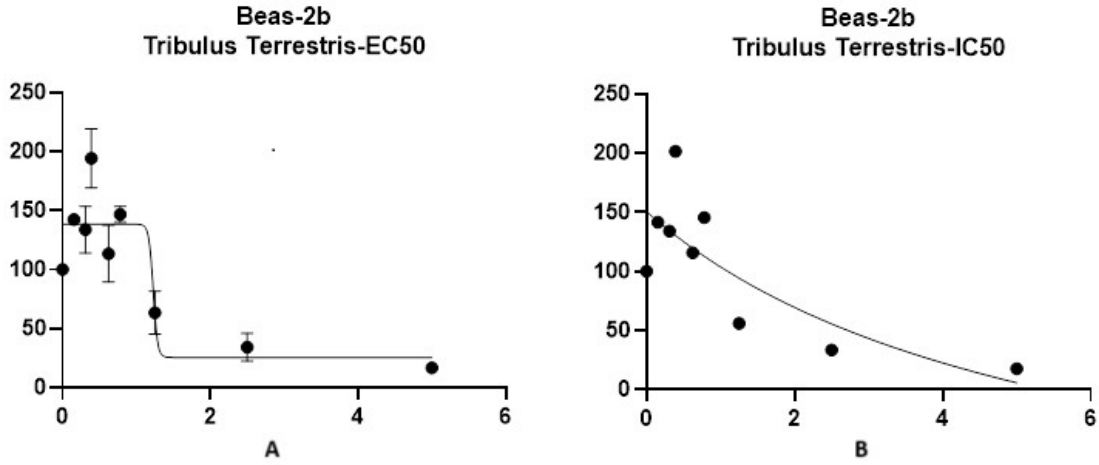
Bu yöntem, hücrelerin mitokondriyal dehidrojenaz enzim aktivitesini ölçerek hücre canlılığını değerlendirir. Canlı hücrelerde artan enzim aktivitesi, MTT'yi mor renkli formazan kristallerine indirger. Sentezlenen bileşiklerin çözeltileri, düşük çözünürlük nedeniyle DMSO/H<sub>2</sub>O karışımında hazırlanacak ve DMSO konsantrasyonu %0.1'i geçmeyecektir. Çözeltiler, 0-50 µM arasında 10 farklı konsantrasyona seyreltilecektir.

MTT testi, hücre canlılığını değerlendirmek için yapılan bir yöntemdir. Bu yöntemde, Thoma lamı ile hücre sayımı yapıp ve 96 kuyucuklu plakaya, her doz için 5.000-10.000 hücre eklenerek üç tekrar yapıldı. Plakalar 37 °C ve %5 CO<sub>2</sub> ortamında 1 gün inkübe edildikten sonra, 24 saat sonra bileşik çözeltileri (0-50 µM) eklenip ve plakalar 24 saat inkübe edildi. MTT boyası, 5 mg/mL konsantrasyonunda hazırlanarak her kuyucuğa 10 µL eklenip ve 4 saat inkübe edildi. Ardından, çözünürleştirme solüsyonu eklenip 12 saat inkübe edilerek, absorbans değeri 570 nm'de ölçüldü. Canlılık oranı, absorbans farklarıyla hesaplandı ve IC<sub>50</sub> değeri % hücre canlılık grafiği ile belirlendi. Ayrıca, bileşiklerin seçicilik indeksi hesaplanıp ve deneyler üç tekrar edildi.

### BULGULAR

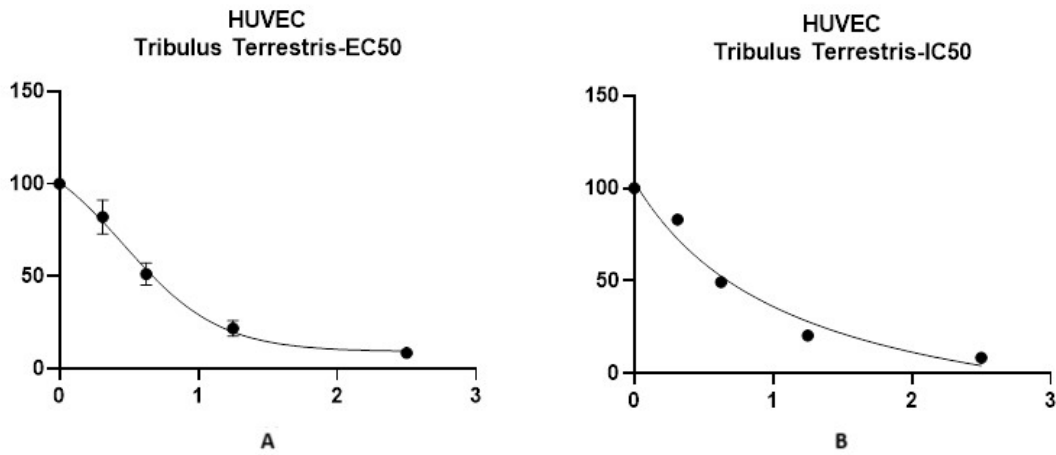
Bitkiler kurutulup öğütüldükten sonra 26 gram bitki metanolde çözüldü ve Soxhlet ekstraksiyon cihazında 65°C'de ekstrakte edildi. Elde edilen özüt, çözücüsü uzaklaştırılarak kurutuldu ve +4°C'de saklandı. Beas-2B hücre hattı DMEM ile kültüre edilip, MTT assay ile hücre canlılığı değerlendirildi. Absorbans 570 nm'de ölçülerek IC<sub>50</sub> ve seçicilik indeksi hesaplandı. Beas-2B ve Huvec hücre hatlarında yapılan hücre canlılık testlerine ilişkin elde edilen veriler, çeşitli konsantrasyonlardaki bileşiklerin etkisini göstermektedir ve bu sonuçlar grafiklerle sunulmuştur(Fig1, Fig2, Fig3 ,Fig4). İstatistiksel analizler, farklı tedavi gruplarının karşılaştırılmasında anlamlı farkların olup olmadığını belirlemek amacıyla yapılmış ve anlamlılık düzeyi P<0,05 olarak kabul edilmiştir. Bu, elde edilen hücre canlılığı üzerindeki etkisinin istatistiksel olarak anlamlı olduğunu göstermektedir.





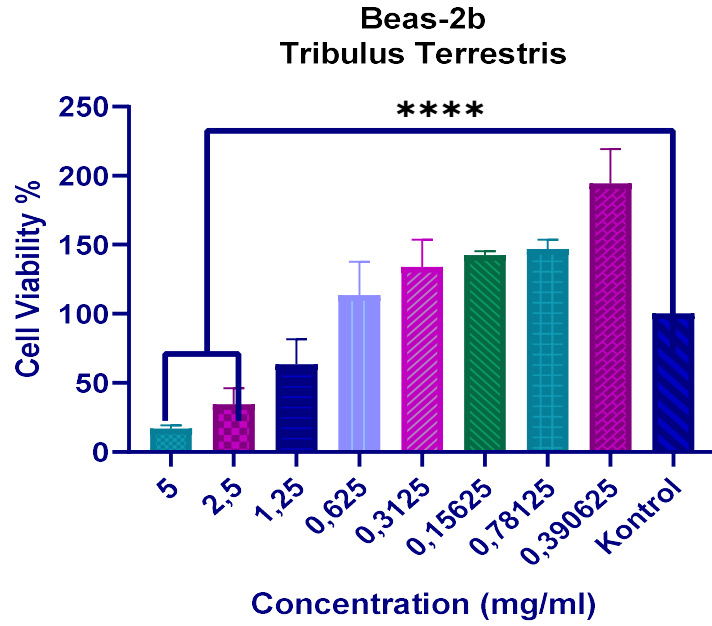
**Figür 1:** Tribulus terrestris Beas-2b hücre hatlarında MTT testi hücre canlılık testleri sonuçları.

**A.** EC50 Değeri: Hücrelerin %50'sinin canlı kalmasını sağlayan bileşik konsantrasyonu.  
**B.** IC50 Değeri: Hücre canlılığını %50 oranında inhibe eden bileşik konsantrasyonu, toksik etkinin derecesi.

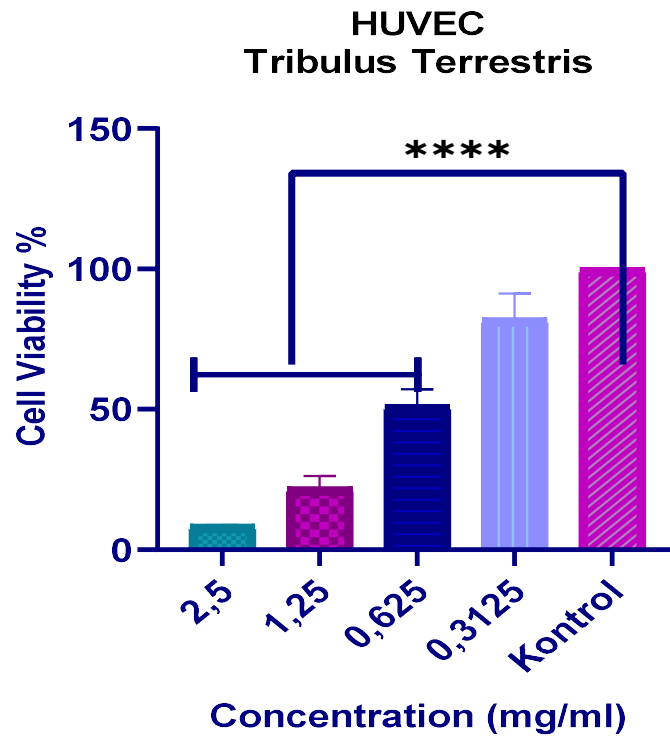


**Figür 2:** Tribulus terrestris HUVEC hücre hatlarında, MTT testi hücre canlılık testleri sonuçları.

**A.** EC50 Değeri: Hücrelerin %50'sinin canlı kalmasını sağlayan bileşik konsantrasyonu.  
**B.** IC50 Değeri: Hücre canlılığını %50 oranında inhibe eden bileşik konsantrasyonu, toksik etkinin derecesi



**Figür 3:** Beas-2b hücre hatlarında Tribulus terrestris çözeltilerinin etkisiyle elde edilen hücre canlılık oranları, MTT boyası kullanılarak absorbans ölçülerek hesaplanmıştır. İstatistiksel analizler, farklı konsantrasyonlardaki etkilerin  $P < 0,05$  anlamlılık düzeyinde olduğunu göstermektedir.



**Figür 4:** HUVEC hücre hatlarında Tribulus terrestris çözeltilerinin etkisiyle elde edilen hücre canlılık oranları, MTT boyası kullanılarak absorbans ölçülerek hesaplanmıştır. İstatistiksel analizler, farklı konsantrasyonlardaki etkilerin  $P < 0,05$  anlamlılık düzeyinde olduğunu göstermektedir.

## TARTIŞMA

Çalışmamızda, TT bitkisinin tamamından elde edilen bir özütünün, sağlıklı hücreler üzerinde in vitro sitotoksik etkisini değerlendirmeye yönelik yeni bulgular elde edilmiştir. Yapılan analizler sonucunda, bu bitki özütünün sağlıklı hücreler üzerinde belirli etkiler gösterebileceğine dair önemli kanıtlar ortaya konmuştur. Elde edilen bu bulgular, TT bitkisinin biyolojik etkilerini daha iyi anlamak ve güvenli kullanım aralığını değerlendirmek açısından önemli bir referans noktası oluşturabilir. Ayrıca, bu sonuçlar, gelecekte yapılacak toksikolojik çalışmalar ve terapötik potansiyel araştırmaları için de değerli bir temel sunmaktadır.

TT özütünün, farklı dozlarda çeşitli kanser türlerinde kanser karşıtı etkilerinin bildirildiği mevcut literatürde yer almaktadır. Yapılan araştırmalar, TT özütünün farklı hücreler mekanizmalarına etki ederek kanser hücrelerinin büyümesini baskıladığı, apoptoz (programlanmış hücre ölümü) indükleyebildiği ve kanser hücrelerinin çoğalmasını engelleyebildiğini ortaya koymuştur (Shu et al., 2021; Patel, Soni, Siddiqi, & Sharma, 2019; Wei et al., 2014).

Yan Cao ve arkadaşları (2024), farklı konsantrasyonlarda (0, 5, 10, 20 µM) tribulosid uygulamasının ardından hücreler bir deney sistemi kullanarak hem hücreler tirozinaz aktivitesi hem de mantar tirozinaz aktivitesini ölçmüşlerdir. Yapılan deneyler sonucunda, tribulosidin etkili dozunun 6 µM olarak belirlendiği ifade edilmiştir. Bu sonuç, tribulosidin tirozinaz aktivitesi üzerindeki etkisini değerlendirmek için kritik bir referans noktası oluşturmuş ve etkili konsantrasyonun belirlenmesine katkı sağlamıştır (Cao et al., 2024).

Maria N. Povydysh (2023) yaptığı çalışmada, Spirostanol saponin TED'in LO2 ve 293T hücreleri üzerinde önemli bir sitotoksik etkisi gösterdiğini belirtti. TED'in konsantrasyonu 10,3 - 41,3 µM aralığında iken, 24 saatlik tedavi sonrası yapılan ölçümlerde LO2 hücreleri için IC50 değeri 16,88 µM, 293T hücreleri için ise 21,80 µM olarak tespit edildi. Bu sonuçlar, TED'in her iki hücre hattında da doz bağımlı bir sitotoksik sergilediğini göstermektedir. Buna karşılık, Furostanol saponinleri (terrestrosin K, terrestrosin B ve tribulosin A), aynı hücre modellerinde (LO2 ve 293T) 2,6 - 41,3 µM aralığında uygulandığında herhangi bir sitotoksik sergilemedi. Ayrıca, bu bileşikler için IC50 değerlerinin gözlenmediği bildirildi. Bu bulgular, furostanol saponinlerinin TED'in aksine, toksik etkiler göstermediğini ortaya koymaktadır (Povydysh et al., 2023).

Abdullah Khalid (2022) yaptığı çalışmada, *T. terrestris* özütlerinin HepG-2 hücre hattına karşı sitotoksik etkisini 48 saatlik bir süre sonunda değerlendirmiştir. Çalışma kapsamında test edilen tüm özütler, kontrol grubuna (M) kıyasla önemli düzeyde sitotoksik aktivite göstermiştir. Özellikle, metanol bazlı kök özütü, 80 µg/ml konsantrasyonunda, karaciğer kanseri hücrelerinin canlılığında %40,98'lik bir azalmaya neden olmuştur. Metanol bazlı özütlerin etanol bazlı özütlere kıyasla daha güçlü bir inhibisyon gösterdiği gözlemlenmiş ve bu durum, metanolün sitotoksik aktivitede daha etkili bir çözücü olduğunu destekleyen bir bulgu olarak öne çıkmıştır. Metanol bazlı *T. terrestris* özütlerinin, HepG-2 hücre hattında sitotoksik etki açısından güçlü bir potansiyele sahip olduğu ve inhibisyon etkisinin etanol bazlı özütlere oranla daha baskın bir şekilde izlediği ifade edilmiştir (Khalid, Nadeem, Khan, Ali, & Zubair, 2022).

Sonuç olarak, *T. terrestris* özütünün her çalışmada farklı dozlarda kullanılabilirliği gibi, akciğer ve meme kanseri hücre hatlarında elde ettiğimiz MTT sonuçları da bu dozların etkisini incelemek için kullanılabilir. BEAS-2B hücre hatlarından elde edilen veriler, kontrol grubu ile TT'nin ilk iki dozu arasında hücre canlılığında önemli farklılıklar olduğunu göstermektedir. HUVEC hücre hatlarında ise, kontrol grubu ile T'nin ilk üç dozu arasında

anlamli farkliliklar gözlemlenmiştir. Bu bulgular, bu dozların TT'in terapötik potansiyelini araştıran gelecekteki çalışmalarda dikkate alınabileceğini düşündürmektedir.

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# Use of Contralateral Suppression Test in Evaluation of Efferent Auditory System

## *Efferent İşitsel Sistemin Deęerlendirilmesinde Kontralateral Supresyon Testinin Kullanılması*

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### ABSTRACT

The medial olivocochlear (MOC) tracts are associated with the medial olivocochlear bundle (MOCB), which consists of efferent auditory fibers. The MOC reflex regulates cochlear amplification by inhibiting the electromotility of the outer hair cell. The MOC reflex can be evaluated by giving otoacoustic emission stimuli to the ipsilateral ear and noise to the contralateral ear. This evaluation is performed using the otoacoustic emission (OAE) test and is known as contralateral suppression. In order to evaluate the MOC reflex in various clinical situations, the contralateral DPOAE or TEOAE suppression test can be used. In our study, studies between 2019-2024 in the Pubmed and Web of Science databases were examined using the keywords "otoacoustic emissions, OAE, contralateral suppression" and 11 studies suitable for the purpose of our study were included. In these studies, it was determined that the contralateral suppression test was applied in areas such as tinnitus, dance, autism, central auditory processing disorder, obstructive sleep apnea syndrome, specific learning disability, COVID-19, hyperbilirubinemia and understanding speech in noise. In this study, it is recommended to investigate the use of contralateral suppression in different clinical situations other than the specified clinical situations.

**Keywords:** Medial olivocochlear reflex, otoacoustic emission, contralateral suppression

### ÖZET

Medial olivokoklear (MOC) yolları efferent işitsel liflerden oluşan medial olivokoklear demet (MOCB) ile ilişkilidir. MOC refleksi, dış tüy hücresinin elektromotilitesini inhibe ederek koklear amplifikasyonu düzenler. MOC refleksi, ipsilateral kulağa otoakustik emisyon uyarını kontralateral kulağa gürültü verilerek değerlendirilebilir. Bu değerlendirme otoakustik emisyon (OAE) testi kullanılarak yapılmakta ve kontralateral supresyon olarak bilinmektedir. Çeşitli klinik durumlarda MOC refleksini değerlendirebilmek için kontralateral DPOAE ya da TEOAE supresyon testi kullanılabilir. Çalışmamızda Pubmed ve Web of Science veri tabanlarında 2019-2024 yılları arasındaki çalışmalar "otoacoustic emissions, OAE, contralateral suppression" anahtar kelimeleri kullanılarak incelendi ve çalışmamızın amacına uygun olan 11 çalışma dahil edildi. Bu çalışmalarda

kontralateral supresyon testinin tinnutus, dans, otizm, santral işitsel işleme bozukluğu, obstrüktif uyku apnesi sendromu, özel öğrenim güçlüğü, COVID-19, hiperbilirubinemi ve gürültüde konuşmayı anlama gibi alanda uygulandığı belirlenmiştir. Bu çalışmada, belirlenen klinik durumların haricinde, kontralateral supresyonun farklı klinik durumlardaki kullanımının araştırılması önerilmektedir.

**Anahtar Kelimeler:** Medial olivokoklear refleksi, otoakustik emisyon, kontralateral supresyon

## 1. Giriş

İnsanların afferent ve efferent işitsel yolları, işitme sisteminin temeli oluşturmaktadır (Galhom vd., 2022). Efferent işitsel lifler işitsel korteksten başlayarak corpus geniculatum mediale (CGM), inferior colliculus'a ve daha alt düzeylere uzanmaktadır. Primer efferent fibriller, bulbus'un rostral bölümünde bulunan superior olivary kompleksten (SOC) çıkarlar. Bu fibriller kokleada yer alan dış tüylü hücrelerde sonlanırlar. Bu sayede merkezi sinir sisteminin iç tüylü hücrelerin duyarlılığını kontrol etmesine olanak sağlanır (Serbetçioğlu, 2021:1-17).

Superior olivary kompleksten başlayarak korti organında yer alan dış tüylü hücrelerle bağlantı kuran liflere "Olivokoklear Demet (OCB)" denir. Olivokoklear demeti oluşturan olivokoklear lifler, SOC'deki konuma bağlı olarak medial ve lateral olarak sınıflandırılmıştır (Lopez-Poveda, 2018). Medial yer alan olivokoklear lif medial olivokoklear (MOC), lateralde yer alan olivokoklear lif ise lateral olivokoklear (LOC) olarak isimlendirilmiştir. Hem MOC hem LOC lifleri her iki kokleaya ulaşan OCB'yi oluşturur (Dhar ve Hall, 2011: 193-210).

LOC ve MOC lifler, olivokoklear işitsel innervasyon olarak olivokoklear akustik refleksi yollarını oluşturur. Yapılan araştırmalarda, MOC ipsilateral ve kontralateral akustik refleksi yolları LOC akustik refleksi yoluna göre daha kolay anlaşılır olduğu bildirilmiştir (Stuart ve Butler, 2012). MOC akustik refleksinin arka plan gürültü varlığında istenilen sese odaklanarak konuşmayı anlama, konuşulanları ayırt etme, sesin lokalizasyonunu sağlama ve akustik travmadan iç kulağı koruma gibi işlevleri vardır (Bozhöyük vd., 2024). MOC akustik refleksi bu işlevleri dış tüylü hücrelerinin koklear amplifikatör mekanizmasının sağladığı akustik kazancı kontrol ederek yapmaktadır. MOC akustik refleksi koklear amplifikatör mekanizmasını inhibe eder ve baziler membranın hareketliliğini değiştirerek koklear kazancı azaltmaktadır (Guinan, 2006).

Otoakustik emisyon, dış tüy hücresinin elektromotilite özelliği tarafından üretilen, kokleadan dış kulak kanalına doğru yayılan ve kokleadaki koklear amplifikatör mekanizmasının bir yan ürünü olarak ortaya çıkan akustik sinyallerdir (Fultz vd., 2020). Bu akustik sinyaller otoakustik emisyon cihazı vasıtasıyla hastaların dış kulak kanalına uygun olarak yerleştirilen mikروفon tarafından kaydedilerek analiz edilir (Bess ve Humes, 2008: 68). Otoakustik emisyonların klinik kullanımı için transient (geçici) evoked(uyarılmış) otoakustik emisyon (TEOAE) ya da distortion (bozulma) product (ürünü) otoakustik emisyon (DPOAE) tercih edilebilmektedir (Pınar ve Şan 2021; Stach ve Ramachandran, 2022: 275).

MOC lifleri dış tüy hücresiyle sinaps yapmasından dolayı meydana gelen iyon değişiklikleriyle birlikte dış tüy hücresinin elektromotilitesini inhibe eder. Bu inhibisyon, otoakustik emisyon amplitüdlerinde azalma ile kendini gösterir (Kumar vd., 2013). MOC liflerinin kontralateral akustik uyarın varlığında otoakustik emisyon amplitüdlerinde

azalması "kontralateral supresyon" olarak bilinmektedir. Kontralateral (OAE ölçümü yapılmayan kulak) olarak verilen akustik uyaran ipsilateral (OAE ölçümü yapılan kulak) kulakta otoakustik emisyon amplitüdünde azalma olması MOC liflerinin efferent aktivitesinin değerlendirildiğinin bir göstergesi olarak kabul edilmektedir (Kim vd., 2002). Kontralateral supresyonunun klinik kullanımı için TEOAE ya da DPOAE ölçümleri tercih edilmektedir (Boboshko vd., 2019). Kontralateral akustik uyaran varlığında otoakustik emisyon amplitüplerinde 1 dB'lik fark supresyon için sınır kabul edilmektedir. Supresyon varlığından söz edebilmek için otoakustik emisyon amplitüplerinde 1 dB'in üzerinde bir azalmanın olması gerekmektedir (Batuk ve Batuk, 2018: 71).

Otoakustik emisyonların kontralateral supresyonu, MOC efferent işitsel sistemin fonksiyonunu değerlendirmek için birçok klinik alanda kullanılmaktadır. Bu alanlara örnek olarak diyabet, fibromiyalji, kemoterapi, öğrenme güçlüğü, işitsel işleme bozukluğu, multiple skleroz, pontoserebellar köşe tümörü, migren verilebilir. Bu alanların çeşitli olması MOC efferent işitsel sistemin klinik olarak değerlendirilmesinin önemini göstermektedir (Dhar ve Hall, 2011: 193-210). Otoakustik emisyonların kontralateral supresyonu, efferent işitsel sistemin fonksiyonel durumunun değerlendirilmesinde kullanılan objektif ve invaziv olmayan bir değerlendirme yöntemidir (Di Girolamo vd., 2007). Bu derleme çalışması ile son beş yılda MOC efferent işitsel sistemin kullanıldığı klinik uygulama alanları belirlenerek MOC efferent işitsel sistemin değerlendirilmesinin önemi ortaya koyulmuştur.

## **2. Materyal ve Method**

### **2.1. Yöntem**

#### **2.1.1. Birinci Aşama: Araştırma Sorusunu Belirleme**

Yaptığımız derleme çalışmasında rehberlik etmek araştırma sorusu "Son beş yılda efferent işitsel sistemin değerlendirilmesi alanında ne tür bulgular var?" olarak belirlendi.

#### **2.1.2. İkinci Aşama: Arama Stratejisi**

Derleme çalışmamız için Pubmed ve Web of Science veritabanları kullanıldı. Çalışmamız kapsamındaki 2019-2024 yılları arasındaki çalışmaları incelemek amacıyla kullandığımız arama sözcüklerimiz "otoacoustic emissions ve OAE ve contralateral suppression" şeklinde belirlendi.

### **2.2. Çalışma Seçimi**

2019'dan 2024'e arama sözcüklerimiz ile toplam 27 çalışma belirlendi. Bu çalışmalar uygunluk açısından incelendi. Kontralateral TEOAE ya da DPOAE supresyonun çeşitli klinik uygulamadaki rolü ve değerlendirme sonuçlarını içeren 10 araştırma makalesi, 1 sistematik derleme çalışması dahil edilmiştir. Dahil edilme prosedürü Şekil 1.'de gösterilmiştir.

Şekil 1. Derleme çalışmasına dahil edilme prosedürü

1.1-Tanımlama	•PubMed ve Web of Science veritabanı araması yoluyla belirlenen toplam çalışma sayısı (Kasım/2024) (n=70)
2- Tarama	•2019-2024 yılları arasındaki PubMed ve Web of Science veritabanı araması yoluyla belirlenen çalışma sayısı (n=27)
3- Uygunluk	•Uygunluk açısından değerlendirilen makale sayısı (n=27)
4- Dahil	•Çalışmamızın amacına yönelik dahil edilen makale sayısı (n=11)

### 2.3. Çalışmaların tablolştırılması

Tüm yazarlar çalışmanın amacına uygun dahil edilen çalışmaların özetlenmesinde ve tablolştırılmasında görev almıştır.

### 2.4. Sonuçların Toplanması, Özetlenmesi ve Raporlanması

Elmoazen vd. (2020) normal işitmeye sahip tinnitüsü 15 hastanın ve normal işitmeye sahip tinnitüsü olmayan 15 kişinin kontralateral TEOAE ve DPOAE supresyon cevaplarını inceledikleri çalışmalarında DPOAE'lerin TEOAE'lere göre üstün olup, subklinik koklear disfonksiyonu daha hassas bir şekilde tespit edebildiğini ve kontralateral supresyonun, normal işitmeye sahip tinnitus hastalarında koklear efferent patolojisinin tespitinde güvenle kullanılabileceğini bildirmişlerdir.

Joseph vd. (2019) Bharatanatyam (kadim Hint dansı) yapan 20 dansçı ve dans yapmayan 20 kişinin kontralateral TEOAE ve DPOAE supresyon cevaplarını inceledikleri çalışmalarında, dansçılarda kontralateral TEOAE ve DPOAE supresyon değerlerinin dansçı olmayanlara kıyasla daha yüksek olduğunu, dans pratiği yapmanın duyuşsal algıyı artırdığını, işitsel dikkati geliştirdiğini ve efferent işitsel sistemde plastisiteye yol açmış olabileceğini bildirmişlerdir.

Aslan vd. (2022) 55 otistik çocuğun ve otistik olmayan 10 çocuğun kontralateral TEOAE supresyon cevaplarını inceledikleri çalışmalarında, otizmli çocuklarda sağ kulakta supresyon değerlerinin sol kulaktaki supresyon değerlerinden daha fazla olduğunu ve bu asimetrinin periferik işitsel lateralizasyon ve sol ile sağ kulak arasındaki farklardan sorumlu olabileceğini bildirmişlerdir.

da Silva vd. (2024) sistematik derleme çalışmalarında 7 ila 14 yaş arasındaki çocukları değerlendiren yedi çalışma dahil edildiğini, supresyon oluşturmak için en çok kontralateral gürültü kullanıldığını ve merkezi işitsel işleme bozukluğu olan gruplarda daha düşük supresyon değerleri gösterdiğini bildirmişlerdir.

Şimşek ve Aslan (2023) obstrüktif uyku apnesi sendromu olan 40 hastanın ve obstrüktif uyku apnesi sendromu olmayan 22 kişinin kontralateral TEOAE supresyon cevaplarını inceledikleri çalışmalarında, sağ ve sol kulakta kontralateral supresyon ile supresyon olmaksızın otoakustik emisyon frekansları için yapılan analizlerde bazı frekanslarda supresyonun gözlenmediğini, bu durumun istatistiksel olarak anlamlı kabul



edildiğini ve obstrüktif uyku apnesi sendromu beyin sapı ve koklea üzerinde olumsuz etkiler yaparak özellikle gürültülü ortamlarda konuşma ayırt edebilme yeteneğini bozabileceğini bildirmişlerdir.

Afifi vd. (2020) çağrı merkezinin operatörü olan 28 kişi ve ağrı merkezinin operatörü olmayan 20 kişinin kontralateral TEOAE ve DPOAE supresyon cevaplarını inceledikleri çalışmalarında, supresyonsuz TEOAE ve DPOAE cevaplarında önemli bir değişiklik olmadığını, ayrıca hem çağrı merkezi operatörleri hem de diğer grup için kontralateral supresyon TEOAE ve DPOAE cevaplarında istatistiksel olarak önemli bir fark olmadığını bildirmişlerdir.

Aksoy vd. (2019) 6-10 yaş arası özel öğrenim güçlüğü (SDL) tanısı almış 30 çocuk ve SDL tanısı olmayan 30 çocuğun kontralateral TEOAE cevaplarını inceledikleri çalışmalarında, İlk supresyonsuz TEOAE ölçümlerinde iki grup arasında 1400, 2000, 2800 ve 4000 Hz frekanslarında istatistiksel olarak anlamlı fark gözlenirken, 1000 Hz frekansında fark gözlenmediğini ve SDL tanısı olmayan çocuklarda daha iyi emisyon cevaplarının gözlemlendiğini bildirmişlerdir. Ayrıca kontralateral TEOAE supresyon cevaplarında her iki grup için hiçbir frekansta fark bulunmadığını bildirmişlerdir.

Çelik vd. (2021) gebelik sırasında COVID-19 tanısı konulduktan sonra doğan 37 bebek ve sağlıklı 36 bebeğin kontralateral TEOAE supresyon cevaplarını inceledikleri çalışmalarında, supresyonsuz TEOAE cevaplarında iki grup arasında 3 kHz ve 4 kHz'de istatistiksel olarak anlamlı fark gözlemlendiğini, supresyonlu TEOAE cevaplarında her iki grup içinde tüm frekanslarda istatistiksel anlamlı fark gözlemlendiğini ve supresyonun sağlıklı bebeklerde tüm frekanslarda daha yüksek olduğunu bildirmişlerdir.

Çulhaoğlu vd. (2021) sarılıklı olup fototerapi alan yenidoğan 42 bebek ve sağlıklı 42 yenidoğan bebeğin kontralateral TEOAE supresyon cevaplarını inceledikleri çalışmalarında, supresyonsuz TEOAE testinde fototerapi alan yenidoğanlarda 1 kHz'de elde edilen yanıtların daha düşük olduğu ve gruplar arasındaki fark olduğunu bildirmişlerdir. Ayrıca fototerapi almayan grupta 2 kHz, 2,8 kHz TEOAE supresyon değerlerinin yüksek bulunduğunu bildirmişlerdir.

Gafoor ve Uppanda (2023) 20 yaşlı birey ve 29 yetişkin bireyin kontralateral TEOAE supresyon cevaplarını inceledikleri çalışmalarında tek heceli sözcükler, kelimeler ve cümleleri gürültü ortamlarda kullanarak değerlendirdikleri kontralateral TEOAE supresyon cevaplarında istatistiksel olarak anlamlı sonuçları bildirmemişlerdir.

Nassar vd. (2024) COVID-19 tanısı alan 30 kişi ve COVID-19 tanısı olmayan 30 kişinin kontralateral TEOAE supresyon cevaplarını inceledikleri çalışmalarında, COVID-19 tanısı alan bireylerin 4 ve 8kHz'de daha kötü işitme eşikleri, 2800 Hz ve 4000 Hz'de daha düşük kontralateral supresyon değerleri bildirmişlerdir. Ancak her iki grup arasında işitsel beyin sapı cevap dalgasının latans değerleri arasında istatistiksel olarak anlamlı sonuç bulunmadığını bildirmişlerdir.

Derleme çalışmamızın sonuçları özetlendi, tartışıldı ve kontralateral TEOAE ya da DPOAE supresyonun çeşitli klinik uygulamasındaki değerlendirme sonuçları Tablo 1.de verilmiştir.

Tablo 2. Derleme çalışmasına dahil edilen çalışmalar ve bulguları

Yıl	Yazar	Kontralateral supresyon	Bulgular ve Öneriler
2020	Elmoazen vd.	TEOAE ve DPOAE	Tinnitus grubunda, kontrol grubuna göre kontralateral DPOAE ve TEOAE supresyon değerlerinin düşük olduğu bildirilmiştir. Tinnitus hastalarında efferent işitsel sistem patolojisi olasılığı göz ardı edilmemesi gerektiği önerilmiştir.
2019	Joseph vd.	TEOAE ve DPOAE	Dans yapan bireylerde TEOAE ve DPOAE supresyonunun, dans yapmayanlara göre daha fazla olduğu ve dans yapmanın, işitsel sistemin işlevini güçlendirdiği ve duyuşsal algıyı artırdığını bildirilmiştir.
2022	Aslan vd.	TEOAE	Otistik çocuklarda MOC sisteminin sağ kulakta daha etkili çalıştığı bildirilmiştir.
2024	da Silva vd.	TEOAE	Santral işitsel işlem bozukluğu olan çocuklarda daha düşük TEOAE supresyon değerleri bulunduğu bildirilmiştir. OAE baskılama ölçümlerinin standardize edilmesi gerektiği önerilmiştir.
2023	Şimşek ve Aslan	TEOAE	Obstrüktif Uyku Apnesi Sendromu beyin sapı ve koklea üzerinde etkili olduğu ve MOC sistemi üzerinde olumsuz etki oluşturarak gürültülü ortamlarda konuşmayı ayırt edilmemesi gibi çeşitli sorunlara yol açabileceğini bildirilmiştir.
2020	Afifi vd.	TEOAE DPOAE	Çağrı merkezi operatörlerinde kontralateral TEOAE ve DPOAE amplitüdlerinde kontrol grubuna göre istatistiksel olarak anlamlı olmayan sonuçlar bildirmiştir.
2019	Aksoy vd.	TEOAE	Özel öğrenim güçlüğü (SDL) tanısı almış çocuklar ile SDL tanısı almamış çocuklar üzerindeki kontralateral TEOAE amplitüdlerinde istatistiksel olarak anlamlı olmayan sonuçlar bildirmiştir.
2021	Çelik vd.	TEOAE	SARS-CoV-2'ye intrauterin maruz kalan bebeklerde MOC efferent sistemde bir yetersizlik olduğunu düşündürdüğünü ve anneleri COVID-19 olan bebeklerde koklear fonksiyonlar incelenmesi gerektiği önerilmiştir.
2021	Çulhaoğlu vd.	TEOAE	Hiperbilirubineminin yenidoğanlarda MOC efferent sistem üzerinde bozucu bir etkisi olabileceği bildirilmiştir. Riskli yenidoğan bebeklerde işitme taramasına ek olarak, kontralateral TEOAE supresyon testinin yararlı olacağı önerilmiştir.
2023	Gafoor ve Uppanda	TEOAE	MOC efferent sistemin gürültüde konuşma algısı üzerindeki herhangi bir modüle edici etkisine dair hiçbir kanıt olmadığı bildirmiştir.
2024	Nassar vd.	TEOAE	COVID-19'un koklear bazal dönüş üzerinde etkisinin olduğu ve MOC efferent sistemi etkilenebileceği ancak işitsel sinir ve afferent beyin sapı yollarının korunduğu bildirmiştir.

### 3. Sonuç ve Öneriler

Koklear efferent sistemi, işitme sisteminin önemli bir bileşeni olarak hem afferent hem de efferent sinir liflerinin etkileşimiyle işlev görmektedir. Özellikle medial olivokoklear (MOC) ve lateral olivokoklear (LOC) sistemleri, dış tüylü hücrelerin elektromotilite özelliklerini etkileyerek işitme ve seslere yanıt verme süreçlerini modüle eder. MOC sistemi, gürültülü ortamlarda koklear hassasiyeti artırırken, LOC sisteminin işlevi hâlâ tam olarak anlaşılammıştır. Efferent sistemin işlevi, otoakustik emisyonlar (TEOAE ve DPOAE) ile değerlendirilebilir ve kontralateral supresyon ölçümleri, MOC efferent işitsel sistemin etkinliğini incelemek için kullanılır. Bu supresyon etkisi, koklear fonksiyonların düzenlenmesinde ve işitmenin değerlendirilmesinde önemli bir rol oynamaktadır. Son yıllarda yapılan çalışmalar incelendiğinde kontralateral TEOAE ya da DPOAE'nun çeşitli klinik durumlarda kullanıldığı gözlenmektedir. Tinnutus, dans, otizm, santral işitsel işleme bozukluğu, obstrüktif uyku apnesi sendromu, çağrı merkezi çalışanları, özel öğrenim güçlüğü, Covid-19, hiperbilirubinemi ve gürültüde konuşmayı anlama gibi klinik kullanım alanlarının olduğu belirlenmiştir. Son beş yılda yapılan çalışmalardan elde edilen bulgular, farklı klinik durumlarda efferent sistemin işitsel süreçlerdeki etkilerini daha iyi anlamak ve klinik odyolojik değerlendirmelerde bu sistemin önemini vurgulamak açısından önemlidir. Bu derleme çalışmasında kullanılan arama sözcüklerinin kapsamı ve tarih aralığını genişletilerek kontralateral supresyonun farklı klinik alanlarda kullanımının araştırılması önerilmektedir.

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# Use of Virtual Reality in Benign Paroxysmal Positional Vertigo

## *Benign Paroksismal Pozisyonel Vertigoda Sanal Gerçekliğin Kullanımı*

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#### **ABSTRACT**

Benign Paroxysmal Positional Vertigo (BPPV) is one of the most common causes of peripheral vertigo. Positional tests are frequently used in the diagnosis of BPPV and the evaluation of the effectiveness of treatment. Recently, virtual reality (VR) systems have begun to be used in the treatment of BPPV. VR increases the patient's compliance with the treatment by allowing the individual to perceive the environment they are in more realistically and immersively with simulated scenarios to challenge and improve the vestibular functions of individuals with BPPV. Since patient cooperation is required during positional tests, the use of VR by individuals with BPPV is advantageous for the individual. In our study, studies between 2018-2024 in Pubmed and Web of Science databases were examined using the keywords "benign paroxysmal positional vertigo, vestibular rehabilitation, virtual reality" and 4 studies that were suitable for the purpose of our study were included. In these studies, it was observed that treatment maneuvers and VR technology have similar therapeutic effects in patients with BPPV and that the healing effects of VR technology are similar to Brand-Daroff, Cawthorne-Cooksey exercises. Since the VR system can be a promising technology in patients with BPPV, it is recommended to be used in clinics.

**Keywords:** Benign paroxysmal positional vertigo, virtual reality, vertigo, vestibular

#### **ÖZET**

Benign Paroksismal Pozisyonel Vertigo (BPPV), periferik vertigonun en yaygın nedenlerinden biridir. BPPV tanı ve tedavinin etkinliğinin değerlendirilmesinde sıklıkla pozisyonel testler kullanılmaktadır. BPPV tedavisinde son dönemlerde sanal gerçeklik (VR) sistemi kullanılmaya başlanmıştır. VR BPPV'si olan bireylerin vestibüler fonksiyonlarını zorlamak ve iyileştirmek için

simüle edilmiş senaryolarla bireyin içerisinde bulunduğu ortamın daha gerçekçi ve sürükleyici olarak algılanmasına olanak sağlayarak hastanın tedaviye uyumunu arttırmaktadır. Pozisyonel testler sırasında hasta kooperasyonunun gerekmesi nedeniyle BPPV'li bireylerin VR'ı kullanılmasının birey için avantaj olmaktadır. Çalışmamızda Pubmed ve Web of Science veri tabanlarında 2018-2024 yılları arasındaki çalışmalar "benign paroxysmal positional vertigo, vestibular rehabilitation, virtualreality" anahtar kelimeleri kullanılarak incelendi ve çalışmamızın amacına uygun olan 4 çalışma dahil edildi. Bu çalışmalarda, BPPV'li hastalarda tedavi manevraları ile VR teknolojisinin benzer tedavi edici etkiye sahip olduğu ve Brand-Daroft, Cawthorne-Cooksey egzersizleri ile VR teknolojisinin iyileştirici etkisinin yakın olduğu görülmüştür. BPPV'li hastalarda VR sisteminin umut verici bir teknoloji olabileceği için kliniklerde kullanılması önerilmektedir.

**Anahtar Kelimeler:** Benign paroksizmal vertigo, sanal gerçeklik, baş dönmesi

## 1. Giriş

Benign paroksizmal pozisyonel vertigo (BPPV), başın ve semisürküler kanalların belirli pozisyonlara gelmesi sonucu ortaya çıkan kısa süreli ve şiddetli ataklar halinde olan illüzyonel rotasyonel hareketin hissedilmesidir (Öztürk vd., 2019). BPPV periferik vestibüler bir bozukluk olup kliniklerde görülen hastaların %14-24'ünde teşhis edilen vertigonun en yaygın nedenidir (Iranfar ve Azad, 2022). BPPV temelde iç kulakta mekanik bir sorun olup, otolit veya otokonia olarak bilinen kalsiyum karbonat kristallerinin utriküldeki konumlarından semisürküler kanalların birine yer değiştirmesi sonucunda meydana gelmektedir (Madrigal vd., 2024; Strupp vd., 2023). BPPV çoğunlukla posterior semisirküler kanal (PSC) ya da horizontal semisirküler kanalda (HSC) gelişir. PSC-BPPV tüm BPPV vakalarının %60-90'ını oluştururken, HSC-BPPV %5-30'unu oluşturur (Picciotti vd., 2021). Anterior semisirküler kanal (ASC) kaynaklı ASC-BPPV ise nadir görülmektedir (Bhandari vd., 2021).

BPPV'nin kesin tanısı için her semisirküler kanalda vertigo ve nistagmusun provokasyonunu içeren tanısal pozisyonel manevralarının uygulanması gerektir (Bae vd., 2022). PSC-BPPV değerlendirilmesi için Dix-Hallpike ya da Side Lying, ASC-BPPV değerlendirilmesi için Dix-Hallpike ya da Straight-Back Head-Hanging (SBHH), HC BPPV değerlendirilmesi için Supine Head-Roll (Pagnini-McClure) manevrasının kullanılması gerekmektedir (Libonati vd., 2022).

BPPV'nin tedavisinde sıklıkla pozisyonel manevralar tercih edilmektedir. PSC-BPPV vakalarında Epley manevrası ya da Semont manevrası uygulanmaktadır. HSC-BPPV'nin kanalitiazis formu olan vakalarda Barbeque Roll manevrası tercih edilirken, HSC-BPPV'nin kupulolitiazis formu olan vakalarda Gufoni manevrası kullanılmaktadır. ASC-BPPV vakalarında ise Kim manevrası ya da Yacovino manevrası tercih edilmektedir (Ardıç, 2019:41-42).

Sanal gerçeklik kavramı ilk kez 1980'lerin sonlarında Jaron Lanier tarafından tanımlanmıştır. Lanier, özel cihazlar aracılığıyla kullanıcıların sanal ortamdaki grafik öğeleriyle etkileşime girmesini sağlayan bilgisayar modeli oluşturmuştur. Teknolojinin ilerlemesi ile sanal gerçekliğin ortaya çıkışı, grafik ve ara yüzleri destekleyen güçlü bilgisayarların geliştirilmesi birbiri ile bağlantılıdır (Bush vd.,2015). Gerçekçi bir dünya meydana getirmek için bilgisayar grafiklerinin birleşmesini sağlayan sanal gerçeklik kullanıcıların sözel ya da sözel olmayan yanıtlarına cevaplayabilen sanal dünyayı

değiştirebilen bir teknolojidir (Valentina vd., 2013). Bu teknolojiye kullanıcıların baş ve vücut hareketlerine uygun olarak işitsel ve görsel ekran anlık güncellemeleri, modern bilgisayar grafikleri ve ses dalgaları sayesinde olur. Sanal gerçeklik teknolojisinin sağlık hizmetleri alanında kullanımı oldukça yaygındır. Hem sağlık personellerinin tıbbi eğitimlerinde hem de çeşitli hasta gruplarının rehabilitasyonunda sanal gerçeklik teknolojisi sıklıkla kullanılmaktadır. Özellikle geleneksel rehabilitasyon yöntemlerine kıyasla sanal gerçeklik altyapılı rehabilitasyonların eğlenceli ve motivasyon kaynaklı oluşu, hastaların uyum ve kooperasyonları üzerinde önemli etkiye sahiptir (Meldrum vd.,2015).

BPPV tanısı alan hastalarda semptomların tedavi edilmesinde kanalit yeniden konumlandırma manevrası (CRM) kullanılmaktadır (Hilton vd., 2014). CRM başarılı olsa da hastalar da hala biraz baş dönmesi olabilmektedir. Geçici olan baş dönmesi ya eksik yeniden konumlandırmadan ya da otolit disfonksiyonundan kalan otokonial kalıntılardan kaynaklanabilir. Başarılı bir CRM'den sonra tipik bir baş dönmesi ve nistagmusun ortadan kalkmasına rağmen dengesizlik, kalıcı baş dönmesi (rezidüel dizziness) gibi semptomlar kalabilir (Martellucci vd., 2016). Vestibüler rehabilitasyon, BPPV'de baş hareketleri veya karmaşık bir görsel ortamda hareketle oluşan baş dönmesini azaltmada etkilidir. Sanal gerçeklik (VR) uygulamaları, vestibüler rehabilitasyonu daha motive edici hale getirmek için gerçek zamanlı simülasyonlar, etkileşimli işlevler ve oyun özellikleriyle donatılabilir (Hsu vd., 2017).

Ancak, göze yakın olmaları nedeniyle, Baş Üstü Ekranlarla 3B bir ortam sağlayan sanal gerçeklik oyunları, kullanıcıların bilgisayar tarafından oluşturulan ortamın bir parçası gibi hissetmelerini sağlayan yüksek çözünürlüklü görüntüler sunabilir (Micarelli vd.,2017). Vestibüler rehabilitasyonda VR teknolojisiyle ilgili mevcut literatür, BPPV<sup>8</sup> ile birlikte periferik vestibüler bozuklukları (yani labirentit, nörit, Meniere hastalığı, akustik nöroma, kronik baş dönmesi) ve 3D başa takılan VR oyun (Hsu vd.,2017; Yeh vd., 2014; Micarelli vd., 2017; Viziano vd., 2019; Huh vd.,2013; Garcia vd., 2013; Smaerup vd., 2016; Philips vd., 2018; Sparrer vd., 2013), 2D bilgisayar tabanlı VR oyun (Philips vd., 2018; Meldrum vd., 2015; Miziara vd., 2019; Szturm vd., 2015) ve egzersiz gerektirmeyen VR sistemlerini (Garcia vd.,2013; Viirre vd., 2002) kullanan merkezi vestibüler bozuklukları içerir. Bu derleme çalışması ile son altı yılda BPPV'de sanal gerçekliğin kullanıldığı klinik uygulama alanları belirlenerek BPPV tedavisinde sanal gerçekliğin kullanılmasının önemi ortaya koyulmuştur.

## **2. Materyal ve Method**

### **2.1. Yöntem**

#### **2.1.1. Birinci Aşama: Araştırma Sorusunu Belirleme**

Yaptığımız derleme çalışmasında rehberlik etmek araştırma sorusu "Son altı yılda benign paroksizmal pozisyonel vertigoda sanal gerçekliğin kullanımı var mıdır?" olarak belirlendi.

#### **2.1.2. İkinci Aşama: Arama Stratejisi**

Derleme çalışmamız için Pubmed ve Web of Science veritabanları kullanıldı. Çalışmamız kapsamındaki 2018-2024 yılları arasındaki çalışmaları incelemek amacıyla kullandığımız arama sözcüklerimiz "benign paroxysmal positional vertigo ve vestibular rehabilitation ve virtual reality" şeklinde belirlendi.

## 2.2. Çalışma Seçimi

Belirlenen tarihler arasında arama sözcüklerimiz ile toplam 7 çalışma belirlendi ve çalışmaya uygunluğu açısından incelendi. Benign paroksizmal pozisyonel vertigoda sanal gerçekliğin kullanımını içeren 4 araştırma makalesi dahil edilmiştir. Dahil edilme prosedürü Şekil 1.'de gösterilmiştir.

1.1-Tanımlama	• PubMed ve Web of Science veritabanı araması yoluyla belirlenen toplam çalışma sayısı (Kasım 2024) (n=9)
2- Tarama	• 2018-2024 yılları arasındaki PubMed ve Web of Science veritabanı araması yoluyla belirlenen çalışma sayısı (n=7)
3- Uygunluk	• Uygunluk açısından değerlendirilen makale sayısı (n=7)
4- Dahil	• Çalışmamızın amacına yönelik dahil edilen makale sayısı (n=4)

## 2.3. Çalışmaların tablolaştırılması

Tüm yazarlar çalışmanın amacına uygun dahil edilen çalışmaların özetlenmesinde ve tablolaştırılmasında görev almıştır.

## 2.4. Sonuçların Toplanması, Özetlenmesi ve Raporlanması

Aytul Ozdil vd. (2024) BPPV hastalarında, sanal gerçeklik tabanlı 3D vestibüler rehabilitasyon terapisinin (VRT) etkinliğini incelemeyi amaçladıkları çalışmalarında, 22 BPPV hastasının 11 hastasına 3D-VRT uygulayan çalışma grubuna ve 11 hastayı yalnızca kanalit repozisyon manevrası (CRM) uygulanan kontrol grubuna dahil etmişlerdir. 8 hafta süresince çalışma grubuna, haftada üç gün 45-50 dakika 3D-VRT yaparken, kontrol grubu sadece CRM uygulandığı ve çalışmalarındaki sonuçlarını ise 10-Metre Yürüme Testi, Dinamik Yürüme İndeksi, Seçmeli Adım Tepki Zamanı, Fullerton İleri Denge Ölçeği ve Görsel Analog Ölçeği kullanılarak değerlendirildiği belirtilmiştir. Sonuç olarak çalışma grubunun yürüme, denge, işlem hızı ve subjektif şikayetlerde (baş dönmesi, denge problemleri, düşme korkusu) kontrol grubuna göre anlamlı bir şekilde daha fazla iyileşme gösterdiğini ortaya koyduğunu ve 3D-VRT'nin CRM sonrası kalıcı baş dönmesi veya denge problemi yaşayan BPPV hastaları için etkili ve uygulanabilir bir tedavi seçeneği olduğunu bildirmiştir.

Otavio Correa vd. (2019) sanal gerçeklik ve belirli oyunlar kullanarak vestibüler rehabilitasyonun BPPV hastalarındaki etkinliği incelemeyi amaçladıkları çalışmalarında, 10 BPPV hastasına Nintendo Wii konsolunun üç oyununu (Snowboard Slalom, Tightrope Walk, Rhythm Parade) 4 hafta boyunca haftada iki kez, her seferinde 10 dakika süreyle oynatarak ve değerlendirmelerini Activity-Specific Balance Confidence Scale (ABC Ölçeği), Dizziness Handicap Inventory, Tinnitus Handicap Inventory, Berg Balance Scale, Balancim, Romberg



ve Dix-Hallpike testleri kullanarak yapıldığı belirtilmiştir. Sonuç olarak Nintendo Wii oyunları sonrasında BPPV hastalarında dengenin iyileştiğini ve sanal gerçeklik oyunlarının, BPPV tedavisinde etkili olduğu bildirilmiştir.

Tabanfar vd. (2018) BPPV'li hastaların evde kullanımı için akıllı telefon tabanlı bir Sanal Gerçeklik Epley Manevrası Sisteminin (VREMS) etkinliği incelemeyi amaçladıkları çalışmalarında, 20 sağlıklı bireyden 10 bireye talimatlar kitapçığı verilmeden VREMS, 10 bireye sistemin talimatlar kitapçığı kullanarak Epley manevrasının uyguladığı ve gözlemcilerin her Epley adımı için 10 üzerinden bir puan verdiği belirtilmiştir. Sonuç olarak VREMS grubunun diğer gruba göre daha yüksek puan aldığı ve Epley manevrasının her adımını analizinde VREMS kullanan grubun Epley manevrasını daha doğru yaptıkları bildirilmiştir.

Yan vd., (2024) kanalit yer değiştirme prosedürü (CRM) sonrasında kalan semptomlarda sanal gerçeklik (VR) teknolojisine dayalı kapsamlı vestibüler rehabilitasyonun rolünü inceledikleri çalışmalarında, BPPV tanısı almış ve CRM sonrası 24 saat içinde kalan semptomları olan 124 hastanın 41 hastasına Cawthorne-Cooksey egzersizi, 41 hastaya Brandt-Daroff egzersizi ve 42 hastaya sanal gerçeklik uygulamasıyla vestibüler rehabilitasyonun verildiği belirtilmiştir. Sonuç olarak VR grubunun skorlarının, Cawthorne-Cooksey ve Brandt-Daroff gruplarından anlamlı derecede daha düşük çıktığı bildirilmiştir.

Derleme çalışmamızın sonuçları özetlendi, tartışıldı ve benign paroksizmal pozisyonel vertigoda sanal gerçekliğin kullanılması Tablo 1.de verilmiştir.

**Tablo 1. Derleme çalışmasına dahil edilen çalışmalar ve bulguları**

Yıl	Yazar	Yöntem	Bulgular ve Öneriler
2024	Aytul Ozdil vd.	- CRM -3D-VRT	3D-VRT'nin BPPV hastalarında yürüme, denge, işlem hızı ve subjektif şikayetlerde iyileşme sağladığını ve CRM sonrası kalıcı baş dönmesi ve denge problemleri yaşayan hastalar için etkili ve uygulanabilir bir tedavi alternatifi sunduğunu bildirilmiştir. Diğer sanal gerçeklik uygulamalarına kıyasla daha erişilebilir ve maliyet açısından daha düşük olan 3D-VRT, daha fazla araştırma ve klinik uygulama için kullanılabileceğini önerilmiştir.
2019	Otavio Correa vd.	Nintendo Wii	Wii tabanlı vestibüler rehabilitasyon, BPPV hastalarında etkili bir tedavi yöntemi olabileceğini ve bireylerin yaşam kalitesi iyileştirebileceğini bildirilmiştir.
2018	Tabanfar vd.	-Epley manevrası -VREMS	VREMS platformu, evde Epley tedavilerinin doğruluğunu ve etkinliğini artırabilecek umut verici bir teknoloji olduğunu bildirmişlerdir.
2024	Yan vd.	-Cawthorne-Cooksey -Brandt-Daroff -VR	VR teknolojisine dayalı kapsamlı vestibüler rehabilitasyon, kanalit yeniden konumlandırma prosedüründen sonra kalan semptomları tedavi edebildiğini ve denge yeteneğini yeniden yapılandırmada rol alabileceği önerilmiştir.

### 3. Sonuç ve Öneriler

BPPV tanı ve tedavisinde sıklıkla etkili bir yöntem olarak CRM kullanılmaktadır. Gelişen teknolojiyle birlikte BPPV tedavisinde, VR teknolojisi geliştirilmiştir. VR teknolojisinin BPPV'li hasta grubunda CRM'ye benzer etkide tedavide etkinliği yakın tarihli yapılan çalışmalarda bildirilmiştir. VR teknolojisi ev egzersizleri gibi BPPV tedavisinde rehabilitatif etkiye sahip olabileceği belirtilmiştir. Bu bağlamda VR teknolojisinin BPPV'nin tedavisi, rehabilitasyonu ve evde tedavi uygulamalarının etkinliğini artırması yönünden bir dizi klinik ve rehabilitatif amaçla kullanılabileceği önerilmektedir.

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# Age-related Features of the Layered Structure and Microcirculation of the skin in Women with Different Morphotypes of Aging

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## ABSTRACT

The article analyzes the data of ultrasound examination of age-related features of structural changes in the layers and vessels of the skin. The soft tissues of the face were evaluated and ultrasound examinations of the skin layers and vessels of sixty female patients aged 45 to 55 years were characterized. A correlation has been revealed between changes in the mechanical properties of the skin layers and microcirculation features in different morphotypes of aging, which manifest themselves in different thicknesses, mechanical properties and microcirculation features. Signs of involution of the fine-wrinkled type of aging are caused by a violation of microcirculation of the first type, in which the intensity of blood flow correlates with the level of metabolic activity of the surrounding tissues. The deformational type of aging is characterized by blood deposition, venous stagnation and, as a result, destruction of capillaries, an increase in the size of the perivascular zone.

**Keywords:** skin, epidermis, dermis, subcutaneous tissue, morphotype of aging.

## Introduction

All layers of the skin are susceptible to age-related changes. The study of these deformations leads to the emergence of various algorithms for combating age-related changes. Correction of age-related changes requires an individual integrated approach in the selection of therapy [1]. One of the main signs of skin damage that requires correction is the formation of wrinkles. The appearance of wrinkles is the result of age-related skin changes at

different levels. The mechanism of formation of skin creases is still being studied and is not fully understood [2].

It is known from mechanics that a thin layer of rigid material lying on a thicker, malleable and loaded layer demonstrates various types of mechanical deformation, including the formation of folds [3]. Such layered structures are widespread in engineering and therefore well studied. It was found that for such deformations to develop, the stress in the upper layer of the rigid material must exceed a certain critical value [4]. This is due to the fact that the mechanical system always adopts a configuration that can be achieved with minimal energy expenditure, and that deformation of the surface under critical load is more advantageous from an energy point of view than all other types of deformation.

The magnitude of the critical load depends on several factors, such as the coefficients of elasticity, the coefficients of tensile and flexural strength in adjacent layers of the material, as well as the relative thickness of these layers. In the structure of the skin, the stratum corneum, epidermis, papillary and reticular dermis, and subcutaneous fat have very different mechanical properties [5].

Structural changes occur in the multilayer skin and subcutaneous tissue, which are known from the theory of deformation of composite layers under the influence of critical mechanical stress [6]. These structural changes on the surface of the skin take on forms characteristic of aging skin, namely, folds or wrinkles. The magnitude of the critical mechanical stress in the skin, at which their formation begins, depends on the difference in the elasticity of adjacent skin layers, their thickness and bending ability, as well as the strength of adhesion between the individual layers. Age-related changes are limited not only by structural changes in the skin layers, but also by the vessels located in it [4].

**The aim** of the work is to study the physical properties of the skin layers in women with different morphotypes of aging.

### **Materials and methods.**

The study involved 60 women aged 45 to 55 years. The type of facial skin aging was analyzed.

There are three main types of aging.

1. The fine-wrinkled type is characterized by degenerative-dystrophic changes in the epidermis and dermis, decreased turgor, decreased skin elasticity, dehydration, many fine wrinkles (even in a state of facial rest), pronounced dryness and coarse porosity of the skin.
2. The deformity type is characterized by a change in facial muscle tone, impaired lymphatic outflow, and venous stasis. The facial muscles of the upper and lower thirds of the face are hypertonic, and the muscles of the middle third of the face are hypotonic. A change in the oval line of the face, sagging skin of the upper and lower eyelids, the formation of a "hernia" of the lower eyelid, a double chin. Gravitational displacement of subcutaneous fat, hanging cheeks.
3. Combined type a combination of signs of fine wrinkled and deformed types of aging

A Double focused high-intensity ultrasound machine with a 15 MHz linear sensor was used to analyze the skin layers using ultrasound scanning. The echogenicity of individual layers of dermis and subcutaneous tissue was evaluated. The thickness of the

epidermis, dermis, and hypodermis was measured in the forehead, zygomatic, buccal, chin, submandibular, and neck regions, with an assessment of the vascular elements of the skin.

### The results of the study

A fine-wrinkled type of aging was found in 25.4% of the study group. In these patients, there was a change in skin color, it acquired a grayish tint, and a network of fine wrinkles was observed on the face. This type of aging was characterized by dry skin, pronounced "crow's feet" in the periorbital region, wrinkling of the upper and lower eyelids, "purse wrinkles" in the upper lip, and the presence of wrinkles in the chin area.

The ultrasound picture of the skin (Fig.1) was characterized by the presence of linear structures in the epidermis, the appearance in the dermis of a large number of areas with a high degree of fiber destruction, thinning, decreased acoustic density, and the presence of a wide subepidermal hypoechoic band. There was a decrease in the density of the capillary network and an increase in its tortuosity. Thus, the signs of involution may be caused by a violation of microcirculation of the first type, in which the intensity of blood flow is actively adjusted to the level of metabolic activity of the surrounding tissues.

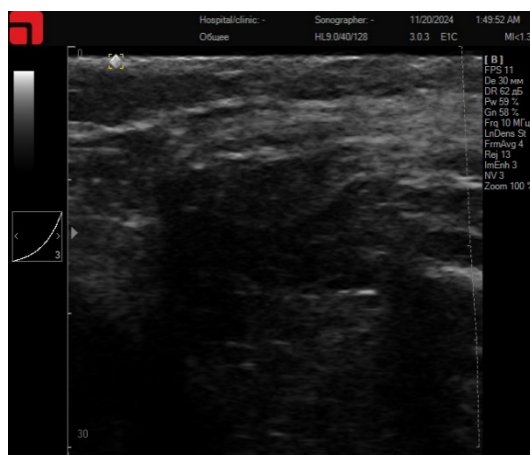


Fig. 1. Echogram of the skin with a fine wrinkled type of aging, 15 MHz sensor

Deformational type of skin aging was observed in 41.8% of the subjects. Clinically, it was manifested by a decrease in the elasticity of the soft tissues of the face and neck. The characteristic external signs of aging of this type were pasty skin, pronounced nasolabial fold, and drooping corners of the mouth. This type of aging was most typical for people with oily and combination skin ( $\text{pH} < 6.0$ ). In 40% of the subjects in this group, rosacea and rosacea were observed, the oval of the face changed, sagging cheeks, and the presence of a double chin were noted. Wrinkles are not pronounced except for facial ones. There is an excess of skin in the upper and lower eyelids.

Ultrasound examination showed (Fig. 2) heterogeneity of skin structures, decreased echogenicity of the dermis, thickening of the epidermis, and the presence of intercellular fluid. An increase in the diameters of the venous and transitional sections of the capillaries (the transitional section in this case begins to perform venous functions), blood deposition, venous stagnation (stasis) and, as a result, capillary destruction, and an increase in the size of the perivascular zone were determined. With an increase in blood volume in microvessels, especially venous ones, perfusion balance increased (blood flow dominates its outflow), compensatory reactions developed aimed at restoring impaired microcirculation. As a result, the capillary tortuosity increased (which increases local resistance to blood flow by 10 or

more times), the diameters of the transitional and venous sections of the capillary bed increased (from 20-30 to 40 microns), blood deposition and venous stagnation developed. Deterioration of blood microcirculation, in turn, can lead to disruption of biogenesis and metabolism (metabolic processes) in tissues.

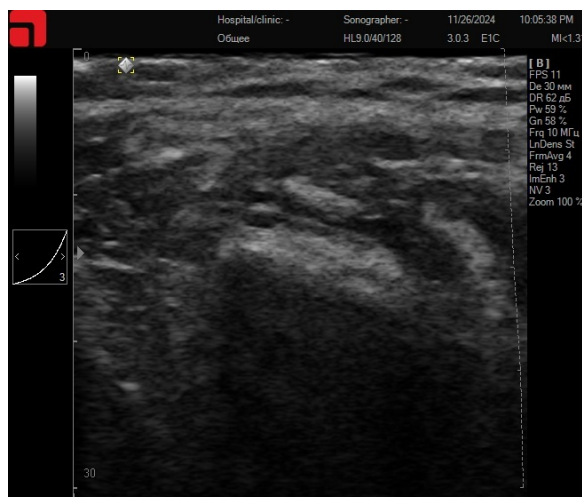


Fig. 2. Echogram of the skin with deformed type of aging, 15 MHz sensor

A mixed type of aging was observed in 32.8% of the subjects. In this group of patients, the involuntional changes varied in different areas of the skin.: Areas with drier skin were identified, according to the wrinkled type, and areas with more oily skin, according to the deformed type. The following signs were observed: hyperkeratosis, pigmentation, pronounced "crow's feet" in the periorbital region, wrinkles on the skin of the upper and lower eyelids, wrinkles in the perioral region, pasty, pronounced nasolabial folds, and a violation of the oval face.

The ultrasound image of different skin areas corresponded to the wrinkled or deformed type of aging. In the area of the chin and cheeks, the skin structure was heterogeneous, there was a decrease in its echogenicity, thickening of the epidermis, and the presence of areas of fiber destruction. A subepidermal hypoechoic band was visualized in the periorbital region, thinning and a decrease in dermis density were observed. Microcirculation disorders in the upper layers of the dermis were mixed, while signs of insufficiency of both arterioles and venules were observed.

## Results

The study showed that different morphotypes of aging are manifested by different thickness, mechanical properties of the skin and features of microcirculation. Skin aging correction methods should be comprehensive and depend on the dominant type of aging, age, and skin type. The strategy of skin aging therapy should be aimed not only at strengthening its individual layers, but also at reducing the difference in the mechanical properties of individual layers of skin and subcutaneous tissue, as well as at strengthening adhesion between them. Ultrasound scanning before the start of treatment makes it possible to individually correct age-related changes, take into account the features of the structure and blood supply to the skin of each patient and monitor the effectiveness of the treatment.

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# The Joint Health and Safety Commission and the challenges of workplace adjustments

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## **ABSTRACT**

**Introduction:** The Joint Health and Safety Commission (JHSC) plays a vital role in preventing occupational risks and improving working conditions in collaboration with occupational health services. In

**Objective:** The main objective of the JHSC is to adapt workplaces to the needs of employees, particularly those experiencing health-related issues.

**Materials and Methods:** Legal Framework: Ensuring compliance with safety regulations, regular meetings, and confidentiality of medical information.

Participatory Approach: Creating a trusting environment to encourage active participation from JHSC members.

**Case Analysis:** Reviewing cases of employees who require workplace adjustments due to health conditions.

**Results and Discussion:** The meetings involved key stakeholders, with the occupational physician as the central coordinator. The physician's tasks included:

- Encouraging active participation and fostering collective discussions.
- Explaining necessary workplace adjustments based on employees' health conditions.
- Turning negative feedback into constructive suggestions.
- Ensuring balanced speaking time to maintain a productive atmosphere.

**Case Studies:** Various roles, including midwives, laboratory technicians, physicians, nurses, and drivers, underwent workplace adjustments.

-Implemented Adjustments

-Technical: Equipment adaptations.

-Organizational: Task reduction or schedule reorganization.

**Conclusion:** Although establishing the JHSC is a legal requirement in Algeria, its effective implementation remains a challenge, requiring enhanced collaboration among stakeholders to ensure a safe and compliant working environment.

**Keywords:** Joint Health, Safety, Commission, Occupational health, Workplace adjustments

## **Introduction**

The Joint Health and Safety Commission (JHSC) plays a pivotal role in occupational health by safeguarding the well-being of employees and fostering safer working environments.

Beyond risk assessment and preventive measures, the JHSC is also actively involved in workplace accommodations, ensuring that tasks and roles are adapted to the physical and psychological needs of employees. This function is especially crucial for workers with specific health conditions or disabilities, as it enables them to maintain their professional activity in an environment that supports their well-being.

Workplace accommodations managed by the JHSC may include ergonomic modifications to workstations, adjustments to work schedules, or reassignment to less physically or emotionally demanding roles.

These efforts not only enhance the health and satisfaction of employees but also improve organizational performance. By addressing individual needs through tailored interventions, the JHSC reduces absenteeism, mitigates the risk of workplace accidents, and fosters a more motivated workforce. Ultimately, this commitment to workplace accommodations underscores the Commission's holistic approach to occupational health, extending its mandate beyond compliance to truly support workers' capabilities and well-being

### **Objective**

Foster a productive dynamic within the Joint Health and Safety Commission to adapt workstations

### **Materials and Methods**

#### **Legal Framework**

Ensuring compliance with safety regulations is a fundamental responsibility of the Joint Health and Safety Committee (JHSC). This includes ensuring that the workplace adheres to local labor laws and regulations concerning health and safety standards. The committee must also hold regular meetings to discuss workplace conditions, review safety policies, and update procedures in accordance with any changes in the law. Additionally, maintaining the confidentiality of medical information is crucial. The committee must handle sensitive health data with the utmost care, ensuring that personal health information of employees is kept private and only shared on a need-to-know basis, in compliance with data protection laws.

#### **Participatory Approach**

Creating a trusting environment is essential to encourage active participation from all JHSC members. This involves fostering open communication between employees, managers, and health and safety experts. When workers feel that their concerns are heard and valued, they are more likely to contribute valuable insights into potential hazards and safety improvements. This participatory approach ensures that everyone involved is invested in creating a safer and more accommodating workplace. By promoting collaboration, the JHSC can better address issues related to employee health, making the work environment more inclusive and responsive to workers' needs.

## Case Analysis

Reviewing cases of employees who require workplace adjustments due to health conditions is another crucial task of the JHSC. This process involves analyzing individual cases where employees may be facing physical or mental health challenges that could impact their ability to perform their job duties effectively. The committee evaluates the nature of the health condition and considers how adjustments can be made to the work environment or job requirements to support these employees. This may involve ergonomic modifications, changes to work hours, or the provision of specialized equipment. By reviewing such cases, the JHSC helps ensure that employees with health concerns are not marginalized and that they can continue contributing to the workplace in a safe and productive manner.

These components form the backbone of an effective JHSC, ensuring that health and safety protocols are followed while maintaining a supportive and inclusive workplace environment.

## Results and Discussion

The meetings conducted within the framework of the Joint Health and Safety Commission brought together key stakeholders, emphasizing the collaborative nature of workplace health and safety management. The occupational physician served as the central coordinator, performing a range of critical tasks to ensure the success and productivity of the discussions.

### Role of the Occupational Physician

The physician's role extended beyond a purely advisory capacity to active facilitation and leadership during meetings. Specific responsibilities included:

**-Time Management:** Ensuring that each agenda item was addressed within the allocated time frame, avoiding unnecessary extensions while maintaining focus on critical issues.

**-Facilitating Communication:** Providing equal opportunities for all participants to express their viewpoints, ensuring smooth and clear dialogue, and minimizing misunderstandings.

**-Clarifying Objectives:** Regularly reiterating the meeting's objectives and aligning discussions to achieve the intended outcomes.

**-Follow-Up:** Documenting decisions and action points to ensure accountability and continuity in addressing identified workplace issues.

**-Conflict Management:** Resolving disagreements or tensions constructively to maintain a respectful and solution-oriented atmosphere.

**-Motivating Participants:** Encouraging active participation, recognizing contributions, and fostering a sense of ownership among attendees.

**-Ensuring Confidentiality:** Reinforcing the importance of discretion when dealing with sensitive information shared during the meetings.

**-Creating a Positive Atmosphere:** Promoting collaboration, respect, and inclusivity, which are essential for productive discussions and collective problem-solving.

## Contributions of Key Stakeholders

### -Decision-Maker (Director)

The director's presence and active involvement played a crucial role in ensuring that the proposals discussed were not only considered but also implemented effectively. The decision-maker's support signaled institutional commitment, facilitating resource allocation and organizational changes.

### -Workers' Representatives

Their participation was indispensable, as they provided first-hand insights into workplace conditions and tasks. Their perspective ensured that proposed measures were practical and directly addressed the needs and concerns of employees.

### -Specialized Stakeholders

Depending on the topics discussed, other experts in health, safety, or workplace organization were invited to provide technical advice and contribute to the development of effective solutions. Their input enriched the discussions and enhanced the feasibility of the proposals.

The collaborative approach adopted in these meetings highlights the importance of stakeholder involvement in occupational health. The structured facilitation by the occupational physician ensured a balanced and constructive dialogue, while the inclusion of decision-makers and workers' representatives led to actionable and well-supported proposals. This process underscores the value of teamwork in achieving safer and healthier workplace environments.

The Joint Health and Safety Commission plays a vital role in addressing workers' health issues and implementing tailored measures to safeguard their well-being while ensuring their continued professional activity. Below are examples of real cases from a healthcare institution, demonstrating the Commission's impact on managing occupational risks and supporting employees with health conditions.

### Case 1: A 37-Year-Old Laboratory Technician

#### Context:

This technician has been employed since 2016 and is exposed to allergenic substances in the workplace. As a result, he suffers from allergic rhinoconjunctivitis, affecting his quality of life and work performance.

#### Actions Taken:

**-Improved protective equipment:** Replacement of his mask and goggles with better-suited options to limit allergen exposure.

**-Regular equipment checks:** Periodic inspections of the fume hood to ensure proper functioning.

**-Upgraded ventilation system:** Enhancement of the local ventilation to reduce allergen levels.

**-Work schedule adjustments:** Reduced exposure time through changes in task organization.

**Expected Results:** A reduction in allergy symptoms and enhanced comfort at work.

### **Case 2: A 47-Year-Old Doctor**

#### **Context:**

Working since 2006, this doctor has been diagnosed with a systemic disease requiring adjustments to her work responsibilities and environment.

#### **Recommendations:**

- Exemption from night shifts and emergency duties to alleviate fatigue.
- Reassignment to less demanding roles, such as vaccination units or school health services.
- Permission for regular medical follow-ups to monitor and manage her condition.

### **Case 3: A 28-Year-Old Nurse**

#### **Context:**

Diagnosed with a cervical disc herniation, this nurse's physically demanding role aggravates her condition.

#### **Proposals:**

- Strengthen the work team to distribute physical tasks more effectively.
- Avoid assignments requiring heavy lifting or significant physical effort.
- Limit duties to basic care to reduce strain.

### **Case 4: A 41-Year-Old Midwife**

#### **Context:**

This midwife has been employed since 2006 and has a cardiac rhythm disorder requiring stress management and specific workplace accommodations.

#### **Proposals:**

- Exclusion from night shifts to minimize fatigue and stress.
- Avoidance of high-pressure situations to prevent exacerbation of her condition.
- Reassignment to a less demanding role in prevention services.

### **Case 5: A 36-Year-Old Nursing Assistant**

#### **Context:**

With 12 years of experience, this nursing assistant suffers from poorly controlled epilepsy, posing a risk during seizures.

#### **Proposals:**

- Exclusion from night shifts to reduce seizure risks.
- Avoidance of high-stress situations, such as emergency duties.
- Reassignment to an administrative position as a receptionist, involving lower physical and emotional demands.

These case studies highlight the Commission's essential role in creating personalized solutions to meet the needs of workers with health conditions. By addressing specific

challenges, the Commission ensures that employees can maintain their professional activity while prioritizing their health and safety. This approach underscores the importance of collaboration, follow-up, and institutional support in fostering a healthy and inclusive workplace environment.

### Conclusion

Although establishing the Joint Health and Safety Commission is a legal requirement in Algeria, its effective implementation remains a challenge, requiring enhanced collaboration among stakeholders to ensure a safe and compliant working environment.

Additionally, it is crucial to regularly evaluate the effectiveness of the Commission's actions to ensure that the recommendations, such as adjustments to workstations and the management of employee health, lead to positive outcomes in terms of workers' health and safety.

Moreover, the State, as the guarantor of legislative compliance, must play a more proactive role in monitoring and overseeing the establishment and functioning of the Commissions. This could involve regular audits, sanctions for non-compliance, and incentives for companies that actively commit to this initiative.

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