



*XX international scientific conference
Rome. Italy
19-20.05.2026*

MODERN SCIENCE: FUNDAMENTAL AND APPLIED ASPECTS

*Proceedings of the XX International
Scientific and Practical Conference*

19-20 May 2026

ROME. ITALY

2026

UDC 001.1

BBC 1

XX International Scientific and Practical Conference «Modern science: fundamental and applied aspects», May 19-20, 2026, Rome. Italy. 98 p.

ISBN 978-91-65424-73-9

DOI <https://doi.org/10.5281/zenodo.20384168>

Publisher: «SC. Scientific conferences»

Main organization: 

Editor: Hans Muller

Layout: Ellen Schwimmer

The conference materials are in the public domain under the CC BY-NC 4.0 International license.

The publisher is not responsible for the materials published in the collection. All materials are provided in the author's edition and express the personal position of the participant of the conference.

The sample of the citation for publication is Gugin Aleksandr, Lisnievska Yuliia ANTI-ADVERTISING IN THE HOTEL BUSINESS // XX International Scientific and Practical Conference «Modern science: fundamental and applied aspects», May 19-20, 2026, Rome. Italy. Pp.9-11, URL: <https://sconferences.com>

Contact information

Website: <https://sconferences.com>

E-mail: info@sconferences.com

Content

Agricultural sciences

Zakirova A.T., Hafiz R.H PREPARATION OF NUTRIENT-ELEMENT-MODIFIED UREA-BASED FERTILIZER	4
---	---

Architecture

Orkhan Teymurlu, R.T. Aliyeva THE ROLE OF GREEN BUILDING IN SUSTAINABLE URBAN DEVELOPMENT	9
---	---

Astronomy

Turkan Mammadova, Mirhasan Tahirov BALMER LINE PROFILES AND ATMOSPHERIC PARAMETERS OF LUMINOUS STARS	12
--	----

Economic sciences

Ilir Hebovija, Ferjolt Ozuni INTERNATIONAL RELATIONS AND DIGITAL DIPLOMACY AS CATALYSTS FOR TOURISM DEVELOPMENT: THE CASE OF ALBANIA AND THE BALKANS	15
Safarova O.O., Amirzoda M.O. MODERN TRENDS IN THE DEVELOPMENT OF THE REAL ESTATE OF THE REPUBLIC TAJIKISTAN IN THE CONTEXT OF ECONOMIC DIGITALIZATION	20
Xhenisa Myshketa IMPACT OF THE NEW FISCAL POLICIES (2024–2025) ON BUSINESS IN ALBANIA: CONSOLIDATION AND CHALLENGES OF THE FISCALIZATION SYSTEM	26

Mathematical sciences

Tamara Mammadova ARTIFICIAL INTELLIGENCE-SUPPORTED DIALOGUE ASSISTANTS IN PRIMARY SCHOOL MATHEMATICS EDUCATION: A METHODOLOGICAL MODEL AND PEDAGOGICAL EXPERIMENT	35
Konysbek Tattibekov, Kurdyukov Vitaly ARTIFICIAL INTELLIGENCE, ROBOTICS AND BIG DATA: CURRENT STATE AND DEVELOPMENT PROSPECTS	40

Pedagogical sciences

Zhanara Muratbekovna Kairova THE INFLUENCE OF CLASSROOM SEATING ARRANGEMENTS ON STUDENTS' SPEAKING PARTICIPATION IN EFL CLASSES	44
Kazyna Faizulla ARTIFICIAL INTELLIGENCE IN ENGLISH LANGUAGE TEACHING FOR TOURISM STUDENTS: MODERN CHALLENGES, OPPORTUNITIES, AND EDUCATIONAL PERSPECTIVES	51
Usarova Madina Odil kizi NEUROCOGNITIVE AND MULTIMODAL TECHNOLOGIES FOR DEVELOPING SPEECH COMPETENCE IN CHILDREN WITH ALALIA	55
Zarbat Ayazhan Serikkyzy, Sadykova Aida Kenesbekovna THE MULTIMODAL NATURE OF DIGITAL AUTHENTIC MATERIALS IN FOREIGN LANGUAGE TEACHER EDUCATION	58
Zhantayeva Marzhan Kumisbekovna MUSIC EDUCATION AND SOCIAL DEVELOPMENT: COMMUNITY FORMATION THROUGH MUSIC	63
Stupnytska Galyna Igorivna INTERACTIVITY OF ONLINE PLATFORMS AS A MEANS OF INCREASING STUDENTS' MOTIVATION WHEN LEARNING ENGLISH IN HIGHER EDUCATIONAL INSTITUTIONS	69

Philological sciences

Uskenbayeva Malika Malikovna ARTIFICIAL INTELLIGENCE IN ADAPTIVE ESL LEARNING SYSTEMS: PERSONALIZED APPROACHES TO LANGUAGE EDUCATION	71
Inna R. Sargsyan COMMUNICATIVE AND PRAGMATIC STRATEGIES OF MANIPULATIVE INFLUENCE IN PUBLIC DISCOURSE	75

Political sciences

Elgun Taghizade DIRECTED ENERGY WEAPONS AGAINST SHORT-RANGE UAVS: RETHINKING AIR DEFENSE IN THE AGE OF ASYMMETRIC WARFARE	81
---	----

Technical sciences

Perviz Gasimov

THE IMPORTANCE AND MAIN ADVANTAGES OF AUTOMATION IN MODERN INDUSTRY: A DESCRIPTIVE-ANALYTICAL STUDY

88

Prokopchenko Sergii

MEASUREMENT UNCERTAINTY EVALUATION OF THE PEAK SOUND PRESSURE LEVEL OF FIREARMS SUPPRESSORS

96

Agricultural sciences

PREPARATION OF NUTRIENT-ELEMENT-MODIFIED UREA-BASED FERTILIZER

Zakirova A.T.

Hafiz R.H

Azerbaijan State Oil and Industry University

20 Azadliq Avenue, Baku AZ1010, Republic of Azerbaijan

Abstract

Urea fertilizer has been widely used as the main nitrogen fertilizer since the 1950s. Its high concentration is due to the presence of approximately 46% nitrogen in its composition. In order to meet the increasing demands of modern agriculture, about 220 million tons of urea fertilizers are currently produced annually worldwide. However, the major drawback of urea application is its low utilization efficiency. Approximately 30–35% of the nitrogen applied to the soil is lost through various processes, leading to both economic losses and environmental pollution. One of the main approaches to solving this problem is to control the release of urea nitrogen in the soil. Studies have shown that slow-release fertilizers provide longer retention of nitrogen in the soil and promote its more efficient uptake by plants. These fertilizers ensure the gradual release of nitrogen, thereby optimizing its accumulation and availability in the soil.

Introduction

In the modern era, the rapid growth of the world population has made ensuring food security one of the most urgent global priorities. The cultivation of agricultural crops requires a high amount of nitrogen; however, the gradual decline in soil fertility further intensifies the demand for this essential element.

To ensure the normal growth and development of plants, it is important to regularly supply the soil with essential nutrients, particularly nitrogen. Therefore, farmers apply nitrogen fertilizers at specific time intervals. Urea is considered the most widely used solid nitrogen fertilizer in developing countries [1]. Approximately 80–85% of the produced urea is used specifically as fertilizer [2]. In addition, a significant portion of global food production — more than 40% — is associated with the application of urea fertilizers [2]. Currently, about 57% of the nitrogen used in agriculture is supplied through urea, and the demand for this substance is projected to increase by an average of 1.5% annually in the coming years [1,3,4].

The industrial-scale production of urea fertilizer is based on the chemical reaction between gaseous carbon dioxide (CO₂) and liquid ammonia under high temperature and pressure conditions. As a result of this process, ammonium carbamate is initially formed, which is subsequently converted into urea through a dehydration stage. The obtained mixture is then processed in granulation units or special towers to produce the final product in the form of granules or compressed pills.

Urea is also distinguished by its high water solubility, which enables its rapid conversion into an active form in the soil. Compared with other nitrogen fertilizers, its high nitrogen content (approximately 46%) makes it a more efficient nutrient source. One of the main advantages of conventional urea application is its versatility in terms of application methods [5,6,7,8]. The fertilizer may be broadcast over the field, applied in bands along plant rows, or incorporated into the soil [7,9,10,11].

After World War II, particularly since the 1950s, the application of inorganic nitrogen fertilizers became a key strategic approach for increasing agricultural productivity and meeting the global food demands of the rapidly growing world population. This process laid the foundation for the “Green Revolution” of the 1960s, characterized by the introduction of high-yield and fertilizer-responsive crop varieties. According to statistical data, the approximately twofold increase in crop production over the last 50 years has been closely associated with a sevenfold rise in nitrogen fertilizer use [12]. Nitrogen fertilizer consumption increased from 10.8 million tons in 1960 to 82 million tons in 2000. Current projections indicate that this figure may reach 249 million tons by 2050. Overall, nearly half of global food production depends on nitrogen fertilizers, highlighting their essential role in accelerating plant growth and increasing crop yields [13].

Ammonia emissions arising from the surface application of urea to soil represent a serious environmental problem closely associated with meteorological factors and the specific characteristics of the soil. These loss mechanisms not only reduce fertilizer efficiency but also artificially increase the global

demand for nitrogen-containing compounds [14]. The increasing need to meet growing food demands has driven the agricultural sector toward more intensive fertilizer use, further emphasizing the factors that limit the agronomic nitrogen use efficiency and crop productivity of conventional urea [8, 15].

In recent years, new formulations prepared using environmentally friendly raw materials have been developed to improve the efficiency of urea while simultaneously minimizing harmful emissions [15]. One of the most effective approaches to reducing nitrogen losses is the production of fertilizers in slow-release or controlled-release forms. By regulating the rate of nitrogen release, the excess amount of ammonium in the soil can be controlled [15, 16]. This contributes to environmental protection by reducing both ammonia volatilization into the atmosphere and nitrate leaching into groundwater [15, 16, 17].

Over recent decades, the increasing global demand for food security has significantly influenced fertilizer consumption. At the same time, future factors affecting fertilizer use will not be limited solely to productivity, but will also encompass broader issues such as reducing environmental impacts. On the other hand, rapid urbanization, soil degradation, climate change, and economic expansion leading to the conversion of arable lands into residential areas have emerged as major challenges [18].

Accurate assessment of global food demands and the implementation of appropriate strategic measures are essential for overcoming existing challenges. Innovations in agriculture and the improvement of management approaches play an important role in this direction. In this context, optimizing the application of urea fertilizers and regulating their release rate in the soil are of particular importance. The use of slow-release and controlled-release fertilizers contributes not only to increasing crop productivity, but also to reducing toxic emissions released into the environment [19, 20].

Furthermore, the development of slow-release, controlled-release, and stabilized fertilizers makes it possible to move significantly closer to the concept of the optimal fertilizer. However, it should be noted that these types of fertilizers cannot completely eliminate agronomic management errors. Nevertheless, they positively affect nitrogen use efficiency and reduce environmental impacts. Therefore, the integration of such fertilizer types into sustainable agricultural strategies and modern management practices is considered highly important [1, 21].

Urea modification is used to alter its physicochemical properties through interaction with various substances in order to improve its resistance to environmental factors such as high temperature, humidity, UV radiation, and corrosion. In general, modification with urea is considered an effective method for enhancing the functional properties of different materials. One of the significant achievements in this field was the development by Chissoasahi of polyolefin-coated urea with a sigmoidal release characteristic. This innovation allows the fertilizer to be placed close to the plant root system and enables single-stage application [21].

Modified urea fertilizers are mainly divided into two groups: slow-release nitrogen fertilizers and controlled-release nitrogen fertilizers [16, 17, 22]. Although these terms appear similar, studies conducted by Trenkel revealed the differences between them [21]. Synthetically modified urea-based fertilizers are generally classified into two principal categories.

The first category involves the incorporation of urea into chemical reactions. In both fertilizer types, nitrogen is supplied to the soil in a more stable manner compared to conventional urea fertilizers; however, their operating principles differ from one another. The main distinguishing feature between these fertilizers is the coating technology. Slow-release nitrogen fertilizers do not employ coating materials, whereas controlled-release nitrogen fertilizers use special coatings to delay nitrogen release [17].

Objective of the Study: To investigate the methods of modifying urea granules with various nutrient elements and to study the mechanical properties of urea-based fertilizers.

Experimental Part

The experimental part demonstrates the modification of 0.5–1 kg of urea-based fertilizer with nutrient elements. As a method, the nutrient element was applied in the form of a coating. Approximately 12.5 g of $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$ was mixed with about 500 mL of distilled water. The mixture was homogenized at 90°C for 40 minutes. The obtained hot solution was sprayed onto 1 kg of urea. The coating process was carried out under constant temperature conditions. The urea granules were maintained in a hot air stream at a temperature of 75°C. The transfer of the hot solution was performed using a peristaltic pump. After the coating stage, the drying process was carried out for 20 minutes, after which the urea was removed from the apparatus.

Carboammophoska is a complex fertilizer containing nitrogen in both ammonia and amide forms. One of the main characteristics of urea-based complex fertilizers is their ability to form double salts.

Studies were conducted on fertilizers of grades 16:16:16 and 17:17:17 in order to investigate the physicochemical and structural properties of urea-based fertilizers.

The molar ratio of $[\text{NH}_3]:[\text{H}_3\text{PO}_4]$ in the produced material was determined by the titrimetric method. Water content was determined at 70°C using an SNOL-3.5.3.5.3.5/3.5-11M drying oven. Potassium was determined by the potassium tetraphenylborate method.

Table 1.

Consumption Values for the Preparation of Fertilizer Grade 16:16:16

$[\text{NH}_3]:[\text{H}_3\text{PO}_4]$ Molar Ratio	Extraction phosphoric acid containing 51.79% P_2O_5	Urea 46,47% N	Ammonium sulfate containing 21.21% N	Potassium chloride containing 60.9% K_2O
1:0,5	0,3089	0,1304	0,2994	0,2632
1:1	0,3089	0,1261	0,3002	0,2632
1:1,5	0,3089	0,1191	0,3023	0,2632
1:2,5	0,3089	0,1024	0,3067	0,2632
1:3	0,3089	0,1089	0,3103	0,2632
1:3,5	0,3089	0,1047	0,3128	0,2632
1:4	0,3089	0,1002	0,3153	0,2632
1:4,5	0,3089	0,0956	0,3182	0,2632

Tablo 2.

Consumption Values for the Preparation of Fertilizer Grade for 17:17:17

$[\text{NH}_3]:[\text{H}_3\text{PO}_4]$ Molar ratio	Extraction phosphoric acid containing 51,79% P_2O_5	Urea 46,47% N	Ammonium sulfate containing 21,21% N	Potassium chloride containing 60,9% K_2O
1:0,5	0,3282	0,1897	0,2012	0,2796
1:1	0,3282	0,1868	0,2040	0,2796
1:1,5	0,3282	0,1793	0,2064	0,2796
1:2,5	0,3282	0,1705	0,2101	0,2796
1:3	0,3282	0,1679	0,2145	0,2796
1:3,5	0,3282	0,1637	0,2167	0,2796
1:4	0,3282	0,1589	0,2200	0,2796
1:4,5	0,3282	0,1538	0,2237	0,2796

The hygroscopicity of fertilizer grades 16:16:16 and 17:17:17 was determined by evaluating the hygroscopicity coefficient. The hygroscopicity coefficient was calculated under variable conditions at 30°C and 70% relative humidity for granules with a diameter of 0.2–2 mm using a BINDER KBF 115 chamber equipped with internal circulation. Investigations were also carried out on powdered samples.

Table 3.

Results of the Analysis of 16:16:16 Grade Samples

Molar ratio $[\text{NH}_3]:[\text{H}_3\text{PO}_4]$	P_2O_5	N	N	K_2O	H_2O
1:0,5	16,01	15,87	9,43	16,31	0,61
1:1	16,06	16,12	10,11	16,23	0,80
1:1,5	16,09	16,01	10,23	16,14	0,69
1:2,5	16,13	16,04	10,72	16,09	0,72
1:3	16,00	16,06	10,89	16,13	0,75
1:3,5	16,04	16,11	11,02	16,17	0,67
1:4	16,09	16,15	11,27	16,19	0,59
1:4,5	16,03	16,03	11,41	16,16	0,65

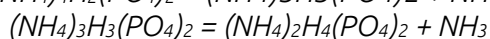
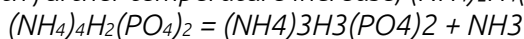
For this purpose, the granular fertilizer was ground into powder with a particle size of 0.1–0.3 mm, after which it was dried at 70°C until a constant weight was achieved. Powdered granule samples weighing 3.4 g or 0.5 g were uniformly distributed in a single layer in a container with a diameter of 40 mm and a height of 12 mm.

Table 4.

17:17:17 marka nümunələrinin təhlilinin nəticələri

Mol nisbəti $[\text{NH}_3]:[\text{H}_3\text{PO}_4]$	P_2O_5 üm	Nüm	Nammo	K_2O	H_2O
1:0,5	17,09	17,08	8,98	17,11	0,57
1:1	17,10	17,11	8,74	17,16	0,69
1:1,5	17,04	17,06	8,42	17,19	0,71
1:2,5	17,12	17,15	8,01	17,29	0,76
1:3	17,16	17,18	7,93	17,01	0,80
1:3,5	17,11	17,01	7,67	16,97	0,82
1:4	17,05	16,97	7,39	16,93	0,84
1:4,5	17,07	16,95	7,23	16,99	0,76

The samples were thermally treated at temperatures of 70–90°C. During this process, water was removed from the mineral composition. At approximately 110°C, the double salt present in the composition began to melt. With further temperature increase, $(\text{NH}_4)_2\text{H}_4(\text{PO}_4)_2$ decomposed.



As a result of the reaction, the release of ammonia gas caused a decrease in weight.

CONCLUSIONS

1. The investigation of the properties of urea-containing fertilizers obtained on the basis of $\text{NH}_4\text{H}_2\text{PO}_4$ and KCl showed that the hygroscopicity of the fertilizer depends on the urea content. According to some studies, an increase in the urea content of the product leads to a decrease in the hygroscopicity coefficient, whereas other sources indicate that an increase in urea concentration increases the hygroscopicity of the product.

2. In recent years, the use of nutrient-element-modified urea-based fertilizers has become an important factor in improving the uptake of mineral nitrogen in soil. These fertilizers not only increase the nitrogen level, but may also reduce nitrogen release, thereby enhancing fertilizer efficiency in crop production. Studies have reported the positive effect of controlled-release fertilizers on plant productivity. However, despite these advances, further investigations are still required to better understand the effects of these compounds.

References

1. Heffer, P.; Prud'homme, M. Global Nitrogen Fertilizer Demand and Supply: Trend, Current Level and Outlook. In *Proceedings of the International Nitrogen Initiative Conference, "Solutions to Improve Nitrogen Use Efficiency for the World"*, Melbourne, Australia, 4–8 December 2016.
2. Alexandratos, N.; Bruinsma, J. *World Agriculture Towards 2030/2050: The 2012 Revision*; FAO: Rome, Italy, 2012.
3. IFA. *Short-Term fertilizer Outlook 2017–2018 Report*; IFA International Fertilizer Association, Services PITaA: Paris, France, 2017.
4. Cantarella, H.; Otto, R.; Soares, J.R.; de Brito Silva, A.G. Agronomic Efficiency of NBPT as a Urease Inhibitor: A Review. *J. Adv. Res.* 2018, 13, 19–27.
5. Bacon, P. *Nitrogen Fertilization in the Environment*, 13th ed.; Marcel Dekker: New York, NY, USA, 1995.
6. Rosmarina, A.K.; Khanif, Y.M.; Hanafi, M.M.; Aminuddin, H.; Abdul Rahim, K.B. Nitrogen Loss Pathways in Anaerobic Soils and Mitigation Approaches Through Inhibitors—A Review. *Am. Eurasian J. Agric. Environ. Sci.* 2016, 16, 641–651.
7. Cameron, K.C.; Di, H.J.; Moir, J.L. Nitrogen Losses from the Soil/Plant System: A Review. *Ann. Appl. Biol.* 2013, 162, 145–173.
8. Terman, G.L. Volatilization Losses of Nitrogen as Ammonia from Surface-Applied Fertilizers, Organic Amendments, and Crop Residues. *Adv. Agron.* 1980, 31, 189–223.
9. Anas, M.; Liao, F.; Verma, K.K.; Sarwar, M.A.; Mahmood, A.; Chen, Z.L.; Li, Q.; Zeng, X.P.; Liu, Y.; Li, Y.R. Fate of Nitrogen in Agriculture and Environment: Agronomic, Eco-Physiological and Molecular Approaches to Improve Nitrogen Use Efficiency. *Biol. Res.* 2020, 53, 1–20.
10. Cao, D.; Cao, W.; Fang, J.; Cai, L. Nitrogen and Phosphorus Losses from Agricultural Systems in China: A Meta-Analysis. *Mar. Pollut. Bull.* 2014, 85, 727–732.
11. Li, S.Q.; Ji, C.R.; Fang, Y.N.; Chen, X.L.; Li, S.X. Advances in Nitrogen Loss Leached by Precipitation from Plant Canopy. *Agric. Sci. China* 2008, 7, 480–486.
12. Han, M.; Wong, J.; Su, T.; Beatty, P.H.; Good, A.G. Identification of Nitrogen Use Efficiency Genes in Barley: Searching for QTLs Controlling Complex Physiological Traits. *Front. Plant Sci.* 2016, 7, 1587.
13. Tilman, D.; Cassman, K.G.; Matson, P.A.; Naylor, R.; Polasky, S. Agricultural Sustainability and Intensive Production Practices. *Nature* 2002, 418, 671–677.
14. Mateo-Sagasta, J.; Zadeh, S.M.; Turral, H.; Burke, J. *More People, More Food, Worse Water? A Global Review of Water Pollution from Agriculture, Executive Summary*; FAO: Rome, Italy, 2017.
15. Azeem, B.; KuShaari, K.; Man, Z. Effect of Coating Thickness on Release Characteristics of Controlled Release Urea Produced in Fluidized Bed Using Waterborne Starch Biopolymer as Coating Material. *Procedia Eng.* 2016, 148, 282–289.
16. Azeem, B.; KuShaari, K.; Man, Z.B.; Basit, A.; Thanh, T.H. Review on Materials & Methods to Produce Controlled Release Coated Urea Fertilizer. *J. Control. Release* 2014, 181, 11–21.

17. Barčauskaite, K.; Braziene, Z.; Avižienyte, D.; Silva, M.; Drapanauskaite, D.; Honer, K.; Gvildiene, K.; Slinksiene, R.; Jancaitiene, K.; Mazeika, R.; et al. Mechanochemically Synthesized Gypsum and Gypsum Drywall Waste Cocrystals with Urea for Enhanced Environmental Sustainability Fertilizers. *J. Environ. Chem. Eng.* 2020, 8, 103965.
18. Jie, C.; Jing-zhang, C.; Man-zhi, T.; Zi-tong, G. Soil Degradation: A Global Problem Endangering Sustainable Development. *J. Geogr. Sci.* 2002, 12, 243–252.
19. Liu, L.S.; Kost, J.; Fishman, M.L.; Hicks, K.B. A Review: Controlled Release Systems for Agricultural and Food Applications. *ACS Symp. Ser.* 2008, 992, 265–281.
20. Beig, B.; Bilal Khan Niazi, M.; Jahan, Z.; Hussain, A.; Hussain Zia, M.; Taqi Mehran, M.; Taqi, M. Coating Materials for Slow Release of Nitrogen from Urea Fertilizer: A Review. *J. Plant Nutr.* 2020, 43, 1510–1533.
21. Trenkel, M.E. *Slow-and Controlled-Release and Stabilized Fertilizers: An Option for Enhancing Nutrient Use Efficiency in Agriculture*, 2nd ed.; International Fertilizer Industry Association: Paris, France, 2010.
22. Kareem, S.A.; Dere, I.; Gungula, D.T.; Andrew, F.P.; Saddiq, A.M.; Adebayo, E.F.; Tame, V.T.; Kefas, H.M.; Joseph, J.; Patrick, D.O. Synthesis and Characterization of Slow-Release Fertilizer Hydrogel Based on Hydroxy Propyl Methyl Cellulose, Polyvinyl Alcohol, Glycerol and Blended Paper. *Gels* 2021, 7, 262.
23. Lawrencia, D.; Wong, S.K.; Low, D.Y.S.; Goh, B.H.; Goh, J.K.; Ruktanonchai, U.R.; Soottitantawat, A.; Lee, L.H.; Tang, S.Y. Controlled Release Fertilizers: A Review on Coating Materials and Mechanism of Release. *Plants* 2021, 10, 238.

Architecture

THE ROLE OF GREEN BUILDING IN SUSTAINABLE URBAN DEVELOPMENT

Orkhan Teymurlu

Azerbaijan University of Architecture and Construction

Sabah Groups

Sustainable Urban Planning and Regional Development

Scientific supervisor: **R.T. Aliyeva**

Assoc. Prof.

Abstract

Green building has become one of the most important approaches in achieving sustainable urban development in modern cities. Rapid urbanization, environmental degradation, climate change, and increasing energy consumption have created significant challenges for urban areas around the world. In this context, green building practices contribute to environmental protection, economic efficiency, and social sustainability by reducing the negative impacts of traditional construction methods. The purpose of this study is to analyze the role of green building in sustainable development and examine its environmental, economic, and social impacts. The study explores the fundamental principles of green construction, including energy efficiency, sustainable material usage, water conservation, indoor environmental quality, and waste reduction. Furthermore, the research investigates how green buildings support sustainable urban planning and improve the quality of life in urban environments.

The research methodology is based on theoretical analysis and comparative evaluation of international sustainable construction practices. The study demonstrates that green building technologies significantly reduce energy consumption and greenhouse gas emissions while increasing resource efficiency. Moreover, sustainable construction contributes to long-term economic benefits through lower operational costs and improved building performance. Socially, green buildings provide healthier and safer living environments for residents by improving air quality and thermal comfort. The article also identifies several challenges affecting the implementation of green building systems, including high initial investment costs, limited public awareness, insufficient governmental support, and technological barriers in developing countries.

The findings indicate that integrating green building principles into urban planning policies can enhance environmental stability and promote sustainable economic growth. Green building is not only an environmental necessity but also an essential strategy for achieving sustainable cities and improving future urban development. The study concludes that broader implementation of sustainable construction practices and stronger governmental policies are required to ensure long-term environmental and economic sustainability in urban areas.

Keywords: green building, sustainable development, sustainable urban planning, environmental sustainability, energy efficiency, urban development, ecological construction, sustainable cities

Introduction

Sustainable development has become one of the most significant global priorities of the twenty-first century. Rapid industrialization, urban population growth, and environmental pollution have increased the necessity for environmentally responsible construction practices. Traditional construction methods consume excessive natural resources and contribute significantly to greenhouse gas emissions, environmental degradation, and energy waste. Therefore, green building has emerged as an effective solution for minimizing environmental impacts and supporting sustainable urban development.

Green building refers to environmentally responsible and resource-efficient construction processes throughout the entire life cycle of a building. Sustainable construction aims to reduce energy consumption, improve indoor environmental quality, and ensure efficient use of natural resources. Today, many countries integrate green building principles into urban planning strategies in order to create healthier and more sustainable cities.

Green Building Concepts

Green building is based on several important principles that focus on environmental protection and sustainable resource management. One of the key concepts is energy efficiency. Green buildings are designed to reduce energy consumption through advanced insulation systems, renewable energy

technologies, and efficient lighting systems. Solar panels, natural ventilation systems, and energy-saving technologies significantly improve building performance.

Another essential principle is sustainable material usage. Environmentally friendly construction materials such as recycled steel, bamboo, low-carbon concrete, and renewable resources help minimize environmental damage. Water conservation is also an important aspect of green construction. Rainwater harvesting systems, water-efficient plumbing technologies, and wastewater recycling reduce water consumption and contribute to environmental sustainability.

Indoor environmental quality is another important factor in green building design. Proper ventilation, natural lighting, and non-toxic materials create healthier indoor spaces and improve human well-being. In addition, green construction practices aim to reduce construction waste and encourage recycling processes during and after building projects.

Environmental and Economic Impacts

Green building practices provide significant environmental benefits by reducing carbon emissions and minimizing environmental pollution. Buildings account for a large percentage of global energy consumption and greenhouse gas emissions. Sustainable construction technologies help decrease dependence on fossil fuels and support climate change mitigation efforts.

From an economic perspective, green buildings reduce operational and maintenance costs through energy and water efficiency. Although sustainable construction projects may require higher initial investment costs, they generate long-term financial savings. Energy-efficient buildings lower electricity consumption, reduce utility expenses, and improve property values. Furthermore, sustainable construction creates employment opportunities in green technology and environmental engineering sectors.

The social benefits of green building are also important. Healthy indoor environments improve productivity, reduce health problems, and increase overall quality of life. Sustainable urban infrastructure contributes to safer and more resilient communities, especially in rapidly urbanizing regions.

Sustainable Urban Development

Sustainable urban development aims to balance economic growth, environmental protection, and social welfare in urban areas. Green building plays a critical role in achieving these objectives. Modern cities face numerous challenges such as air pollution, traffic congestion, population density, and excessive energy demand. Integrating sustainable construction practices into urban planning strategies can help solve these problems effectively.

Green buildings contribute to sustainable cities by reducing urban heat island effects, improving air quality, and promoting efficient land use. Urban green spaces, eco-friendly transportation systems, and smart infrastructure are closely connected with sustainable building principles. Governments and urban planners increasingly encourage green construction through environmental regulations, certification systems, and sustainable development policies.

Moreover, sustainable urban planning requires collaboration between architects, engineers, policymakers, and environmental specialists. Public awareness and education about environmental sustainability are essential for expanding green building practices and supporting long-term urban resilience.

Challenges and Future Perspectives

Despite its numerous advantages, green building still faces several challenges in many countries. One of the major obstacles is the high initial cost of sustainable construction technologies and environmentally friendly materials. In developing countries, limited financial resources and insufficient governmental incentives slow down the implementation of green building systems.

Another challenge is the lack of public awareness and professional expertise in sustainable construction practices. Many developers and construction companies continue to prioritize short-term economic benefits over environmental sustainability. Additionally, technological limitations and weak environmental regulations can negatively affect the development of green infrastructure.

However, future perspectives for green building remain highly promising. Technological innovations, renewable energy systems, and international environmental policies are expected to accelerate sustainable construction worldwide. Smart cities, digital building technologies, and eco-friendly urban planning strategies will further strengthen the role of green building in sustainable development. Governments should continue supporting sustainable construction through financial incentives, environmental legislation, and educational programs.

Conclusion

Green building has become an essential component of sustainable urban development in modern societies. Sustainable construction practices contribute significantly to environmental protection, economic efficiency, and social well-being. By reducing energy consumption, conserving natural resources, and improving indoor environmental quality, green buildings help create healthier and more sustainable urban environments.

The study demonstrates that integrating green building principles into urban planning policies can improve environmental stability and support long-term sustainable development. Although several economic and technological challenges remain, increasing public awareness and governmental support can accelerate the adoption of sustainable construction practices. Ultimately, green building represents an important strategy for creating environmentally responsible cities and ensuring a sustainable future for coming generations.

References

1. *Smith J. Sustainable Urban Development and Green Architecture. London: Green Press, 2020.*
2. *Brown T. Environmental Sustainability in Modern Construction. New York: Urban Publications, 2019.*
3. *Johnson P. Green Building Technologies and Energy Efficiency. Berlin: EcoBuild Publishing, 2021.*
4. *United Nations. Sustainable Development Goals Report. New York: United Nations Publications, 2022.*
5. *Williams R. Sustainable Cities and Urban Planning. Oxford: Oxford University Press, 2018.*
6. *Garcia M. Renewable Energy Systems in Green Construction. Madrid: Environmental Studies Journal, 2021.*
7. *International Energy Agency. Energy Efficiency and Buildings Report. Paris: IEA Publications, 2023.*

Astronomy

BALMER LINE PROFILES AND ATMOSPHERIC PARAMETERS OF LUMINOUS STARS

Turkan Mammadova

Nakhchivan State University, Batabat Astrophysical Observatory

<https://orcid.org/0009-0009-3592-379X>

Mirhasan Tahirov

Nakhchivan State University, Batabat Astrophysical Observatory

<https://orcid.org/0009-0008-9105-0009>

Abstract

This paper presents a comprehensive quantitative analysis of neutral hydrogen Balmer lines (Hydrogen-alpha, Hydrogen-beta, Hydrogen-gamma, and Hydrogen-delta) in the optical spectra of luminous stars, specifically giants, bright giants, and supergiants. Due to highly extended geometries and low surface gravities, their line profiles deviate significantly from Main Sequence dwarfs. This study explores the physical mechanisms governing line formation, including the attenuation of Stark broadening under low electron pressures, thermodynamic population distribution via excitation/ionization equilibria, and the dynamics of radiation-driven stellar winds. Furthermore, a digital data reduction methodology utilizing the DECH software package for high-resolution spectra is detailed. The results reaffirm that precise line profile modeling serves as a fundamental diagnostic for constraining the effective temperature and surface gravity of luminous stellar atmospheres.

Keywords: CCD, Stellar spectroscopy, Luminous stars, Balmer lines, DECH software.

Introduction. Luminous stars—comprising giants, bright giants, and supergiants—occupy a critical evolutionary phase characterized by massive energy outputs, significant mass-loss rates, and extended atmospheres. In stellar spectroscopy, the spectral lines of neutral hydrogen serve as the primary diagnostic indicators for mapping the physical state of these outer layers. In the optical window, the Balmer series lines are particularly sensitive to local physical conditions. While in dwarf stars these lines are primarily governed by pressure effects, in high-luminosity classes they reflect a delicate balance between radiation pressure, low atmospheric density, and hydrodynamical macroscopic motions. This study provides a rigorous quantitative investigation into the behavior of hydrogen line profiles in luminous stellar spectra, analyzing the statistical mechanics of atomic state populations, line-broadening theories, and digital spectral processing using the DECH software suite [1, 2].

Research method. Statistical Mechanics of Hydrogen State Populations.

The equivalent width and core-to-wing topology of Balmer lines are fundamentally dictated by the population density of neutral hydrogen atoms in the first excited state. Under the assumption of Local Thermodynamic Equilibrium (LTE), this distribution is governed by the coupled local kinetic temperature and electron pressure through excitation and ionization equilibria. The ratio of population densities between the first excited state and the ground state requires a significant thermal energy threshold to populate the level responsible for these transitions. Simultaneously, the ratio of neutral hydrogen atoms to ionized protons is dictated by the temperature and surrounding electron pressure; when temperature rises or gas density drops, the equilibrium shifts toward free protons [3, 4].

The interplay between excitation and ionization yields a distinct maximum for Balmer line intensity depending on the spectral class of the luminous star:

- **The Balmer Maximum:** In intermediate-temperature supergiants (early A-type and late B-type), the population of the first excited level reaches its theoretical peak. Thermal energy is sufficient to populate the state heavily, but insufficient to trigger massive ionization.

- **Hot Luminous Stars:** At extreme temperatures in O-type supergiants, ionization dominates completely. Hydrogen is nearly fully ionized, causing the neutral hydrogen population to drop drastically and Balmer lines to weaken, while Helium dominates.

- **Cool Luminous Stars:** In G, K, and M-type giants or supergiants, thermal energy cannot overcome the energy gap to excite electrons to the second energy level. The bulk of neutral hydrogen remains in the ground state, rendering optical Balmer lines exceptionally faint while molecular bands dominate.

3. Atmospheric Pressure Effects and Stark Broadening Attenuation

The defining spectroscopic feature that segregates luminous stars from main-sequence dwarfs is the structural narrowness of their hydrogen line profiles. Because giants and supergiants possess expanded envelopes with radii extending up to several hundred solar radii, their surface gravity parameters drop to remarkably low levels. From the principles of hydrostatic equilibrium, the total gas pressure scales directly with gravity, meaning electron density and gas pressure are orders of magnitude lower in these environments.

Hydrogen atoms possess a highly sensitive linear Stark effect, where energy levels split when exposed to microscopic electric fields generated by surrounding ions and free electrons. In high-density dwarf stars, frequent particle interactions induce strong micro-electric fields, creating broad line wings spanning dozens of Angstroms. In contrast, within the diffuse, low-density photospheres of giants and supergiants, atomic collisions are sparse and the micro-electric field strength approaches minimal levels, causing the Stark broadening mechanism to be severely attenuated. Without pressure-induced wings, the Balmer lines exhibit distinct profiles: they are exceptionally sharp, deep, and narrow. Measuring this lack of Stark broadening via the line profile shape provides an immediate, reliable criterion for assigning the luminosity class.

4. Radiatively Driven Stellar Winds and Kinetic Line Asymmetries

Massive luminous stars often operate near or at the Eddington limit, where radiation pressure balances or exceeds gravitational acceleration. Because hydrogen lines possess exceptional opacity, the outward momentum flux from the stellar continuum transfers directly to gas ions in the upper atmosphere. This continuous radiation force drives an outward hydrodynamical expansion known as a stellar wind, causing the upper atmospheric layers to enter a non-stationary state. This kinetic movement distorts the symmetry of the core Balmer profiles, most notably in the Hydrogen-alpha line.

In highly luminous supergiants, the Hydrogen-alpha line frequently transforms into a hybrid P Cygni profile. This complex shape arises from two distinct spatial zones in the expanding wind:

- **The Blue-Shifted Absorption Core:** The column of gas located directly in front of the stellar disk moves toward the observer, absorbing continuum photons and shifting the absorption core toward shorter wavelengths due to the Doppler effect.
- **The Red-Shifted Emission Peak:** The large, extended envelope surrounding the sides and rear of the star expands away from or transverse to the observer, scattering and re-emitting line photons in all directions to generate a broad emission feature.

By measuring the wavelength displacement of this blue-shifted absorption edge, astrophysicists can calculate the terminal velocity of the stellar wind, which routinely reaches hundreds of kilometers per second [5, 6].

5. High-Resolution Digital Reduction Methodology via DECH

Modern quantitative spectroscopy relies on high-resolution digital data acquired via Charge-Coupled Devices (CCDs) coupled to echelle spectrographs. Extracting physical atmospheric parameters from raw data requires precise mathematical reduction, executed via the specialized DECH software package. The numerical processing pipeline follows a strict, standardized sequence:

First, Continuum Normalization is performed. Because Balmer lines span a large spectral extent, establishing an accurate continuous spectrum baseline is crucial. In the DECH environment, the user identifies anchor points across spectral regions free of strong blending lines, and the software fits these points using high-order mathematical spline or polynomial functions. Second, Numerical Integration of Equivalent Width is conducted. The DECH algorithm computes the area enclosed by the normalized profile relative to the continuum. Because Stark broadening is minimized, the equivalent width values in supergiants are substantially smaller than those found in dwarf stars of identical spectral classes. Finally, Profile Core Parameterization is applied. To evaluate macroscopic motions like microturbulence, the software measures the Full Width at Half Maximum (FWHM) of the absorption core. These observed profiles are iteratively compared to synthetic profiles generated from model atmospheres to extract definitive values for effective temperature and surface gravity [5, 6, 7].

Conclusion. Quantitative spectroscopy of neutral hydrogen Balmer lines remains one of the most robust frameworks for probing the physical conditions within the atmospheres of luminous stars. The systematic decrease in atmospheric gas density from giants to supergiants manifests clearly as a suppression of the linear Stark effect, yielding sharp, high-contrast line profiles. Concurrently, the emergence of asymmetric P Cygni configurations provides a powerful diagnostic tool for quantifying mass loss and stellar wind dynamics. When combined with advanced digital processing suites like DECH and atmospheric modeling, the analysis of these fundamental atomic transitions allows astrophysicists

to map the evolutionary parameters of the universe's most luminous stellar objects with exceptional reliability.

References

1. Gray, D. F. (2008). *The Observation and Analysis of Stellar Photospheres* (3rd ed.). Cambridge: Cambridge University Press.
2. Mihalas, D. (1978). *Stellar Atmospheres* (2nd ed.). San Francisco: W. H. Freeman and Co.
3. Valiyev U.S., Alishov S., Ismailov N.Z., CCD Photometry of Young Stars AS 205, V1082 Cyg and AS 310. 2022, *Peremennye Zvezdy (Variable Stars)* 42 (9), p.51-59. DOI: [10.24412/2221-0474-2022-42-51-59](https://doi.org/10.24412/2221-0474-2022-42-51-59)
4. Kh. M. Mikailov, R. T. Mammadov, A. B. Rustamova, L. R. Mammadova "Photometric observations of symbiotic star AG Peg", *East European Journal of Physics*, 1, 156-160, (2026). <https://periodicals.karazin.ua/eejp/article/view/28409/25013>
5. Kh. M. Mikailov, R.T. Mammadov, I. A. Alakbarov and O. V. Khalilov, "High velocity absorption in the spectra of CH Cyg in 2017", *Astronomical Journal of Azerbaijan*, 15(2), 82-90 (2020). https://aj.shao.az/vol15_n2/AAJ_2020_V15_N2.pdf
6. Kh. M. Mikailov, R.T. Mammadov, B.N. Rustamov, and A.B. Rustamova, "Spectral Variability of the Symbiotic Star CH Cyg". *Proceedings of the Pakistan Academy of Sciences: Part A: PS-671*, 60(1), 9-13 (2023). [https://doi.org/10.53560/PPASA\(60-1\)671](https://doi.org/10.53560/PPASA(60-1)671)
7. <http://www.gazinur.com/DECH-software.html>

Economic sciences

INTERNATIONAL RELATIONS AND DIGITAL DIPLOMACY AS CATALYSTS FOR TOURISM DEVELOPMENT: THE CASE OF ALBANIA AND THE BALKANS

Ilir Hebovija

PhDc.,

Mediterranean University of Albania

Ferjolt Ozuni

PhD.,

Mediterranean University of Albania

Abstract

Is diplomacy really doing the work, or is it just well-dressed bureaucracy? The question keeps coming back as the world watches simultaneous wars in Eastern Europe and the Middle East. This paper takes a different angle. Instead of asking where diplomacy failed, it looks closely at one place where it has clearly worked: the measurable, documented growth of tourism in Albania, the fastest-growing tourism destination in Europe. The argument is simple. International relations aren't only about preventing war. they're also a quiet engine of economic development. Albania's data from 2022 to 2025 carries the weight of the argument: 7.5 million arrivals in 2022 climbing to 12.47 million in 2025, with 5.7 billion Euro in foreign tourist spending in that same year. Set this beside countries caught in armed conflict, from Ukraine to the Gulf, and the contrast becomes hard to ignore. Diplomacy and peace aren't abstractions. they're the conditions that make prosperity possible.

Keywords: *International Relations, Diplomacy, Tourism Development, Albania, Balkans, Soft Power, Foreign Policy, Regional Cooperation, Conflict and Tourism*

1. Introduction

When people debate whether international relations and diplomacy actually work, the conversation tends to focus on failures. Wars not prevented. Agreements broken. The Russia - Ukraine war, now past its third year, gets cited often as proof that diplomatic institutions are oversold. The escalation between the United States, Israel, and Iran from late 2025 into 2026 has only sharpened that skepticism. These are fair concerns, and they deserve an honest answer.

Here's the thing. Honestly, the all-or-nothing framing hides a much messier reality. International relations cover a wide range of activities beyond stopping wars: trade agreements, visa liberalization, regional integration, cultural exchange, security cooperation. Each of these produces concrete benefits for ordinary people. Nowhere is this clearer than in tourism, which depends almost entirely on the plumbing of international relations - visa regimes, air connectivity, bilateral agreements, political stability, and a country's international image.

Albania is the case that makes the argument hard to dismiss. Over the last fifteen years it has moved from diplomatic isolation to what the Spanish Tourism Board's president recently called one of "the consolidating emerging destinations of Europe". None of this happened by accident. it's the result of a deliberate, still-evolving foreign policy strategy, and that's what this paper sets out to unpack.

2. Theoretical Framework

Foreign policy shapes tourist flows in ways that are direct and structural. Visa regimes are the most obvious lever. When entry rules open, arrivals from newly accessible markets tend to climb fast, because practical and psychological barriers drop together. Tense relations have the opposite effect. Visa restrictions, travel warnings, and the absence of direct flights quietly drain tourist flows no matter how beautiful a destination might be. The literature is consistent: political stability has a strong, positive, statistically significant effect on tourism arrivals, while armed conflict is among the most damaging shocks a tourism sector can absorb.

Bilateral and multilateral agreements shape tourism through regional mobility and air connectivity. The EU Schengen Area, the ASEAN Open Skies Policy, and similar frameworks show the same pattern. When internal mobility friction drops, the hospitality sector responds almost immediately. The truth is, in the western balkans, the open balkan initiative - albania, serbia, and north macedonia - attempts the same dynamic through free movement of people, goods, capital, and services.

Tourism isn't only acted on by foreign policy. it's itself a foreign policy instrument. Building on Joseph Nye's concept of soft power, scholars have shown that a country positioned as welcoming, culturally rich, and safe accumulates international goodwill that strengthens its diplomatic standing. The relationship works as a loop: diplomatic openness attracts tourists, positive experiences generate favorable media coverage, and that coverage attracts more visitors. Beyond soft power, tourism also serves as a vehicle for reconciliation. Direct people-to-people contact wears down prejudice and creates constituencies for peaceful relations that elites can't easily ignore. The Albania - Serbia case, discussed below, is a striking example.

3. Albania's Diplomatic Trajectory

Albania came out of one of the most hermetically sealed communist regimes in the world in 1990. Since then, its foreign policy has been organized around two anchors: NATO membership and EU accession. NATO membership, secured on April 1, 2009, was a turning point. It signaled alignment with Western democratic values, dropped Albania's perceived risk profile, and delivered the security guarantee that sustainable tourism needs. The country has since been described as "the anchor of NATO's Balkan strategy".

EU accession is still ongoing, but pre-accession instruments have already produced tangible, tourism-positive outcomes. IPA funds have been channeled into tourism infrastructure, cultural heritage preservation, and local economic capacity in key tourist areas. Alignment with EU regulatory standards has made Albania more credible as a destination for Western European visitors, now one of the fastest-growing inbound segments.

Inside the Western Balkans, Albania has pushed regional normalization through the Berlin Process and the Open Balkan initiative. Trilateral agreements have produced simpler border crossings, mutual document recognition, and better transport connectivity. Each chips away at the friction cost of visiting Albania for citizens of neighboring countries. The Albanian Embassy in Belgrade's promotion of Albanian tourism at the Belgrade International Tourism Fair in February 2024 is a concrete example of tourism diplomacy in action.

4. Strategic Moves and Tourism Growth, 2022 - 2025

4.1 The COVID-19 Gambit

The foundational moment of Albania's current tourism boom was the decision to open borders to foreign tourists on June 1, 2020, when most of the world had shut down international travel. The move was simultaneously a public health gamble, an economic lifeline, and a soft power maneuver. It positioned Albania as the reference destination for European summer travelers who had nowhere else to go. The gamble worked. Albania recorded a drop in foreign visitors of only 11% from 2019 to 2021, against a global average decline of 74% (UNWTO). Among countries with more than 5 million annual tourists, it ranked first globally for post-pandemic recovery. The image effect was decisive and long-lasting: the 2022 record of 7.5 million foreign tourists, 18% over the pre-pandemic peak, with an estimated 3.6 billion Euro for the Albanian economy, is the direct legacy of that opening.

4.2 Visa Diplomacy: Gulf States and China

Albania's geographic position and Muslim-majority identity have historically served as a bridge to the Arab and wider Muslim world, and governments have leaned into that affinity through targeted visa diplomacy. Seasonal visa-free schemes for Saudi Arabia, Oman, and Qatar covering the peak summer season have turned Gulf nationals into one of Albania's high-spending tourist segments. Relations with the UAE have deepened further: UAE investments reached 52 million Euro in 2024, a 280% jump on the prior year. Direct flights now connect Tirana to Dubai and Abu Dhabi, and the visit by UAE President Mohammed bin Zayed Al Nahyan to Tirana in February 2025 lifted the relationship to a new strategic level.

The January 2023 visa-free agreement with China, allowing stays of up to three months without a visa, opened a previously inaccessible market. China is the world's largest source of outbound tourists, and the agreement followed seasonal visa-free pilots in 2018, 2019, and 2020. The effect was immediate. Arrivals from East Asia and the Pacific grew by roughly 172% in the first seven months of 2023 compared with the same period in 2022, the largest growth rate of any source region.

4.3 Performance Data, 2022 - 2025

Albania's tourism performance from 2022 to 2025 is one of the more remarkable development stories in recent European tourism history. In 2022, the country recorded 7.5 million foreign tourists, an 18% increase over the pre-pandemic record. In 2023, arrivals climbed to roughly 10.2 million, a 35% year-on-year increase, while net tourism revenue reached 1.84 billion Euro. Growth continued in 2024 with 11.7 million arrivals, a 15.2% increase, and tourism revenues touching 3.8 billion Euro in the first nine

months alone, contributing roughly 20% of GDP. Albania was ranked Europe's fastest-growing tourism destination, with an 86% growth rate compared to pre-pandemic levels. In 2025, INSTAT confirmed another record: 12.47 million foreign arrivals (a 6.3% increase, deliberately moderated toward quality over volume) and a record 5.7 billion Euro in foreign tourist spending, a 15% increase over 2024 and the highest tourism revenue figure ever recorded in the country's history. Average spend per foreign visitor climbed to 460 Euro in 2025, up from 427 Euro in 2024. The trajectory has lined up almost perfectly with Albania's most intensive period of diplomatic activity.

Table 1. Albania foreign tourist arrivals and key diplomatic context, 2019 - 2025

Year	Foreign Arrivals	Key Diplomatic Context
2019	~6.4 million (pre-pandemic record)	EU candidate, NATO member
2020	~2.6 million (pandemic)	Border reopened June 2020
2021	~5.7 million	First post-pandemic recovery
2022	7.5 million (new record)	Open Balkan active; new record post-COVID
2023	~10.2 million	China visa-free; EU negotiations accelerate
2024	11.7 million	UAE strategic partnership; WTTC #1 in Europe
2025	12.47 million	5.7B Euro revenue record; Iran conflict redirects tourists

4.4 Digital Diplomacy and Social Media

Digital tourism promotion has become hard to separate from the diplomatic toolkit that small nations rely on. Actually, for Albania, several things came together at once: euro-atlantic integration brought EU digital standards, unrestricted access to global platforms, and a more transparent regulatory environment, while short-form video on TikTok and Instagram exploded in parallel. The combination produced a tourism promotion effect that no conventional advertising budget could have replicated. Diaspora artists like Dua Lipa, Rita Ora, and Bebe Rexha, who publicly celebrate their Albanian heritage to combined global audiences in the hundreds of millions, have functioned as an unpaid, highly credible ambassador corps. Research on the 2023 tourism surge identifies this social media effect as one of the three primary drivers of growth alongside visa liberalization and regional integration. The tricky part is that this digital dimension is itself a product of international relations. A closed Albania wouldn't have the platform access, the diaspora visibility, or the credible international image needed to use digitalization as a tourism instrument.

5. The Albania - Serbia Case

The Albania - Serbia relationship is a useful test case, both for what diplomatic normalization can do and where it still hits a wall. The legacy of the Kosovo conflict, deep nationalist narratives, and inflammatory incidents like the drone moment during the September 2014 Euro qualifier in Belgrade looked at the time like insurmountable barriers. Yet exactly one month after that incident, Prime Minister Edi Rama travelled to Belgrade, the first visit by an Albanian prime minister in 68 years. That opening launched a normalization process which, despite resistance from nationalist quarters on both sides, has produced remarkable tourism outcomes.

Between the leaders, things have looked broadly constructive. Among populist counterparts, less so. Serbian nationalist politicians have publicly discouraged citizens from visiting Albania. The practical response of Serbian tourists was unambiguous. Arrivals grew from roughly 3,000 to 6,000 per year in 2018 - 2019 to an estimated 110,000 in 2023, and over 150,000 by 2025, with a 16% growth rate in January - July 2025 and a 28% surge in July alone. As one Albanian operator working with the Serbian market put it, "the tens and hundreds of statements of politicians absolutely can't be louder and more powerful than the tens of thousands of tourists who have already been in Albania." The Open Balkan initiative's removal of passport requirements between Serbia and Albania from January 2021 created the structural conditions that made this flow possible.

Albanian Foreign Minister Ferit Hoxha's bilateral meeting with Serbia's Foreign Affairs Minister Marko Đurić in May 2026, focused on economic ties, consular expansion, and bilateral cooperation, represents the quiet maintenance work that keeps the normalization architecture standing. In this case, tourism has been both a beneficiary and an accelerant of diplomatic progress. The sector has outpaced political resistance, creating facts on the ground that make backsliding increasingly costly.

6. Wars and Their Destructive Toll on Tourism

6.1 The Russia - Ukraine War

The Russia - Ukraine war, in its full-scale invasion phase since February 2022, has done deep and lasting damage to European tourism. Research published in *Current Issues in Tourism* (2026), using difference-in-differences across 27 European countries, confirms that nations neighboring the conflict zone experienced significantly larger tourism declines than non-neighboring countries. The impact spread far beyond the directly involved states. Ukraine, which contributed roughly 70,000 tourists to Albania in

2021 alone, effectively stopped functioning as both a tourist-sending and tourist-receiving country after February 2022. The war's inflationary shockwaves - energy price spikes, supply chain disruptions, reduced household disposable income - created structural headwinds for European tourism throughout 2022 and 2023. With no ceasefire in sight, those costs keep accumulating.

6.2 The Iran War and the Middle East Collapse

The escalation involving the United States, Israel, and Iran from late February 2026 has triggered what Oxford Economics describes as a potential 11 - 27% decline in international arrivals to the Middle East in 2026 - a loss of 23 to 38 million visitors and between 34 billion and 56 billion dollars in tourism spending in a single year. The WTTC estimates that every day of war costs the Middle East tourism industry approximately 515 million Euro, against a regional sector valued at 367 billion Euro annually. Before the conflict, the Middle East and North Africa had been, in UNWTO's words, "one of the fastest-growing tourism regions in the world", with nearly 100 million international travelers in 2025. That momentum has been wiped out almost overnight.

The physical effects on aviation have been severe. Within 48 hours of the February 2026 escalation, over 5,000 flights were cancelled. Within four days, the count exceeded 19,000. Airspace closures over Israel, Iran, Iraq, Kuwait, Qatar, Bahrain, and the UAE shut down some of the busiest aviation corridors in the world. Gulf airports, which handle roughly 14% of all global passenger traffic, were effectively closed. The war's reach extends well beyond the Middle East. The Eastern Mediterranean - Cyprus, Turkey, Greece - has absorbed spillover anxiety from European holidaymakers now switching to what travel agencies describe as "familiar, easy-to-reach locations": Spain, Italy, Malta, Croatia, and "consolidating emerging destinations such as Albania and Montenegro." Albania, already on a record-breaking trajectory, is well positioned to absorb a portion of that displaced demand thanks to geography, established Gulf-state diplomacy, and a competitive price point that still surprises first-time visitors.

7. Conclusions and Policy Implications

Albania's tourism trajectory from 2022 to 2025 - from 7.5 million to 12.47 million visitors, from 3.6 billion Euro to 5.7 billion Euro in foreign tourist spending - is more than a success story for one small Balkan country. It's a proof of concept for the economic value of strategic international relations. NATO membership provided the security guarantee. EU accession negotiations drove institutional reform and Western European market access. Visa liberalization opened the Gulf and East Asian markets. The Open Balkan initiative reduced regional friction. And the normalization process with Serbia, contested as it's, showed that diplomatic progress generates real economic gains even when politics resist.

The contrast with the Russia - Ukraine and Iran conflicts is deliberately instructive. These wars have devastated the tourism industries of the directly involved countries and imposed significant negative externalities on the entire international tourism system, from Eastern Europe to the Gulf. The cost of diplomatic failure, in tourism revenue alone, runs into hundreds of billions of dollars each year.

For policymakers in Albania and across the Balkans, a few practical implications follow. Visa liberalization should continue to be treated as a high-take advantage of development instrument. Market diversification toward Western European and East Asian visitors needs to keep moving so the sector reduces structural dependence on diaspora tourism. The Open Balkan initiative deserves deepening and expansion. And tourism should be explicitly integrated into bilateral diplomatic agendas, not only as economic policy but as a tool of people-to-people reconciliation. The Iran conflict's displacement of Middle Eastern tourists toward Europe, and specifically toward emerging Mediterranean destinations, is an immediate window that Albanian foreign policy and tourism promotion authorities should use while it's open.

Diplomacy, in the end, isn't overrated. As Albania's experience shows, it's the foundation that sustainable development, including tourism development, gets built on.

Bibliography

1. Teshaboyeva, N. Z., & Aliyeva, S. A. (2025). Tourism and International Relations: Factors That Influence Tourism Industry Promotion. *Ta'lim Innovatsiyasi Va Integratsiyasi*, 58(2), 251 - 256.
2. Antoniou, A. Tourism as a Form of International Relations: An Introduction. University of Teramo.
3. World Tourism Forum Institute. (2024). *The Interplay Between Foreign Policy and Tourism: A Strategic Nexus*.
4. Özgür, H. (2025). *Diplomacy and Tourism in 19th - 20th Century Europe: Historical Interactions and Contemporary Implications*.
5. Chiu, C.-N. (2026). The cost of war and peace: evidence from the impact of Russia - Ukraine war on European tourism. *Current Issues in Tourism*, 29(6), 1216 - 1226.

6. Yang, J. (2019). *Analyzing the Effects of International Tourism on Soft Power*. Capstone Paper. University of San Diego.
7. Domyshche-Medyanyk, A., et al. (2025). *The Impact of War on Ukraine's Tourism Sector: Global Challenges and Implications*. *International Journal of Contemporary Economics and Administrative Sciences*, 15(1), 274 - 295.
8. Sadowski, S. *Tourism as a Soft Power Tool: The Role of Public Diplomacy in Tourism*. *Journal of Tourism and Services*.
9. Burlea-Schiopoiu, A.; Ozuni, F. *The Potential of Albanian Tourism Sector*. *Sustainability* 2021, 13, 3928. <https://doi.org/10.3390/su13073928>
10. Lena, O. (2022). *Tourism and Hospitality in Albania 2022*. UNDP Albania / Albanian Tourism Association. Tirana: UNDP.
11. Musabelliu, M. (2023). *Tourism and Albania in 2023: Welcoming, Reshaping, Projecting*. China-CEE Institute Briefing, Vol. 65, No. 3.
12. INSTAT - Albanian Institute of Statistics. (2022 - 2026). *International Tourism Arrivals Statistics*. Tirana: INSTAT. <https://www.instat.gov.al>
13. Bank of Albania. (2025). *Balance of Payments Statistics, Travel Item, Q3 2025*. Tirana: Bank of Albania. <https://www.bankofalbania.org>
14. World Travel & Tourism Council (WTTC). (2024). *Albania's Travel & Tourism Sector Bursts onto the World Stage*. London: WTTC.
15. OECD. (2020). *Rebuilding Tourism for the Future: COVID-19 Policy Responses and Recovery*. Paris: OECD.
16. European Commission. (2021). *Key Findings of the 2021 Report on Albania*. Brussels: European Commission.
17. Oxford Economics. (2026). *Tourism Impacts in the Middle East from the Iran War*. Oxford: Oxford Economics.
18. WTTC. (2026). *Middle East Tourism Loss Estimates*. Cited in: Euronews, 10 March 2026.
19. Reuters. (2026, March 3). *Iran conflict threatens Gulf tourism, undermining years of investment*.
20. EConStor / UTM Skopje. *Open Balkan Initiative: Prospects for Tourism Development*. *Journal of Economics*, Vol. 13, No. 2.
21. Albanian Ministry for Europe and Foreign Affairs. (2026). *Minister Hoxha Met with Serbia's Foreign Affairs Minister Đurić*. <https://ambasadat.gov.al>
22. INSTAT Tourism Review. (2025). *Albania's Tourism Benefits from Serbian Visitors*.
23. Spanish Tourism Board / European Travel Commission. Cited in: Euronews Travel, 19 March 2026.
24. The Guardian. (2026, March 14). *War Prompts Europeans to Switch Holidays Away from Eastern Mediterranean*.
25. DW / Deutsche Welle. (2026, March 6). *US - Israel War on Iran Could End Middle East Tourism Boom*.
26. Travel and Tour World. (2026, April 4). *Europe Seizes the Easter 2026 Travel Boom as Iran War Shatters Middle East Tourism*.

MODERN TRENDS IN THE DEVELOPMENT OF THE REAL ESTATE OF THE REPUBLIC TAJIKISTAN IN THE
CONTEXT OF ECONOMIC DIGITALIZATION

Safarova O.O.

Amirzoda M.O.

TTU named after academician M.S. Osimi, Dushanbe, Tajikistan

ТАМОЮЛҲОИ МУОСИРИ РУШДИ БОЗОРИ АМВОЛИ ҒАЙРИМАНҚУЛИ ҶУМҲУРИИ ТОҶИКИСТОН
ДАР ШАРОИТИ РАҚАМИКУНОНИИ ИҚТИСОДИЁТ

Сафарова О.О.

Амӯрзода М.О.

ДТТ ба номи академик М.С.Осимӣ, Душанбе, Тоҷикистон

УДК 332.7:004.9

СОВРЕМЕННЫЕ ТЕНДЕНЦИИ РАЗВИТИЯ РЫНКА НЕДВИЖИМОСТИ РЕСПУБЛИКИ ТАДЖИКИСТАН В
УСЛОВИЯХ ЦИФРОВИЗАЦИИ ЭКОНОМИКИ

Сафарова О.О.

Амӯрзода М.

ТТУ имени академика М.С.Осими, город Душанбе,

Республика Таджикистан

Abstract

The article examines the development trends of the modern real estate market of the Republic Tajikistan in the context of economic digitalization. Special attention is paid to the analysis of macroeconomic indicators, the development of the construction sector, and the impact of digital technologies on the real estate market. Based on statistical data for 2020-2024, the main trends in the growth of the construction industry, investments, and housing construction have been identified.

Шарҳи мухтасар

Дар мақола тамоюлҳои рушди бозори муосири амволи ғайриманқули Ҷумҳурии Тоҷикистон дар шароити рақамикунонии иқтисодиёт мавриди таҳқиқ қарор дода шудаанд. Ба таҳлили нишондиҳандаҳои макроиқтисодӣ, рушди бахши сохтмон ва таъсири технологияҳои рақамӣ ба бозори амволи ғайриманқул диққати махсус дода шудааст. Дар асоси маълумоти омӯрӣ барои солҳои 2020-2024 тамоюлҳои асосии рушди соҳаи сохтмон, сармоягузорӣ ва сохтмони манзил муайян карда шудаанд.

Аннотация

В статье исследуются тенденции развития современного рынка недвижимости Республики Таджикистан в условиях цифровизации экономики. Особое внимание уделено анализу макроэкономических показателей, развитию строительного сектора и влиянию цифровых технологий на рынок недвижимости. На основе статистических данных за 2020-2024 гг. выявлены основные тенденции роста строительной отрасли, инвестиций и жилищного строительства.

Keywords: real estate market, digitalization, construction, investments, electronic cadaster, BIM technologies, smart city, digital economy, Tajikistan

Калидвожаҳо: бозори амволи ғайриманқул, рақамикунонӣ, сохтмон, сармоягузорӣ, кадастри электронӣ, технологияҳои BIM, smart city, иқтисоди рақамӣ, Тоҷикистон.

Ключевые слова: рынок недвижимости, цифровизация, строительство, инвестиции, электронный кадастр, BIM – технологии, smart city, цифровая экономика, Таджикистан.

Развитие рынка недвижимости является важным фактором экономического роста государства, поскольку данная отрасль тесно связана со строительством, инвестициями, банковским сектором и социальной инфраструктурой. В современных условиях цифровизация становится одним из значимых факторов повышения эффективности функционирования рынка недвижимости, который в свою очередь оказывает значительное влияние на инвестиционную активность, уровень урбанизации, развитие строительной отрасли и качество жизни

населения В условиях глобальной цифровой трансформации особую актуальность приобретает внедрение цифровых технологий в процессы управления недвижимостью, государственного регулирования и строительного производства.

В Республике Таджикистан развитие цифровой экономики определено одним из приоритетных направлений государственной политики. Постановлением Правительства Республики Таджикистан № 642 от 30 декабря 2019 года утверждена Концепция цифровой экономики Республики Таджикистан [1], предусматривающая внедрение цифровых технологий во все отрасли экономики. В 2026 году также была утверждена Среднесрочная программа развития цифровой экономики на 2026 – 2030 годы, ориентированная на ускорение цифровой трансформации отраслей экономики и государственного управления [2].

На фоне активной урбанизации, роста жилищного строительства и повышения инвестиционной активности возникает необходимость модернизации рынка недвижимости на основе цифровых решений.

Рынок недвижимости Республики Таджикистан в последние годы характеризуется устойчивым ростом объемов жилищного строительства, расширение городской инфраструктуры и увеличением спроса на жилую и коммерческую недвижимость. Особенно активное развитие наблюдается в крупных городах, прежде всего в Душанбе, где формируются новые жилые комплексы, деловые центры и объекты инфраструктуры. Одновременно с этим сохраняется ряд системных проблем:

- недостаточная прозрачность рынка;
- ограниченный доступ к достоверной информации о недвижимости;
- высокий уровень бумажного документооборота;
- низкая степень автоматизации кадастровых и регистрационных процедур;
- недостаточное развитие цифровых платформ.

В условиях цифровой экономики данные проблемы становятся существенным барьером для повышения инвестиционной привлекательности отрасли.

Для оценки тенденций развития рынка недвижимости необходимо проанализировать основные макроэкономические показатели Республики Таджикистан за 2020-2024 гг., представленные в таблице 1.

Таблица 1. – Основные макроэкономические показатели РТ за 2020-2024 гг.

№ п/п	Показатель	Ед.изм.	Годы					Темп роста 2024 к 2020 г, %
			2020	2021	2022	2023	2024	
1	2	3	4	5	6	7	8	9
1.	ВВП	млн. сомони	86958,3	101076,3	118181,7	132781,9	153402,2	176,4
2.	ВВП на душу населения	сомони	8922,2	10312	11838,8	13039,2	14597,9	163,61
3.	Уровень инфляции	%	8,5	9,0	6,6	3,7	3,5	
4.	Доходы на душу населения	сомони	6725,156	8143,059	9438,472	11733,24	13940,77	207,2
5.	Инвестиции в основной капитал	млн. сомони	11775,5	15124,9	16655,2	20699,8	23042,3	195,7

Составлена автором. Статистический ежегодник РТ, 2025 г.

Таблица 1 показывает общую экономическую среду, влияющую на рынок недвижимости. Данные таблицы свидетельствуют о положительной динамике социально-экономического развития Республики Таджикистан. За исследуемый период объем ВВП увеличился с 86958,3 млн.сомони в 2020 году до 153402,2 млн.сомони в 2024 году, где темп прироста составил 76,4 %. Это свидетельствует об устойчивом экономическом росте страны, который оказывает непосредственное влияние на развитие рынка недвижимости и строительного сектора.

Показатель ВВП на душу населения также демонстрирует устойчивую положительную динамику. В 2024 году он достиг 14597,9 сомони против 8922,2 сомони против 2020 году. Рост доходов населения способствует увеличению платежеспособного спроса на жилье и коммерческую недвижимость. Доля строительной отрасли в ВВП за рассматриваемый период сохраняется в пределах 8 %, что подтверждает стратегическую роль рынка недвижимости в социально-экономическом развитии Республики Таджикистан.

Особое значение имеет снижение уровня инфляции с 9,0 % в 2021 году до 3,5 % в 2024 году. Стабилизация инфляционных процессов создает более благоприятные условия для долгосрочных инвестиций в недвижимость и повышает устойчивость строительного рынка.

Доходы на душу населения за рассматриваемый период выросли более чем в два раза. Данный фактор положительно влияет на развитие ипотечного кредитования, расширение жилищного строительства и активизацию операций на рынке недвижимости.

Инвестиции в основной капитал за рассматриваемый период увеличились с 11775,5 млн. сомони до 23042,3 млн. сомони. Рост инвестиционной активности свидетельствует об усилении роли капитального строительства и инфраструктурных проектов в экономике страны.

Таким образом, макроэкономические показатели подтверждают наличие объективных предпосылок для дальнейшего развития рынка недвижимости Республики Таджикистан, включая внедрение цифровых технологий и электронных систем управления.

Развитие рынка недвижимости тесно связано с динамикой строительного сектора (Таблица 2).

Таблица 2. – Показатели развития строительного сектора РТ за 2020-2024 гг.

№ п/п	Показатель	Ед.изм.	Годы				
			2020	2021	2022	2023	2024
1	2	3	4	5	6	7	8
1.	Объем строительных работ	тыс. сомони	17895642,3	225001076,3	24597325,7	30154695,2	33155074,6
2.	Ввод жилья	тыс.м ²	1463,4	1546,0	1739,5	1823,0	1796,7
3.	Инвестиции в строительство	млн. сомони	2378,7	4261,7	4508,5	6367,7	7457,5
4.	Доля строительства в ВВП	%	10,6	11,3	11,2	11,2	8
5.	Операции с недвижимым имуществом	млн. сомони	1103,3	1228,9	1323,0	1339,3	1340,1

Статистический сборник -Строительство в Республике Таджикистан, 2025г.

Развитие рынка недвижимости тесно связано с динамикой строительного сектора, уровнем инвестиционной активности и операциями с недвижимым имуществом. Анализ данных таблицы 2 позволяет выявить основные тенденции развития строительной отрасли Республики Таджикистан.

Согласно данным таблицы, объем строительных работ увеличился в 2024 году по сравнению с 2020 г. (33,2 млрд. сомони), прирост составил 85 %. Это свидетельствует об активизации инвестиционно-строительной деятельности, расширении жилищного строительства, росте спроса на недвижимость.

Показатель ввода жилья также демонстрирует положительную динамику. Если в 2020 году было введено 1463,4 тыс.м² жилья, то в 2023 году показатель достиг максимального значения – 1823,0 тыс.м², а в 2024 году наблюдается незначительное снижение до 1796,7 тыс.м², что может быть связано с ростом стоимости строительных материалов, увеличение себестоимости строительства, инфляционными процессами, изменением инвестиционной конъюнктуры. Несмотря на небольшое снижение, объем жилищного строительства остается высоким. Это свидетельствует о сохранении спроса на жилую недвижимость, продолжении процесса урбанизации, развитии жилищной инфраструктуры.

Инвестиции в строительство за анализируемый период увеличились более чем в 3,1 раза (с 2378,7 млн.сомони до 7457,6 млн.сомони). Рост инвестиционной активности формирует основу для дальнейшего развития современного рынка недвижимости.

Доля строительства в ВВП в течение 2020-2023 гг. сохранялась на достаточно высоком уровне – 10,6 – 11,3 %. Это подтверждает о значительном вкладе строительной отрасли в экономику страны, высоком уровне капиталобразования, активном развитии инвестиционно-строительных процессов. Снижение удельного веса строительства в ВВП в 2024 году связано с более быстрым ростом других отраслей экономики, увеличением общего объема ВВП, структурными изменениями экономики.

Объем операций с недвижимым имуществом увеличился с 1103,3 млн.сомони в 2020 году до 1340,1 млн.сомони в 2024 году, что свидетельствует о сохранении положительной динамики рынка недвижимости году. Рост операций с недвижимым имуществом отражает повышение рыночной активности, увеличение количество сделок купли-продажи, развитие арендных отношений, расширение инвестиционного спроса на недвижимость

Для оценки финансовых факторов развития рынка недвижимости необходимо проанализировать динамику кредитования экономики и ипотечного сектора Республики Таджикистан.

Таблица 3. - Информация о выданных кредитах по отраслям экономики Республики Таджикистан за 2024-2025 гг.

№ п/п	Отрасли	Январь-ноябрь 2024 г.		Январь-ноябрь 2025 г.		Темп роста, %	Изменение (+увелич/- снижение)
		млн. сомони	%	млн. сомони	%		
1	2	3	4	5	6	7	8
	Всего	21864,8	100	26724,0	100	122,2	
1.	Промышленность	2828,0	12,9	2257,7	8,4	79,8	-4,5
2.	Сельское хозяйство	2807,0	12,8	3165,3	11,8	112,8	-1,0
3.	Строительство	884,2	4,0	1267,2	4,7	143,3	+0,7
4.	Транспорт	130,2	0,6	148,8	0,6	114,3	0
5.	Услуги	1693,9	7,8	2134,7	8,0	126,0	+0,2
6.	Торговля и общественное питание	3049,9	14,0	3837,2	14,4	125,8	+0,4
7.	Потребление	7916,7	36,2	10716,2	40,1	135,4	+3,9
8.	Ипотека (покупка жилья, капитальный ремонт)	1485,7	6,8	1808,2	6,8	121,7	0
9.	Автокредит	752,8	3,5	983,4	3,7	130,6	+0,2
10.	Другие	317,0	1,4	405,3	1,5	127,9	+0,1

Статистический сборник - Социально-экономическое положение Республики Таджикистан, 2025 г.

Данные таблицы 3 свидетельствуют об активном расширении кредитного рынка Республики Таджикистан. Общий объем выданных кредитов увеличился с 21864,8 млн. сомони до 26724,0 млн. сомони, что соответствует приросту в 22,2 %. Наиболее высокий рост наблюдается в строительстве, в потребительском кредитовании, в автокредитовании. Особый интерес представляет динамика кредитования строительной отрасли, прирост в 43,3 % свидетельствует об активации инвестиционных процессов и расширении строительной деятельности. Это напрямую связано с развитием рынка недвижимости, увеличением спроса на жилье и инфраструктурные объекты.

Ипотечное кредитование является одним из ключевых механизмов развития современного рынка недвижимости. Согласно представленным данным, темп роста объема ипотечных кредитов в 2025 году составил 121,7 %, что свидетельствует о постепенном расширении ипотечного рынка в стране. Этот рост обусловлен рядом факторов, таких как: увеличение доходов населения, рост потребности в жилье, расширение жилищного строительства, развитие банковских услуг, усиление урбанизации.

Ипотека играет важную роль в стимулировании спроса на жилую недвижимость, инвестиционной активности, строительного производства, развития городской инфраструктуры. Одновременно ипотечное кредитование способствует мультипликативному эффекту в экономике, поскольку развитие рынка жилья стимулирует производство строительных материалов, транспортные услуги, архитектурно-проектную деятельность, цифровые сервисы недвижимости.

Структурный анализ показывает, что наибольшую долю в кредитном портфеле занимает потребительское кредитование – 40,1 % в 2025 году. Доля строительного сектора увеличилась с 4,0 до 4,7 %, что подтверждает усиление роли строительства в экономике страны.

Особое внимание заслуживает стабильная доля ипотечного кредитования – 6,8 %. Несмотря на рост абсолютного объема ипотечных кредитов, их удельный вес в общей структуре кредитования остается неизменным. Это означает, что ипотечный рынок развивается параллельно с общим ростом банковского кредитования, однако пока не демонстрирует опережающего роста, пока остается относительно ограниченным по сравнению с развитыми странами. Основными проблемами являются:

- высокие процентные ставки;
- ограниченная доступность долгосрочных кредитов;
- недостаточный уровень доходов населения;
- ограниченность цифровых ипотечных платформ.

В современных условиях цифровизация способна существенно повысить эффективность ипотечного кредитования.

Наиболее перспективными направлениями являются:

- электронная подача ипотечных заявок;

- цифровая идентификация клиентов;
- онлайн-оценка недвижимости;
- интеграция банковских и кадастровых систем;
- электронная регистрация сделок;
- использование Big Data для оценки платежеспособности заемщиков.

Внедрение цифровых ипотечных платформ позволит сократить сроки оформления кредита, снизить транзакционные издержки, повысить доступность ипотеки, увеличить прозрачность операций на рынке недвижимости.

Анализ статистических показателей показывает, что дальнейшее развитие рынка недвижимости невозможно без комплексной трансформации отрасли. Цифровизация рынка недвижимости представляет собой процесс внедрения информационно-коммуникационных технологий в операции купли-продажи, аренды, оценки регистрации и управления объектами недвижимости.

Под цифровизацией в сфере недвижимости понимается интеграция цифровых технологий и платформ для оптимизаций процессов, повышения эффективности и общей прозрачности отрасли [4].

В таблице 4 приведены наиболее перспективные направления процесса цифровизации.

Таблица 4. – Основные направления цифровизации рынка недвижимости

№ п/п	Цифровые технологии	Результат
1	2	3
1.	Электронные платформы недвижимости	Создание единой цифровой платформы позволит автоматизировать: - регистрацию недвижимости; - сделки купли-продажи; - аренду; - кадастровый учет; - оценочную деятельность.
2.	BIM - технологии	Внедрение BIM-моделирования способствует: - сокращению строительных затрат; - повышению качества проектирования; - управлению жизненным циклом объекта недвижимости
3.	Геоинформационные системы (GIS)	Использование GIS – технологий обеспечивает: - пространственный анализ территорий; - цифровое планирование городской среды; - мониторинг земельных ресурсов.
4.	Smart City	Концепция «умного города» предполагает цифровое управление: - транспортной инфраструктурой; - коммунальными системами; - жилыми комплексами; - энергетическими ресурсами.
5.	Технологии больших данных – Big Data	Применение технологий больших данных позволяет осуществлять: - прогнозирование спроса на недвижимость; - анализ динамики цен на рынке; - оценку инвестиционной привлекательности объектов; - оценку платежеспособности заемщиков.

Проведенный анализ позволяет сделать следующие выводы:

1. Макроэкономические показатели Республики Таджикистан демонстрируют устойчивую положительную динамику, создающую условия для развития рынка недвижимости.

2. Строительный сектор характеризуется высоким уровнем инвестиционной активности и ростом объемов строительства.

3. Развитие рынка недвижимости сопровождается необходимостью внедрения цифровых технологий и электронных сервисов.

4. Основными направлениями цифровизации являются BIM – технологии, электронный кадастр, цифровые платформы недвижимости, Smart City.

5. Цифровая трансформация рынка недвижимости способствует:

- повышению прозрачности рынка;
- снижению транзакционных издержек;
- росту инвестиционной привлекательности;
- повышению эффективности государственного управления.

Заключение

Таким образом, современный рынок недвижимости Республики Таджикистан развивается в условиях активного экономического роста и расширения строительного сектора. Анализ статистических данных показал устойчивое увеличение объемов строительства, инвестиций и доходов населения. Вместе с тем, дальнейшее эффективное развитие рынка недвижимости невозможно без масштабной цифровизации отрасли. Внедрение современных цифровых технологий позволит повысить конкурентоспособность строительного комплекса, обеспечить прозрачность операций и создать условия для устойчивого социально-экономического развития страны.

Литература

1. Концепция цифровой экономики Республики Таджикистан, утвержденная постановлением Правительства Республики Таджикистан от 30 декабря 2019 года № 642
2. Среднесрочная программа развития цифровой экономики Республики Таджикистан на 2026 – 2030 годы. - Душанбе, 2025
3. Стратегия развития строительной отрасли Республики Таджикистан на период до 2030 года, от 27 апреля 2022 года № 203
4. Зеленков Т.В. Цифровая трансформация рынка недвижимости.// Электронная библиотека Института бизнеса БГУ, Минск, Беларусь. 2024.

IMPACT OF THE NEW FISCAL POLICIES (2024–2025) ON BUSINESS IN ALBANIA: CONSOLIDATION AND CHALLENGES OF THE FISCALIZATION SYSTEM

Xhenisa Myshketa

MSc., Assistant lecturer of Accounting, Finance and Accounting Department, University "Aleksandër Moisiu", Durrës, Albania, Business Risk Officer, Union Bank, Albania

Abstract

A healthy economy of a country is always related to the governance of a country. Since the time of Adam Smith, to this day we continue to strongly believe that the state is the one that plays a key and useful role in regulating the economic situation of a country and the tool that the state has to play the role of regulator is precisely **fiscal policy**. This is what we will analyze in this paper: The role and how the fiscal policies during 2024-2025 have affected the business in Albania. A general analysis of the economic situation. What impact do fiscal policies have on businesses, how interested are taxpayers in getting to know the changes that **government** is making at the beginning of the year? A special part of the work is the **fiscalization** process. A whole new process, a way to adapt and develop in the same way as the neighboring countries, but a bit chaotic in the system we are in. We are a country that has often changed the **fiscal system** as it seems we have not yet found the right path. But what impact does this have on businesses in Albania? How do they expect it and the measures they are taking to cope with the new fiscal situation?

Keywords: *fiscal policy, government, business, fiscalization, system*

TABLE OF CONTENTS

Chapter 1: How fiscal policy works in Albania?

- 1.1. What are the challenges of fiscal policy?
- 1.2. How fiscal policy affects business?

Chapter 2: The impact of fiscal policy 2024-2025 in Albania

- 2.1. The fiscal framework in 2024-2025 and its macroeconomic impact
- 2.2. Current fiscal policy vs. previous fiscal policies
- 2.3. Challenges faced by SME businesses due to fiscal packages

Chapter 3: Fiscalization

- 3.1. What is fiscalization?
- 3.2. Why did the need for the fiscalization system arise?
- 3.3. What are the benefits of fiscalization?
- 3.4. What does an electronic invoice contain?
- 3.5. How does the registration of sales and purchase books work?
- 3.6. What does the fiscalization procedure consist of?
- 3.7. What happens in case of internet connection interruption?
- 3.8. How is the fiscalization of corrective/rectifying invoices performed?

Chapter 4: Summary

Chapter 5: References

ABBREVIATIONS:

- GDP** – Gross Domestic Product
C – Private Consumption
I – Investments
G – Government Expenditures
NX – Net Exports
MoF – Ministry of Finance
GDT – General Directorate of Taxes
RDT – Regional Directorate of Taxes
CIT – Corporate Income Tax
VAT – Value Added Tax
NAIS – National Agency for Information Society (AKSHI)

RESEARCH METHODOLOGY

Objectives:

- ✓ To understand the concept of fiscal policy and the role of government in economic development.
- ✓ To examine how changes in fiscal policies have affected businesses in the country.
- ✓ To make a comparison between the economic situation at the beginning and after the 2025 fiscal package.
- ✓ To understand how well-informed businesses are regarding the fiscalization process.
- ✓ To assess how ready businesses are to adapt to fiscalization.

Purpose:

The purpose of this study is to understand how well taxpayers are informed regarding the fiscal packages applied by the government at the beginning of each year. We analyze how much the information level of taxpayers regarding legal changes impacts the effectiveness of these fiscal packages. Furthermore, this work aims to evaluate how prepared businesses in Albania are for the fiscalization process. What are the main challenges and problems to be encountered in this process, and what are the benefits derived from fiscalization?

Methodology:

To conduct this study, a methodology consisting of a combination of primary and secondary data has been used. A significant portion of the secondary data was obtained through the use of electronic libraries of various universities. Additionally, various websites featuring studies on fiscal policies and the official pages of the Ministry of Finance, which publish updates on the tax system, served as an important source.

Chapter 1 – How fiscal policy works in Albania?

1.1. What are the "challenges" of fiscal policy in our country?

One of the main issues is determining the volume and direction of government expenditures, not only to provide specific services but also to align public spending with the general pattern of total expenditures currently occurring in the economy. These objectives are not always aligned, particularly those related to price stability and full employment.

The objective of equitable income distribution may conflict with the objectives of economic efficiency and economic growth. Fiscal policy can be directed toward transferring wealth from the rich to the poor through taxation to achieve income redistribution; however, transferring income from the rich to the poor will negatively affect savings and capital formation. Thus, equality and growth objectives clash.

Public expenditures include normal government spending, capital expenditures for public works, relief expenditures, subsidies of various kinds, transfer payments, and social security benefits. Government expenditures generate income, whereas taxes primarily reduce income. The management of public debt in most countries has also become an important tool of fiscal policy. It aims to influence total spending through changes in the holding of liquid assets. During inflation, fiscal policy aims to control excessive aggregate spending, while during a depression, it aims to supplement the lack of effective demand to lift the economy from the depths of the depression. The following considerations can be noted in adopting the appropriate policy instruments. Designing and implementing fiscal policies has its difficulties, as it is a complex process that must be examined in detail because the consequences are severe. We can mention two "challenges", if we may call them that, of fiscal policies:

Built-in Flexibility: A practical difficulty in public finance is making fiscal tools flexible enough for quick and effective use. For instance, the pace of business activity can change suddenly, manifesting in booms and recessions, but fiscal tools cannot be used immediately to address such situations. To overcome such practical difficulties, built-in flexibility must be provided within fiscal instruments. A fiscal system possesses built-in flexibility if a change in employment within the economy brings about a noticeable compensatory change in government revenues and expenditures. Unemployment insurance schemes have high flexibility on both the expenditure and taxation sides. However, built-in flexibility may be inadequate to cope with strong deflationary and inflationary pressures. Therefore, formula flexibility (or flexibility by executive judgment) is required. A system of formula flexibility provides for specific changes in the tax structure and the volume of government spending as required by certain clearly recognized problems in business activity. It requires administrative decisions regarding the necessary changes, which must be put into effect without delay.

Built-in stabilizers: The fact that both taxes and transfer payments automatically change with shifts in income levels is the basis of trust in built-in stabilizers. The term 'stabilizer' is used because they act in a way that counteracts fluctuations in economic activity. They are called 'built-in' because they automatically come into play when the income level changes. Taxes can act as a stabilizing influence on

the economic system if the tax structure is such that the amount of taxes collected by the government increases automatically with a rise in national income, because in this case, the effect will be to reduce the expansion of disposable income. From a stabilization perspective, this means slower growth in induced consumption. If the tax system is such that not only the absolute amount of tax revenue but also the percentage of income paid in taxes increases with a rise in income, its stabilizing impact will be greater. This occurs if the rate structure of the tax system is progressive, meaning effective rates increase as the income level rises. Similarly, various forms of transfer payments also act in a countercyclical manner. Only such transfer payments have a stabilizing effect, such as decreasing in amount when income rises and increasing when income falls. For example, when employment falls, payments to the unemployed increase automatically, thereby increasing disposable income, and vice versa. It would be too much to assume that these stabilizers alone can smooth out income fluctuations, but most would agree that they are effective complements to discretionary actions aimed at stabilizing the economy.

1.2 How fiscal policy affects business?

Businesses directly see the effects of an economy's fiscal policy, whether in the form of spending or taxation. Fiscal policy can have the following four effects on business:

1. **Investment opportunities:** Businesses can see investment opportunities from government spending as well as private investments. This usually happens during an expansionary policy, when more money is being poured into the economy by the government and other sources since taxation is also low. When a balance between price and demand is met, then businesses can expect to thrive and grow.

2. **Slower growth:** A contractionary financial policy may be initiated to prevent inflation when the equilibrium is disrupted and demand (and prices) fall. Businesses usually restrain their growth due to increased taxes and take measures to stay in the black with less money flowing through the economy.

3. **Tax changes:** Depending on their location, businesses face several levels of taxation, including local, state, and federal. Businesses must contend with how their state and government tax them and how it intersects with federal fiscal policy.

4. **Unemployment rate:** A key objective of fiscal policy is to minimize unemployment. For example, the government may cut taxes to put more money back into consumers' pockets. As such, people may be able to spend more money, and companies may face increased demand. With increased demand can come additional production tasks for companies to complete, and businesses may respond by creating more jobs and hiring more employees. As such, with the right fiscal policy in place, a low unemployment rate can gradually rise.

When policymakers seek to influence the economy, they have two main tools at their disposal: monetary policy and fiscal policy. Central banks indirectly target activity by influencing the money supply through adjustments to interest rates, bank reserve requirements, and the buying and selling of government securities and foreign currencies. Governments influence the economy by changing the level and types of taxes, the extent and composition of spending, and the degree and form of borrowing. Governments directly and indirectly influence how resources are used in the economy. A basic national income accounting equation that measures the output of an economy or gross domestic product (GDP) according to expenditures helps show how this happens:

$$GDP = C + I + G + NX$$

On the left side is GDP, which we know is the value of all final goods and services produced in the economy. On the right side are the sources of total spending or demand: private consumption (\$C\$), private investment (\$I\$), purchases of goods and services by the government (\$G\$), and exports minus imports (net exports, \$NX\$). This equation makes it clear that governments influence economic activity (GDP) by controlling \$G\$ directly and influencing \$C\$, \$I\$, and \$NX\$ indirectly through changes in taxes, transfers, and spending.

Fiscal policy that increases aggregate demand directly through an increase in government spending is typically called expansionary or "loose". Conversely, fiscal policy is often considered contractionary or "tight" if it reduces demand through lower spending. Aside from providing goods and services like public safety, highways, or primary education, the objectives of fiscal policy vary. In the short term, governments may focus on macroeconomic stabilization, for example, by expanding spending or cutting taxes to stimulate an economy in recession, or cutting spending or raising taxes to combat rising inflation or to help reduce external vulnerabilities. In the long term, the goal may be to foster sustainable growth or reduce poverty with supply-side actions to improve infrastructure or education. Although these objectives are widely shared across countries, their relative importance varies depending on country circumstances. In the short term, priorities may reflect the business cycle or the response to a natural disaster or a surge in global food or fuel prices. In the long term, factors may be development levels,

demographics, or natural resource endowments. The desire to reduce poverty may lead a low-income country to tilt spending toward primary healthcare, while in an advanced economy, pension reforms may target near-term long-term costs related to an aging population. In an oil-producing country, policymakers may aim to better align fiscal policy with broader macroeconomic developments by moderating procyclical spending, such as limiting spending surges when oil prices rise and smoothing cuts when they fall. Thus, the fiscal policies a country chooses to apply are influenced by many micro- and macroeconomic factors. Therefore, we say it is a complex process from the drafting of the plan to its implementation.

Chapter 2 – The impact of fiscal policy 2024-2025 in Albania

2.1. The fiscal framework in 2024-2025 and its macroeconomic impact

Following the financial contraction and various problems that the economic sphere in Albania faced in 2020 due to the pandemic, today we find ourselves in conditions where the macroeconomic environment deals with efforts and measures for stable economic growth (around 3.5%-3.8% of GDP), while not dismissing global challenges such as inflation and job cuts. One of the fundamental objectives of any country, not just Albania, is the drive toward reducing the budget deficit and lowering the public debt to a level below 60% of GDP. Therefore, we currently operate under stricter tax and fiscal policies, which have been heavily supported by the fiscalization process.

Their main impact has been concretized through the full implementation of the new Law No. 29/2023 "On Income Tax", which began its practical journey on January 1, 2024. This law not only altered and affected a broad segment of the economy, but specifically targeted the following groups:

1. **Taxation of freelancers (free professions):** Sole proprietors and small businesses providing services (accountants, lawyers, financial or legal consultants, dentists, doctors, etc.), who were previously taxed at 0%, are now required to pay a 15% tax rate for declared incomes up to 14,000,000 ALL, and a 23% tax rate for incomes exceeding this threshold. Naturally, this converted into an increase in tax expenditures for this sector.

2. **Revision of recognized expenses:** This is directly related to the recognition of the actual expenses of the entity, which translates into a reduction of net profit but a parallel increase in compliance costs, as this revision requires more advanced and thorough financial and accounting practices.

2.2. Current fiscal policy vs. Previous fiscal policies

It appears that the austerity measures and fiscal advancements introduced during the pandemic period, referring to the 2020 timeframe, paved the way for and enabled solid results, as well as even stricter measures in recent years. The proper functioning of this system and the accumulation of revenues generated from VAT and personal income tax have translated into stable revenue growth.

It must be asserted that this was achieved not only through measures of this nature, but also through:

- Reducing the possibility of manipulation or intervention in the monthly declarations of businesses, achieved thanks to the option of pre-filled declarations.
- The widespread utilization of pre-filled sales and purchase books generated automatically by the fiscalization system.
- Expanding the tax base, specifically focusing on the digital economy and incorporating short-term rentals into the invoicing scheme.

2.3. Challenges faced by SME businesses due to fiscal packages

One of the segments that remained relatively unaffected by the fiscal packages implemented in recent years has been large businesses and corporations; however, what waves of changes have crashed into SME businesses in our country? The SME segment encompasses small and medium enterprises, which represent the main engine of our domestic economy. Below are some of the challenges that these entities have encountered and are currently facing:

- Continuous and daily updates to the invoicing system in order to adapt to new policies and new electronic declarations.
- The increase in the minimum wage for employees (currently at 50,000 ALL, with a programmatic tendency to increase), which constitutes extra and higher expenses for the entity, as they are obliged to pay a higher base wage and higher social and health contributions, while also channeling all employee salaries through banks.
- Frequent changes in laws and instructions from the Ministry of Finance and the General Directorate of Taxes, which poses a risk for businesses, as any operational mistake is costly.
- Liquidity difficulties regarding VAT payments due to pre-filled schemes and declarations. If a business issues a fiscalized invoice and the client has not yet settled the payment, the system immediately

calculates the VAT liability for the following month, forcing the entity to pay taxes on an invoice that has not yet been liquidated.

If we summarize the above changes briefly, we see that fiscal policies do not only affect tax-paying businesses, but are comprehensive, extending from legal definitions of concepts down to individuals. These new reforms seem to have been carried out within the framework of reducing informal economy in the country. This is mainly intended to be achieved through the fiscalization process, which is expected to be highly effective, though it remains to be seen to what extent it will succeed.

Chapter 3 - Fiscalization

3.1. What is fiscalization?

As we all know, the fiscalization process has begun in our country. But what is it? How will it work? What are the changes that businesses must adapt to? Why did the need for this change arise? What is intended to be achieved? To address all these questions, we will perform an analysis, and to make it as concrete as possible, we will conduct a survey with businesses to see what they think and how informed they are, given that the fiscalization process for large businesses started on July 1st 2020.

3.2. Why did the need for the fiscalization system arise?

Almost all the businesses where we work use a fiscal cash register, which became mandatory in 2009, through which information was and continues to be sent to the General Directorate of Taxes via daily reports at the end of the day. According to experts, this is not a highly effective method since the information is not provided in real time, increasing the opportunity for tax evasion.

The new system is intended to create a mechanism for real-time monitoring of fiscal devices operating with or without cash. The issuance of a tax invoice will be registered and transmitted to the tax authorities in real time, and this can be verified at any moment by the citizen since the invoice will feature a QR code that can be scanned and sent to the relevant tax department. In this manner, the citizen receives immediate information confirming that this invoice has actually been declared for the exact value they paid, provided the data is accurate. This new system enables the relevant tax departments to have real-time information on businesses, making it easier to identify entities prone to cheating or concealing data, thereby avoiding unnecessary audits on compliant businesses.

Fiscalization is software-based, meaning it can be implemented on existing hardware without the strict need to add extra physical devices. The model chosen for this system was selected because it guarantees the application of the latest technology based on European Union standards, offering better adaptation capabilities for the structure of the Albanian economy. This model is used in many EU countries and has shown effectiveness in the region, so we hope it will have the same impact here, despite businesses being highly skeptical about it.

3.3. What are the benefits that come from Fiscalization?

Tax reduction: This will be achieved because there will now be more taxpayers. Even those who attempted to evade taxes will no longer have the opportunity; thus, businesses that used to pay for those who evaded will be relieved, and everyone will pay what they legally owe.

Reduction of informal economy: The primary goal of fiscalization is to reduce informality in the country, which we all know is at a high level, even if many refuse to admit it. This new process achieves better control and efficient tax inspection.

Assistance in identifying irregularities: Given that every citizen will have the ability to check invoices in real time, they can report any irregularities they identify.

Business modernization: We will see a minimization of bureaucracy and a modernization of business since everything will become technological.

EU Membership: The use of electronic invoicing is one of the conditions for EU accession.

Increased efficiency and effectiveness: Businesses save time; they will no longer need to manually submit VAT declarations every month, as they will be generated automatically upon the registration of electronic invoices.

3.4. What does an electronic invoice contain?

An electronic invoice must contain the following data to be valid:

1. the title "tax invoice" (faturë tatimore);
2. the date and time of invoice issuance;
3. the invoice number;
4. the unique identification number of the seller;
5. the name of the taxpayer/name and surname of the seller;
6. the address of the seller;

7. the unique identification number of the buyer, name of the taxpayer/name, surname, and address of the buyer. These details are mandatory only if the buyer is:

- a taxpayer, subject to corporate income tax, simplified income tax for small businesses, or subject to VAT, in accordance with the relevant legislation;

- a legal entity;

- an individual purchasing personal property with an individual value over 500,000 ALL;

- in other cases, when the buyer requests these details to be noted on the invoice;

8. the operator code, determined in accordance with Article 15 of this law;

9. the business location code, determined in accordance with Article 14 of this law;

10. the date or period in which the supply of goods or services was carried out, or the date on which the payment was made;

11. the quantity and description of the supplied goods or services and the unit price;

12. the full value;

13. any other applied increases or discounts (information on compensation or payment, if applicable);

14. the total value to be paid;

15. payment details, including the payment method (banknotes and coins, card, check, bank transaction, payment order, electronic money, or other cashless payment methods);

16. the currency and exchange rate, if the invoice is not expressed in the albanian national currency (LEK), and the payment deadline if the payment is not made at the moment of invoice issuance;

17. the Unique Invoice Identification Number (NIVF), expressed as an alphanumeric code;

18. the Invoice Issuer Security Number (NSLF), expressed as an alphanumeric code;

19. the QR code, which contains the data specified by the instruction of the Minister responsible for finance;

20. the applied VAT rate.

In the case of exporting goods outside the territory of the Republic of Albania, in addition to the information referred to above, the invoice must include the name of the taxpayer/name, surname, and address of the buyer, if they are a taxpayer or a legal entity in their country of residence, as well as the tax identification number issued in their country of residence. If the buyer is an individual who is not a taxpayer in their country of residence, their full name and the address where the goods are sent are recorded on the invoice.

If we look closely at all the points with the elements that a tax invoice must contain, we notice that the novelty, besides being electronic, lies in the inclusion of the NIVF and NSLF numbers, which are the unique invoice identification number and the security number of the invoice issuer. In addition to the descriptions and data provided, the electronic invoice contains process details, invoice identifiers, electronic addresses of the seller and the buyer on the central invoice platform, and where applicable:

- ✚ payment beneficiary details;

- ✚ details of the seller's tax representative;

- ✚ contract reference;

- ✚ delivery details;

- ✚ price details.

3.5. How does the registration of sales and purchase books work?

Within the framework of procedural updates in recent years, if the taxpayer does not perform the manual closure of the books in the SelfCare portal by the 10th day of the month, the fiscalization system automatically closes and transfers them on the 11th day to the e-Filing system. Furthermore, during the current period, this data serves to pre-fill the monthly VAT declaration automatically, reducing human errors and increasing real-time monitoring by the tax administration.

The sales book and purchase book on the central invoice platform must remain available to the taxpayer issuing invoices throughout the timeframe specified for invoice retention, according to the provisions in force for value-added tax legislation..

☞ **Invoices for cash payments:**

Invoices for cash payments must be printed on paper, contain all the aforementioned data, undergo the fiscalization procedure, and be delivered to the buyer at the moment of the supply of goods or services. In the case of supplying goods with transport, the transporter must hold the invoice issued by the seller throughout the duration of the transport of the goods, from the point of origin to the

destination or until delivery to the buyer, and are obliged to place this document at the disposal of central tax administration employees upon request.

If electronic services are offered or the supply of goods or services is contracted and paid for via a mobile application, online store, or similar, the invoice does not need to be printed on paper, but can be sent to the buyer or recipient of the invoice via electronic mail (e-mail) or as an electronic invoice. If the buyer is an individual or a person who is not an invoice-issuing taxpayer, then sending the invoice electronically can only be carried out with the consent of the buyer. For other buyers, an electronic invoice can be issued without specific consent from the buyer, provided the buyer is registered on the central invoice platform.

Electronic invoices for cashless payments

Invoices for the supply of goods and services in transactions where both the seller and the buyer are taxpayers, subjects of VAT, corporate income tax, or simplified income tax for small businesses, must be issued, sent, and accepted as an electronic invoice if the invoice has been paid or will be paid without cash. The electronic invoice must contain all necessary data, be issued by applying fiscalization procedures, and comply with the technical specifications defined in Albanian Standards. The electronic invoice must be sent or made available to the buyer at the moment of the supply of goods or services.

In the case of supplying goods with transport, the taxpayer issuing the invoice is obliged to issue an electronic invoice and apply the fiscalization procedure immediately before the transport of goods, print the QR code on paper with the data specified in the finance minister's instruction, and hand it over to the transporter. The transporter must retain this document throughout the duration of the transport of goods, from the point of origin to the destination or until the goods are delivered to the buyer, and is obliged to make this document available to tax administration representatives upon request.

In all other cashless transactions, when the buyer is not a taxpayer and when there is an obligation to issue an invoice under this law, the invoice paid or to be paid without cash can be issued as an electronic invoice. The buyer may, but is not obliged to, accept it as an electronic invoice; therefore, it can be printed on paper or sent to the buyer via electronic mail (e-mail) with their consent. Taxpayers issuing invoices can issue and send invoices when issuing invoices that are paid or will be paid without cash, in the case of exporting goods outside the territory of the Republic of Albania, or providing services to non-resident buyers. If the buyer is a resident of a European Union member state, the invoice can be issued as an electronic invoice only with the buyer's consent. The buyer's consent must be given in writing or by agreement during invoice processing or upon making the payment for the received invoice.

Electronic invoices in transactions with public bodies

Invoices in transactions with public bodies must be issued, sent, and accepted as electronic invoices. The obligation to issue an electronic invoice does not apply to invoices issued as a result of fulfilling a public procurement contract where the procurement and fulfillment of the contract are declared secret or must be accompanied by special security measures, in accordance with relevant laws, regulations, or administrative provisions, and provided that key interests cannot be guaranteed by less stringent measures.

3.6. What does the fiscalization procedure consist of?

Taxpayers exercising economic activity in retail sales, providing services in places or units open to the public, or any other similar activity involving cash, must install the fiscalization system, including the printer if it is not an integral part of the fiscal device, and utilize a certified software solution. All taxpayers who were equipped with and installed fiscal devices prior to the entry into force of this law continue using them with the new fiscalization system. The fiscalization system mandatorily enables the storage of every transaction carried out through these fiscal devices in memory. To ensure data interfacing for existing fiscal devices, an intermediary infrastructure (intermediary server) can be used, which is developed by software solution manufacturers and maintainers, ensuring that the data exchange of this server with the fiscalization system is done in real time and data is exchanged with secure authentication provided by the electronic certificate obtained by taxpayers from NAIS (AKSHI).

Taxpayers, for the purpose of implementing the fiscalization procedure of issued invoices, are obliged to issue an invoice for cash payments for every transaction through the use of the fiscalization system. The fiscalization system enables the storage of every transaction in memory, electronically signed for each invoice using the electronic certificate, and an internet connection for the electronic exchange of data with the central tax administration. Taxpayers issuing invoices, for the purpose of implementing the invoice fiscalization procedure, must use a certified software solution that enables them to operate in accordance with the provisions of this law and prevents actions that bypass the

invoice fiscalization procedure. The taxpayer issuing invoices can test the invoice data and the fiscalization procedure.

By decision of the Council of Ministers, the methodology and monitoring procedures of circulation for taxpayers in specific sectors of the economy are determined. The methodology for testing invoice data and the fiscalization procedure by the taxpayer issuing invoices is determined by an instruction from the minister responsible for finance. In order to implement the invoice fiscalization procedure, the taxpayer issuing invoices must be equipped with an electronic certificate generated and issued by NAIS (AKSHI), as the central state institution that administers and maintains the government public key infrastructure. The electronic certificate issued by NAIS must be stored in a physical environment with a high level of security, without compromising its conformity and confidentiality. For the issued electronic certificate, the fee determined by decision of the Council of Ministers applies to the electronic services provided by NAIS.

3.7. What happens in case of internet connection interruption?

The taxpayer issuing invoices must, within 48 hours starting from the moment of connection interruption, re-establish an electronic (internet) connection and submit all issued invoices to the central tax administration through a special protocol in the form of an electronic invoice. Invoices issued are considered correctly fiscalized if the fiscalization process was performed within the specified deadline. In order for the described process to remain an exception, the taxpayer issuing invoices must ensure appropriate software and hardware support for data exchange and transmission to the central tax administration, alongside a suitable internet connection.

The taxpayer issuing the invoice is responsible for verifying the appropriate network capacity, which must be determined independently, based on the number of messages per second at peak load moments. The central tax administration assigns a NIVF to all invoices and returns it to the taxpayer issuing invoices as confirmation of acceptance for invoices sent late.

If the taxpayer issuing the invoice cannot re-establish the internet connection within the specified deadline due to the need to replace the connection device, the inability to establish the internet connection for which the service provider is responsible, or due to force majeure, they must notify the tax administration about this and submit documentation or other proof demonstrating the inability to establish the internet connection, according to the instruction of the minister responsible for finance. For invoices for which the obligation of electronic transmission is not specified, the taxpayer issuing the invoice must, at the buyer's request, issue a paper copy of the invoice with a NIVF after the subsequent fiscalization procedure has been performed.

3.8. How is the fiscalization of corrective/rectifying invoices performed?

All obligations specified in the provisions of this law for invoice issuance and the fiscalization procedure apply, as necessary, to the issuance of corrective/rectifying invoices, as defined in the value-added tax legislation in force. The corrective/rectifying invoice must contain a reference to the original invoice being corrected.

Chapter 4: Summary

This project aims precisely at providing a theoretical summary of the measures undertaken in our country, as well as evaluating—through informational and descriptive methods—our country's approach toward the new policies implemented. Are they encountering difficulties in their development? The subsequent development of the thesis will feature data from questionnaires, where the research samples will consist of SME businesses operating within our country.

References

1. BENT HANSEN. *The Economic Theory of Fiscal Policy*. Translated by P. E. Burke. Pp. xv, 450. Cambridge, Mass.: Harvard University Press, 1958
2. Benedict J. Clements ; Ruud A. de Mooij ; Sanjeev Gupta ; Michael, September 21, 2015
3. *The Limits of Fiscal Policy*, Anthony J Makin, 2018
4. *Fiscal Policy for Development: Poverty, Reconstruction and Growth* (Paperback), Macmillan, Tony Addison and Alan Roe, 15 Nov 2014
5. *Policy Instruments for Sound Fiscal Policies*, J. Ayuso-i-Casals, S. Deroose, E. Flores, Laurent Moulin, 2009
6. *Fiscal Policies and Growth in the World Economy, Third Edition*, By Jacob A. Frenkel and Assaf Razin, September 1996
7. *Urban Economics and Fiscal Policy*, Holger Sieg, Aug 4, 2020

8. *Fiscal Policy Making in the European Union: An Assessment of Current Practice and Challenges*, Larch Martin, João Nogueira Martins, 2009
9. *A Guide to Chi-Squared Testing*, Cindy Greenwood, M.S. Nikulin, 1990
10. *An Introduction to Statistical Analysis in Research*, Pablo F. Weaver, Kathleen F. Weaver, Kanya Godde, Sarah L. Dunn, Vanessa C. Morales, August 4, 2017
11. *The World After GDP: Politics, Business and Society in the Post Growth Era*, Lorenzo Fioramonti, February 2017
12. *Measuring What Counts: The Global Movement for Well-Being*, Jean-Paul Fitoussi, Martine Durand, November 19, 2019
13. *The Macroeconomics of Fiscal Policy*, Richard W. Kopcke, Geoffrey M. B. Tootell, and Robert K. Triest
14. *Blinder, Alan, J. 2006. The case against the case against discretionary fiscal policy. In The macroeconomics of fiscal policy. Cambridge: MIT Press.*

Website

<https://www.investopedia.com/terms/f/fiscalpolicy.asp>
https://www.investopedia.com/terms/j/john_maynard_keynes.asp
<https://www.elibrary.imf.org/view/books/071/04393-9781589060944-text=sustainable%20exes%2>,
<https://www.routledge.com/Using-Fiscal-Policy-and-Public-Financial-Management-to-Promote-Gender-Equality/Stotsky/p/book/9780367278663>
<https://www.tatime.gov.al/c/8/44/496/fiskalizimi>
<https://www.tatime.gov.al/c/424/431/baza-ligjore>
<https://www.tatime.gov.al/c/424/491/specifikimet-teknike-regjistrimi-i-pagesave>
<https://www.financa.gov.al/>
<https://www.financa.gov.al/programi-ekonomiko-fiskal/>
<https://financa.gov.al/raporte-dhe-statistika-fiskale/>

Mathematical sciences

ARTIFICIAL INTELLIGENCE–SUPPORTED DIALOGUE ASSISTANTS IN PRIMARY SCHOOL MATHEMATICS EDUCATION: A METHODOLOGICAL MODEL AND PEDAGOGICAL EXPERIMENT

Tamara Mammadova

Associate professor of the Department Primary school educators, Faculty of Education, Baku Slavic University, Baku, Azerbaijan

İBTİDAİ SINIF RİYAZİYYAT TƏLİMİNDƏ SÜNİ İNTELLEKT DƏSTƏKLİ DİALOQ KÖMƏKÇİLƏRİ: METODİK MODEL VƏ PEDAQOJİ EKSPERİMENT

Tamara Məmmədova

İbtidai təhsil kafedrası, Təhsil fakultəsi, Bakı Slavyan Universiteti, Bakı, Azərbaycan

Abstract

The rapid development of digital technologies and artificial intelligence (AI) has significantly transformed modern educational environments and created new opportunities for improving teaching and learning processes. One of the promising directions in contemporary pedagogy is the integration of AI-based interactive systems that support personalized and student-centered learning. This study investigates the methodological foundations and pedagogical potential of using artificial intelligence–supported dialogue partners in primary school mathematics lessons. The research is based on the idea that modern children, often referred to as the Alpha generation, grow up in a technology-rich environment and therefore require innovative learning approaches that differ from traditional teacher-centered instruction.

The theoretical framework of the study is grounded in the cognitive development theory of Jean Piaget, which emphasizes that children aged 7–11 years are in the stage of concrete operational thinking. At this stage, students learn mathematical concepts more effectively through interactive, visual, and dialogue-based learning activities. In this context, AI-supported dialogue partners can function as intelligent learning assistants that guide students through questions and prompts rather than directly providing answers. This approach is conceptually related to the dialogical learning principles of the Socrates method, where knowledge is constructed through guided questioning and reasoning.

The study employs a pedagogical experimental design involving two parallel primary school classes. In the control group, mathematics lessons were conducted using traditional teaching methods, while in the experimental group AI-supported dialogue assistants were integrated into the learning process once or twice per week. The AI systems used in the study were designed to engage students in step-by-step problem-solving through interactive dialogue scenarios and adaptive feedback mechanisms. Data collection methods included classroom observation, analysis of students' test results, and evaluation of students' participation and learning motivation.

The results of the experiment demonstrate that the integration of AI dialogue partners positively influences students' engagement, mathematical reasoning, and confidence in solving mathematical problems. Students in the experimental group showed higher levels of participation and improved performance compared to those in the control group. Additionally, the use of AI-based dialogue assistants contributed to reducing students' fear of making mistakes and helped create a supportive and motivating learning environment.

The findings suggest that AI-supported dialogue partners can serve as an effective pedagogical tool in primary school mathematics education. Their integration into classroom practice can enhance personalized learning, support the development of mathematical literacy, and increase students' interest in mathematics. The study highlights the importance of developing methodological guidelines for teachers on the effective and pedagogically sound use of AI technologies in early mathematics education.

Annotasiya

Rəqəmsal texnologiyaların və süni intellektin (Sİ) sürətli inkişafı müasir təhsil mühitinin transformasiyasına səbəb olmuş və təlim prosesinin təşkilində yeni imkanlar yaratmışdır. Müasir pedaqogikada perspektivli istiqamətlərdən biri süni intellekt əsaslı interaktiv sistemlərin təlim prosesinə integrasiyasıdır. Bu sistemlər fərdiləşdirilmiş və şagirdyönlü təlim mühitinin formalaşdırılmasına kömək edir. Məqalədə ibtidai sinif riyaziyyat dərslərində süni intellekt dəstəkli dialoq tərəfdaşlarından

istifadə metodikası və onların pedaqoji imkanları araşdırılır. Tədqiqat müasir uşaqların — texnologiya mühitində böyüyən və tez-tez Alfa nəsli kimi xarakterizə olunan şagirdlərin — öyrənmə xüsusiyyətlərinin ənənəvi təlim modellərindən fərqləndiyi fikrinə əsaslanır. Bu səbəbdən ibtidai təhsil mərhələsində innovativ və interaktiv təlim üsullarının tətbiqi xüsusi aktuallıq kəsb edir.

Tədqiqatın nəzəri əsasını koqnitiv inkişaf nəzəriyyəsi təşkil edir. Bu nəzəriyyəyə görə, Piaje tərəfindən müəyyən edilmiş 7–11 yaş dövrü konkret əməliyyatlar mərhələsi hesab olunur və bu mərhələdə uşaqlar riyazi anlayışları daha çox vizual, praktiki və dialoq əsaslı fəaliyyət vasitəsilə mənimsəyirlər. Bu baxımdan süni intellekt əsaslı dialoq tərəfdaşları şagirdlərlə interaktiv ünsiyyət quraraq onları suallar vasitəsilə düşünməyə yönəldən və problemlərin həllinə addım-addım istiqamətləndirən ağıllı təlim köməkçiləri kimi çıxış edə bilər. Bu yanaşma həmçinin dialoq və sual-cavab yolu ilə biliklərin formalaşmasını nəzərdə tutan *Socrates* metodunun prinsiplərinə uyğundur.

Tədqiqat çərçivəsində pedaqoji eksperiment aparılmışdır. Eksperiment iki paralel ibtidai sinifdə həyata keçirilmişdir. Nəzarət sinfində riyaziyyat dərsləri ənənəvi təlim üsulları ilə keçirilmiş, eksperiment sinfində isə dərslərin bir hissəsində süni intellekt dəstəkli dialoq köməkçilərindən istifadə olunmuşdur. Süni intellekt sistemləri şagirdləri addım-addım düşünməyə yönəldən interaktiv dialoq ssenariləri və adaptiv geribildirim mexanizmləri əsasında fəaliyyət göstərmişdir. Tədqiqat zamanı şagirdlərin test nəticələri, dərstdə fəallıq səviyyəsi və öyrənmə motivasiyası təhlil edilmişdir.

Eksperimental tədqiqatın nəticələri göstərmişdir ki, süni intellekt dəstəkli dialoq tərəfdaşlarının istifadəsi şagirdlərin dərş prosesində aktivliyini artırır, riyazi problemlərin həllində məntiqi düşünmə bacarıqlarının inkişafına müsbət təsir göstərir və onların özünə inamını gücləndirir. Eksperiment sinfində şagirdlərin nəticələrinin nəzarət sinfi ilə müqayisədə daha yüksək olduğu müşahidə edilmişdir. Bundan əlavə, süni intellekt əsaslı köməkçilər şagirdlərdə səhv etmək qorxusunun azalmasına və daha motivasiyaedici öyrənmə mühitinin formalaşmasına şərait yaratmışdır.

Tədqiqatın nəticələri göstərir ki, süni intellekt dəstəkli dialoq tərəfdaşları ibtidai sinif riyaziyyat dərslərində effektiv pedaqoji vasitə kimi istifadə oluna bilər. Bu texnologiyalar fərdiləşdirilmiş təlim imkanlarını genişləndirir, riyazi savadlılığın inkişafına kömək edir və şagirdlərin riyaziyyata marağını artırır. Araşdırma müəllimlər üçün süni intellekt texnologiyalarının təlim prosesinə metodik və səmərəli şəkildə integrasiyasının vacibliyini vurğulayır.

Keywords: artificial intelligence in education, primary mathematics education, dialogue-based learning, intelligent tutoring systems, personalized learning, educational technology.

Açar sözlər: süni intellekt, ibtidai təhsil, riyaziyyatın tədrisi metodikası, dialoq əsaslı öyrənmə, fərdiləşdirilmiş təlim, ağıllı təlim sistemləri.

Giriş

Müasir dövrdə təhsil sisteminə baş verən transformasiya prosesləri, xüsusilə rəqəmsallaşma və süni intellekt texnologiyalarının sürətli inkişafı, tədris metodlarının və pedaqoji yanaşmaların yenidən nəzərdən keçirilməsini zəruri edir. Rəqəmsal texnologiyaların təhsilə integrasiyası yalnız texniki yenilik kimi deyil, həm də təlimin məzmununun, formalarının və metodlarının yenilənməsi kimi qiymətləndirilməlidir. Bu kontekstdə süni intellekt əsaslı təhsil texnologiyaları müəllim və şagird qarşılıqlı əlaqəsini zənginləşdirən, fərdiləşdirilmiş öyrənməni dəstəkləyən və təlim prosesini daha interaktiv edən mühüm vasitə kimi çıxış edir.

Son illərdə təhsil tədqiqatlarında süni intellekt sistemlərinin xüsusilə riyaziyyat təlimində tətbiqi geniş müzakirə olunur. Riyaziyyat abstrakt düşünmə, məntiqi təhlil və problem həll etmə bacarıqlarının inkişafını tələb edən fənlərdən biri olduğuna görə, bu sahədə şagirdlərin fəal iştirakını və düşünmə prosesini stimullaşdıran metodların tətbiqi xüsusi əhəmiyyət kəsb edir. Ənənəvi müəllim mərkəzli təlim modellərində şagirdlər çox vaxt passiv bilik qəbul edən rolunda çıxış edir. Lakin müasir pedaqoji yanaşmalar öyrənmənin dialoq, əməkdaşlıq və problem həll etmə fəaliyyəti əsasında qurulmasını zəruri hesab edir.

Təlim prosesində dialoq əsaslı öyrənmə ideyası hələ antik dövrdə formalaşmışdır. Bu yanaşmanın fəlsəfi əsasları qədim yunan filosofu Sokrat tərəfindən irəli sürülmüş dialoq və sual-cavab metoduna söykənir. Bu metodun əsas mahiyyəti şagirdin hazır cavabları qəbul etməsi deyil, istiqamətləndirici suallar vasitəsilə müstəqil düşünərək nəticəyə gəlməsidir. Müasir təhsil texnologiyaları bu yanaşmanı yeni səviyyəyə qaldıraraq interaktiv və adaptiv öyrənmə mühitlərinin yaradılmasına imkan verir.

Digər tərəfdən, uşaqların idrak inkişafının mərhələləri ilə bağlı aparılmış fundamental tədqiqatlar göstərir ki, ibtidai məktəb yaşlı şagirdlər konkret əməliyyatlar mərhələsində düşünürlər. Bu konsepsiya

məşhur psixoloq Jean Piaget tərəfindən əsaslandırılmışdır. Onun nəzəriyyəsinə görə, 7–11 yaşlı uşaqlar riyazi anlayışları daha effektiv şəkildə konkret situasiyalar, vizual modellər və interaktiv fəaliyyət vasitəsilə mənimsəyirlər. Bu baxımdan dialoq və qarşılıqlı fəaliyyət elementlərini özündə birləşdirən təlim mühitləri riyazi təfəkkürün inkişafı üçün daha əlverişli hesab olunur.

Süni intellekt texnologiyalarının təhsil sahəsinə tətbiqi məhz bu pedaqoji və psixoloji prinsiplərə yeni imkanlar əlavə edir. Sı əsaslı dialoq sistemləri şagirdlərlə interaktiv ünsiyyət quraraq onların düşünmə prosesini istiqamətləndirir, problemlərin həlli zamanı addım-addım kömək göstərə və fərdi öyrənmə trayektoriyalarını dəstəkləyə bilir. Bu sistemlər müəllimin rolunu əvəz etmədən, əksinə, təlim prosesində əlavə dəstək mexanizmi kimi çıxış edir. Beləliklə, şagirdlərin səhv etmək qorxusu azalır, onların riyazi mühakimə və problem həll etmə bacarıqları inkişaf edir.

Müasir təhsil tədqiqatları göstərir ki, süni intellekt əsaslı təlim vasitələrinin tətbiqi şagirdlərin motivasiyasını artırır, öyrənmə prosesini fərdiləşdirir və müəllimlər üçün təlimin monitorinqi və qiymətləndirilməsi baxımından yeni imkanlar yaradır. Lakin bu texnologiyaların səmərəli tətbiqi üçün metodik əsasların və pedaqoji modellərin işlənməsi mühüm elmi və praktik vəzifə olaraq qalır.

Bu baxımdan təqdim olunan tədqiqatın məqsədi ibtidai siniflərdə riyaziyyat təlimində süni intellekt əsaslı dialoq tərəfdaşlarının pedaqoji potensialını araşdırmaq və onların təlim prosesinə integrasiyasının metodik xüsusiyyətlərini müəyyən etməkdir. Tədqiqat çərçivəsində Sı dəstəklı dialoq sistemlərinin şagirdlərin riyazi təfəkkürünün inkişafına, öyrənmə motivasiyasına və problem həll etmə bacarıqlarına təsiri təhlil edilir.

Aparılan araşdırmanın nəticələri ibtidai siniflərdə riyaziyyat təliminin modernləşdirilməsi, innovativ təlim metodlarının tətbiqi və süni intellekt texnologiyalarının pedaqoji baxımdan əsaslandırılmış istifadəsi üçün metodik tövsiyələrin hazırlanmasına xidmət edə bilər.

Süni intellekt texnologiyalarının təhsil sahəsində tətbiqi son illərdə geniş araşdırılan mövzulardan biridir. Bu sahədə aparılan tədqiqatlar göstərir ki, süni intellekt əsaslı təlim sistemləri şagirdlərin fərdi xüsusiyyətlərinə uyğun təlim mühiti yarada bilər (Luckin və s., 2016).

Bu istiqamətdə aparılan tədqiqatlarda süni intellekt texnologiyalarının adaptiv öyrənmə platformalarında, ağıllı repetitor sistemlərində, virtual tədris köməkçilərində və avtomatik qiymətləndirmə sistemlərində tətbiq olunduğu edilir.

İbtidai təhsildə süni intellekt texnologiyalarının tətbiqi şagirdlərin idrak xüsusiyyətləri ilə sıx bağlıdır. Bu sahədə aparılan araşdırmalar göstərir ki, dialoq əsaslı öyrənmə metodları uşaqların riyazi anlayışları daha dərinlən mənimsəməsinə kömək edir (Paul & Elder, 2007).

Uşaqların idrak inkişafı ilə bağlı ən mühüm nəzəriyyələrdən biri Jean Piaget tərəfindən irəli sürülmüş koqnitiv inkişaf nəzəriyyəsidir. Bu nəzəriyyəyə görə 7–11 yaş arası uşaqlar konkret əməliyyatlar mərhələsində olur və onlar riyazi anlayışları əsasən konkret situasiyalar və vizual modellər vasitəsilə daha yaxşı mənimsəyirlər (Piaget, 1972).

Dialoq əsaslı təlim metodunun fəlsəfi əsasları Sokrat metoduna əsaslanır. Bu metod şagirdin ardıcıl suallar vasitəsilə düşünməsinə və nəticəyə özünün gəlməsini nəzərdə tutur.

Tədqiqat metodologiyası: Tədqiqatda pedaqoji eksperiment metodundan istifadə edilmişdir. Eksperiment iki paralel ibtidai sinifdə həyata keçirilmişdir.

Tədqiqatın mərhələləri aşağıdakılardır:

- nəzarət və eksperiment siniflərinin seçilməsi;
- süni intellekt əsaslı dialoq köməkçilərinin dərs prosesinə integrasiyası;
- təlim nəticələrinin müqayisəli təhlili.

Eksperiment sinfində riyaziyyat dərsləri həftədə 1–2 dəfə süni intellekt köməkçilərinin dəstəyi ilə keçirilmişdir. Nəzarət sinfində isə dərslər ənənəvi üsulla aparılmışdır.

Tədqiqat zamanı aşağıdakı göstəricilər analiz edilmişdir:

şagirdlərin test nəticələri

dərsdə fəallıq səviyyəsi

riyazi problemlərin həllində müstəqillik

riyazi həyəcan səviyyəsi.

Tətbiq metodikası: Süni intellekt köməkçilərinin əsas funksiyası şagirdə hazır cavab vermək deyil, onu düşünməyə yönəltməkdir. Buna görə də bu sistemlərdə istifadə olunan dialoq ssenariləri xüsusi metodik prinsiplərə əsaslanmalıdır.

Məsələn, riyazi məsələnin həlli zamanı virtual köməkçi aşağıdakı şəkildə dialoq qurur:

Virtual personaj: "Mənim 10 çiyələyim var idi. 4 dənəsini yedim. Səncə çiyələyim çoxaldı, yoxsa azaldı?"

Şagird: "Azaldı."

Virtual personaj: "Əgər azaldısa, hansı riyazi əməliyyatı istifadə etməliyik?"

Bu metod şagirdin düşünmə prosesini aktivləşdirir və nəticəyə özünün gəlməsinə şərait yaradır.

Nəticələr: Aparılan son qiymətləndirmə testlərinin nəticələrinə görə, ənənəvi üsulla dərslərin keçildiyi nəzarət sinfində riyazi məsələ həlli üzrə keyfiyyət göstəricisi 72% olduğu halda, süni intellekt dəstəklili dialoq tərəfdaşlarından istifadə edilən eksperiment sinfində bu göstərici 86% təşkil etmişdir. Həmçinin, xüsusi anketləşdirmə vasitəsilə ölçülən 'riyazi həyəcan' səviyyəsi eksperiment sinfindəki şagirdlərin 64%-də əhəmiyyətli dərəcədə azalmışdır. Eksperiment sinfində test nəticələrinin orta göstəricisi nəzarət sinfi ilə müqayisədə daha yüksək olmuşdur.

Müzakirə: Tədqiqat nəticələri süni intellekt texnologiyalarının ibtidai təhsildə tətbiqinin perspektivli istiqamət olduğunu göstərir. Bu texnologiyalar müəllimin rolunu əvəz etmir, əksinə onu dəstəkləyən əlavə vasitə kimi çıxış edir. Süni intellekt köməkçiləri şagirdlərin fərdi xüsusiyyətlərinə uyğunlaşaraq fərdiləşdirilmiş öyrənmə mühiti yaradır və riyaziyyatın tədrisini daha interaktiv edir.

Bununla yanaşı, metodikanın tətbiqi zamanı bəzi texniki və pedaqoji məhdudiyyətlər də nəzərə alınmalıdır. İbtidai sinif şagirdlərinin səs tanıma sistemləri ilə işləyərkən tələffüz fərqlilikləri bəzən SI sistemlərində anlaşılmazlığa səbəb ola bilər. Həmçinin, bu texnologiyanın tətbiqi məktəblərin yüksəksürətli internet və planşet/kompüter avadanlıqları ilə təminatından birbaşa asılıdır.

Nəticə

Nəzəri nəticələr: Aparılan tədqiqat süni intellekt dəstəklili dialoq tərəfdaşlarının ibtidai sinif riyaziyyat təlimində metodik və pedaqoji potensialını nəzəri baxımdan əsaslandırır. Tədqiqat nəticələri göstərir ki, dialoq əsaslı süni intellekt sistemləri şagirdlərin idrak fəaliyyətini aktivləşdirən və riyazi anlayışların mənimsənilməsinə dərinləşdirən effektiv didaktik vasitə kimi çıxış edə bilər. Bu yanaşma konstruktivist təlim konsepsiyası ilə uyğunluq təşkil edir və şagirdlərin bilikləri passiv şəkildə qəbul etməsi deyil, onların aktiv kəşf yolu ilə formalaşmasını təmin edir.

Xüsusilə dialoq əsaslı süni intellekt sistemlərinin istiqamətləndirici suallar vasitəsilə şagirdləri müstəqil düşünməyə yönəltməsi klassik dialoji təlim prinsipləri ilə səsleşir. Bu baxımdan tədqiqat nəticələri qədim dialoq əsaslı öyrənmə yanaşmasının, xüsusilə Sokrat metodunun müasir texnoloji mühitdə yeni formada tətbiq imkanlarını göstərir. Eyni zamanda, bu yanaşma ibtidai sinif şagirdlərinin idrak inkişaf xüsusiyyətlərini izah edən Piaje (Jean Piaget) nəzəriyyəsi ilə də uzlaşır. Belə ki, süni intellekt dəstəklili vizual və interaktiv dialoq mühiti konkret əməliyyatlar mərhələsində olan şagirdlərin riyazi anlayışları daha səmərəli mənimsəməsinə kömək edir.

Beləliklə, tədqiqat süni intellekt əsaslı dialoq texnologiyalarının ibtidai riyaziyyat təlimində istifadə olunması üçün metodoloji əsasların formalaşdırılmasına töhfə verir və bu istiqamətdə yeni elmi yanaşmaların inkişaf perspektivlərini müəyyənləşdirir.

Praktiki nəticələr: Eksperimental tədqiqatın nəticələri göstərmişdir ki, süni intellekt dəstəklili dialoq tərəfdaşlarının dərs prosesinə inteqrasiyası şagirdlərin riyazi fəaliyyətə fəal qoşulmasına və öyrənmə motivasiyasının artmasına müsbət təsir göstərir. Eksperiment sinfində aparılmış müşahidələr və test nəticələri göstərmişdir ki, süni intellekt köməkçiləri ilə işləyən şagirdlər riyazi məsələlərin həlli zamanı daha çox müstəqillik nümayiş etdirir, problemlərin həlli prosesini addım-addım analiz etməyə çalışır və nəticəni əsaslandırmağa meyilli olurlar.

Süni intellekt sistemlərinin mühüm üstünlüklərindən biri onların fərdiləşdirilmiş təlim imkanlarını genişləndirməsidir. Belə sistemlər şagirdlərin fərdi öyrənmə tempini və bilik səviyyəsini nəzərə alaraq tapşırıqları uyğunlaşdırmağa imkan verir. Nəticədə zəif hazırlıqlı şagirdlər daha sadə və izahlı istiqamətləndirici suallar vasitəsilə dəstək alır, yüksək nəticə göstərən şagirdlər isə daha mürəkkəb tapşırıqlarla qarşılaşır.

Eyni zamanda, tədqiqat nəticələri göstərir ki, süni intellekt əsaslı dialoq köməkçiləri şagirdlərdə riyazi həyəcanın azalmasına da müsbət təsir göstərir. Kompüter əsaslı interaktiv sistemlər səhvlərə qarşı daha tolerant və dəstəkləyici reaksiya verdiyi üçün şagirdlər tapşırıqları yerinə yetirərkən daha rahat və inamlı davranırlar. Bu isə ümumilikdə daha müsbət və motivasiyaedici təlim mühitinin formalaşmasına kömək edir.

Məhdudiyyətlər və gələcək tədqiqat istiqamətləri: Tədqiqatın əldə etdiyi nəticələr müsbət olsa da, müəyyən məhdudiyyətlər mövcuddur. Eksperimental araşdırma yalnız məhdud sayda sinifdə və qısa müddət ərzində həyata keçirilmişdir. Bu səbəbdən daha geniş miqyaslı və uzunmüddətli tədqiqatların aparılması süni intellekt texnologiyalarının təlim nəticələrinə təsirini daha obyektiv şəkildə qiymətləndirməyə imkan verə bilər.

Gələcək tədqiqatlarda süni intellekt dəstəkli dialoq sistemlərinin müxtəlif riyazi mövzuların tədrisində tətbiq imkanlarının araşdırılması, onların ibtidai sinif kurikulumuna integrasiyası və müəllimlərin rəqəmsal pedaqoji kompetensiyalarının inkişafı kimi məsələlərin daha geniş şəkildə öyrənilməsi məqsədəuyğun hesab olunur. Bundan əlavə, süni intellekt texnologiyalarının inklüziv təhsil mühitində, xüsusilə fərqli öyrənmə ehtiyaclarına malik şagirdlərlə işləmə prosesində istifadə imkanlarının tədqiqi də mühüm elmi istiqamətlərdən biri kimi qiymətləndirilə bilər.

Ədəbiyyat siyahısı

1. Holmes, W., Bialik, M., Fadel, C. (2019). *Artificial Intelligence in Education: Promises and Implications for Teaching and Learning*. Center for Curriculum Redesign.
2. Luckin, R. et al. (2016). *Intelligence Unleashed: An Argument for AI in Education*. Pearson.
3. Luckin, R., Holmes, W., Griffiths, M., & Forcier, L. B. (2016). *Intelligence Unleashed: An argument for AI in Education*. London: Pearson.
4. Paul, R., & Elder, L. (2007). *The Art of Socratic Questioning*. Foundation for Critical Thinking.
5. Piaget, J. (1972). *The Psychology of the Child*. New York.
6. Prensky, M. (2001). *Digital Natives, Digital Immigrants*. On the Horizon.

ARTIFICIAL INTELLIGENCE, ROBOTICS AND BIG DATA: CURRENT STATE AND DEVELOPMENT PROSPECTS

Konysbek Tattibekov¹

Candidate of physical and mathematical sciences, associate Professor.

Kurdyukov Vitaly²

Master of Computer Science, Senior Lecturer

Almaty Technological University¹

Taraz Regional University named after M.H.Dulati²

ИСКУССТВЕННЫЙ ИНТЕЛЛЕКТ, РОБОТОТЕХНИКА И BIG DATA: СОВРЕМЕННОЕ СОСТОЯНИЕ И ПЕРСПЕКТИВЫ РАЗВИТИЯ

Таттибеков Конысбек Сатиевич¹

к.ф.-м.н., ассоциированный профессор.

Курдюков Виталий Владимирович²

магистр информатики, старший преподаватель

Алматинский технологический университет¹

Таразский региональный университет имени М.Х.Дулати²

Abstract

This paper reviews the current state and development trends of Artificial Intelligence (AI), robotics, and Big Data technologies. It is shown that recent breakthroughs in machine learning and deep neural networks have been largely driven by the growth of computational power and the availability of massive datasets. The role of databases and data management systems in modern digital infrastructure is discussed. Special attention is given to the integration of AI in robotics, including navigation, perception, and autonomous decision-making. In addition, key challenges such as cybersecurity, ethical issues, personal data protection, and trust in algorithmic decisions are analyzed. The study concludes that the convergence of AI, robotics, and Big Data forms the foundation of digital transformation in society and economy.

Аннотация

В статье рассматриваются современные направления развития искусственного интеллекта, робототехники и технологий Big Data. Показано, что успехи в области машинного обучения и глубоких нейронных сетей во многом обусловлены ростом вычислительных ресурсов и доступностью больших массивов данных. Анализируются ключевые подходы к построению интеллектуальных систем, роль баз данных и систем управления базами данных в формировании цифровой инфраструктуры. Отдельное внимание уделено применению ИИ в робототехнике, а также современным вызовам: кибербезопасности, этическим аспектам, защите персональных данных и вопросам доверия к алгоритмическим решениям. Сделан вывод о том, что интеграция ИИ, робототехники и Big Data становится фундаментом цифровой трансформации общества и экономики.

Keywords: *artificial intelligence, machine learning, deep learning, neural networks, robotics, big data, databases, digital transformation.*

Ключевые слова: *искусственный интеллект, машинное обучение, глубокое обучение, нейронные сети, робототехника, большие данные, базы данных, цифровая трансформация.*

Введение

Искусственный интеллект (ИИ) является одной из наиболее значимых и быстро развивающихся областей современной науки и техники. Под ИИ понимают совокупность методов и технологий, позволяющих компьютерным системам выполнять задачи, традиционно требующие интеллектуальных способностей человека: анализ информации, обучение на примерах, распознавание образов, обработку естественного языка, планирование и принятие решений. В XXI веке искусственный интеллект стал основой цифровой трансформации экономики и общества. Его внедрение наблюдается в промышленности, банковской сфере, медицине, образовании, транспорте, государственном управлении и информационной безопасности.

Развитие ИИ тесно связано с робототехникой и технологиями обработки больших данных (Big Data). Робототехника обеспечивает взаимодействие алгоритмов с физической средой, а Big Data создаёт основу для обучения и повышения точности интеллектуальных моделей. В совокупности эти направления формируют современную технологическую платформу для построения автономных и интеллектуальных систем.

Целью данной обзорной статьи является анализ современных подходов к искусственному интеллекту, описание взаимосвязи ИИ с робототехникой и Big Data, а также определение перспектив и ключевых вызовов развития.

Основная часть

1. Понятие и основные направления искусственного интеллекта. Первые исследования в области искусственного интеллекта начались в середине XX века и были связаны с попытками формализовать человеческое мышление. Одним из важнейших философских критериев оценки разумности машины является тест Тьюринга, согласно которому интеллектуальной можно считать систему, если её ответы в диалоге неотличимы от ответов человека.

Современный искусственный интеллект включает несколько ключевых направлений: экспертные системы, машинное обучение, нейронные сети, обработку естественного языка, компьютерное зрение и интеллектуальное управление. Наибольшее развитие в последние годы получило машинное обучение (Machine Learning), при котором алгоритм строит модель на основе данных. Важнейшей разновидностью является глубокое обучение (Deep Learning), использующее многослойные нейронные сети.

Особую роль в современном ИИ играют генеративные модели, способные создавать тексты, изображения и программный код. Большие языковые модели (LLM) стали новым этапом развития, поскольку они демонстрируют способность к контекстному анализу и генерации сложных смысловых конструкций.

2. Искусственный интеллект и робототехника. Робототехника является прикладной научной областью, занимающейся разработкой автоматизированных технических систем и роботизированных устройств. Она опирается на мехатронику, электронику, информатику, механику, радиотехнику и теорию управления. Основная задача робототехники заключается в создании устройств, способных выполнять полезные действия без непосредственного участия человека.

Интеграция искусственного интеллекта в робототехнические системы позволяет создавать автономных роботов, способных адаптироваться к окружающей среде. Интеллектуальные роботы применяют методы компьютерного зрения для распознавания объектов, используют алгоритмы локализации и построения карт (SLAM), а также технологии планирования траектории. Современные робототехнические комплексы могут выполнять манипуляции с объектами, сортировку товаров, сборку деталей, контроль качества и транспортировку.

Примером интеллектуальных роботов являются системы Pleo, AIBO, QRIO, а также современные сервисные и гуманоидные роботы, применяемые в промышленности и медицине. В перспективе робототехника будет тесно связана с развитием интеллектуальных алгоритмов и автономных систем управления.

3. Технологии Big Data и их значение для искусственного интеллекта. Развитие искусственного интеллекта стало возможным благодаря накоплению больших массивов информации. Технологии Big Data представляют собой методы сбора, хранения и анализа данных, которые по объёму и сложности превышают возможности традиционных информационных систем.

Классическая концепция Big Data включает три ключевых характеристики: Volume (объём), Velocity (скорость обработки) и Variety (разнообразие форматов). В настоящее время модель расширена дополнительными параметрами: Value (ценность) и Veracity (достоверность).

Анализ больших данных позволяет выявлять скрытые закономерности, которые невозможно обнаружить при ручной обработке. Методы Data Mining и машинного обучения активно используются для прогнозирования спроса, анализа поведения клиентов, оптимизации производственных процессов и мониторинга социальных явлений.

В области искусственного интеллекта большие данные выполняют роль обучающей базы, позволяя нейросетям и алгоритмам машинного обучения повышать точность. Однако рост

объёмов данных приводит к необходимости применения распределённых вычислений, облачных платформ и специализированных инструментов обработки.

4. Базы данных и системы управления данными. База данных представляет собой организованную совокупность взаимосвязанных данных, предназначенных для хранения и использования в информационных системах. Базы данных являются основой цифровой инфраструктуры организаций, поскольку обеспечивают систематизацию информации и возможность многопользовательского доступа.

Следует различать понятия данных и информации. Данные — это формализованные сведения, представленные в виде, пригодном для машинной обработки. Информация возникает в результате интерпретации данных и зависит от контекста.

Современные СУБД позволяют хранить не только данные, но и методы их обработки: процедуры, функции, триггеры, механизмы разграничения доступа. По способу хранения различают централизованные базы данных, размещённые на одном сервере, и распределённые базы данных, элементы которых находятся на разных узлах сети.

С развитием Big Data и облачных технологий появились распределённые хранилища, NoSQL базы данных и системы управления потоками данных, которые обеспечивают высокую скорость обработки и масштабируемость.

5. Программирование как основа интеллектуальных технологий. Программирование является фундаментом разработки искусственного интеллекта и цифровых систем. Алгоритмы машинного обучения реализуются на языках программирования, которые обеспечивают поддержку различных парадигм: процедурной, объектно-ориентированной, функциональной и логической.

В настоящее время наиболее популярным языком в области ИИ является Python, благодаря широкому набору библиотек (NumPy, Pandas, TensorFlow, PyTorch, Scikit-learn). Для высокопроизводительных задач широко применяются C++ и Java. При анализе данных востребованы R и Julia.

Развитие программных средств позволило создавать сложные интеллектуальные системы, которые могут работать в режиме реального времени, адаптироваться к изменяющимся условиям и обеспечивать высокую точность прогнозов.

6. Этические и технологические вызовы развития искусственного интеллекта. Несмотря на преимущества, искусственный интеллект порождает ряд серьёзных вызовов. Во-первых, возрастает риск ошибок алгоритмов в критически важных сферах: медицине, транспорте, финансах и государственном управлении. Во-вторых, актуальной проблемой является защита персональных данных, поскольку обучение моделей требует больших объёмов информации.

Кроме того, современные генеративные модели могут использоваться для создания ложной информации, deepfake-контента и автоматизированного распространения дезинформации. Это приводит к необходимости развития правовых механизмов регулирования и внедрения принципов ответственного ИИ.

Этические вопросы включают также проблему дискриминации, возникающей из-за предвзятости данных, и вопрос ответственности за решения, принимаемые автономными системами.

Таблица 1 — Сравнение технологий искусственного интеллекта и Big Data

Критерий	Искусственный интеллект	Big Data
Основная цель	Автоматизация интеллектуальных задач и принятия решений	Хранение, обработка и анализ больших массивов данных
Основной объект	Модели, алгоритмы, нейросети	Данные, потоки данных, хранилища
Методы	Машинное обучение, глубокое обучение, NLP, компьютерное зрение	Data Mining, ETL, распределённые вычисления, статистический анализ
Инструменты	TensorFlow, PyTorch, Scikit-learn, LLM	Hadoop, Spark, NoSQL, облачные платформы
Результат применения	Прогнозы, классификация, генерация контента, управление роботами	Выявление закономерностей, оптимизация процессов, аналитика
Основные проблемы	Этика, интерпретируемость, безопасность моделей	Качество данных, масштабируемость, защита информации

Выводы

Искусственный интеллект является ключевой технологией современного этапа развития цифрового общества. Его практическая эффективность во многом обусловлена развитием машинного обучения и глубоких нейронных сетей, а также ростом вычислительных мощностей. Робототехника и ИИ тесно связаны, поскольку интеллектуальные алгоритмы

обеспечивают автономность роботов, их способность к навигации, распознаванию объектов и взаимодействию с человеком.

Big Data играет фундаментальную роль в развитии искусственного интеллекта, обеспечивая модели необходимыми данными для обучения и анализа. Современные базы данных и системы управления данными формируют основу цифровой инфраструктуры, позволяя хранить и обрабатывать большие объёмы информации.

В то же время развитие искусственного интеллекта требует решения вопросов безопасности, защиты персональных данных и этического регулирования. Перспективы дальнейшего прогресса связаны с разработкой ответственных, интерпретируемых и безопасных интеллектуальных систем, способных эффективно интегрироваться в различные сферы жизни общества.

Список литературы

1. Russell S., Norvig P. *Artificial Intelligence: A Modern Approach*. — Pearson, 2021.
2. Goodfellow I., Bengio Y., Courville A. *Deep Learning*. — MIT Press, 2016.
3. Bishop C. M. *Pattern Recognition and Machine Learning*. — Springer, 2006.
4. Murphy K. P. *Machine Learning: A Probabilistic Perspective*. — MIT Press, 2012.
5. Han J., Pei J., Kamber M. *Data Mining: Concepts and Techniques*. — Morgan Kaufmann, 2011.
6. Tanenbaum A., Van Steen M. *Distributed Systems: Principles and Paradigms*. — Pearson, 2017.
7. Floridi L. *Ethics of Artificial Intelligence*. — Oxford University Press, 2022.

Pedagogical sciences

THE INFLUENCE OF CLASSROOM SEATING ARRANGEMENTS ON STUDENTS' SPEAKING PARTICIPATION IN EFL CLASSES

Zhanara Muratbekovna Kairova

S.Seifullin Kazakh agrotechnical research university,

Senior lecturer

Astana, Kazakhstan

Abstract

This research article investigates the profound impact of various classroom seating arrangements on the speaking participation of university-level English as a Foreign Language (EFL) students. Drawing upon established theories such as Edward T. Hall's proxemics, Robert Sommer's classroom ecology, and Stephen Krashen's affective filter hypothesis, this study explores how the physical configuration of a learning space can significantly influence student comfort, interaction, and communicative engagement. A comparative analysis of traditional rows, U-shape, and cluster/group seating arrangements reveals distinct patterns in student speaking activity. The findings suggest that sociopetal arrangements, particularly cluster seating, foster a more conducive environment for active participation, reduce speaking anxiety, and enhance overall classroom interaction among B1 English level students. This article advocates for a thoughtful consideration of classroom design as a pedagogical tool to optimize communicative opportunities in EFL contexts.

Keywords: *Classroom proxemics, seating arrangements, student speaking participation, communicative engagement, EFL classroom interaction, classroom environment, affective filter, sociopetal arrangements.*

Introduction

The classroom, often perceived merely as a physical space for instruction, is in reality a dynamic environment where spatial configurations can profoundly shape pedagogical outcomes. In the context of English as a Foreign Language (EFL) education, where communicative competence is a primary goal, the arrangement of student seating holds particular significance. Effective language acquisition, especially in speaking, relies heavily on opportunities for interaction and a low-anxiety learning atmosphere. This article delves into the intricate relationship between classroom seating arrangements and students' speaking participation in EFL classes, arguing that intentional spatial design can serve as a powerful catalyst for enhanced communicative engagement.

*The theoretical underpinnings of this investigation are rooted in several key academic disciplines. **Proxemics**, a term coined by anthropologist Edward T. Hall, explores the human use of space as a specialized elaboration of culture [1]. Hall's work highlights how individuals perceive and utilize personal and social space, which directly translates to classroom dynamics. Complementing this, Robert Sommer's concept of **classroom ecology** examines the interplay between the physical environment and human behavior within educational settings, emphasizing how different arrangements can either facilitate or hinder interaction [2]. Furthermore, Stephen Krashen's **affective filter hypothesis** posits that emotional variables such as anxiety, motivation, and self-confidence can act as a mental block, impeding language acquisition [3]. A classroom environment that lowers this filter is therefore crucial for effective language learning.*

This study focuses on university EFL students at a B1 English level, a stage where learners are capable of understanding and producing simple connected text on familiar topics, but often require encouragement and a supportive environment to engage in spontaneous conversation. We compare three common seating arrangements: traditional rows, U-shape, and cluster/group seating. Each arrangement presents unique opportunities and challenges for student interaction and speaking participation. By analyzing the observed participation data, this article aims to demonstrate how specific seating configurations can either promote or inhibit communicative activities, ultimately influencing the effectiveness of EFL instruction. The central argument advanced is that sociopetal arrangements, such as cluster seating, are more effective in fostering communication and reducing speaking anxiety, thereby optimizing the conditions for second language acquisition.

Proxemics and classroom ecology

The study of **proxemics**, introduced by Edward T. Hall, provides a foundational understanding of how individuals perceive and utilize space, and how these spatial behaviors are culturally influenced [1]. Hall identified different zones of personal space—intimate, personal, social, and public—each dictating appropriate distances for various interactions. In a classroom setting, these proxemic zones are constantly at play, influencing student-teacher and student-student interactions. For instance, a teacher standing within a student's intimate or personal space might be perceived differently depending on cultural norms, potentially affecting comfort levels and willingness to participate.

Building upon the principles of proxemics, Robert Sommer's work on **classroom ecology** delves into the specific ways in which the physical arrangement of a learning environment impacts human behavior and interaction [2]. Sommer distinguished between sociopetal and sociofugal arrangements. **Sociopetal arrangements** are those that bring people together, encouraging interaction and communication, such as circular or semi-circular seating. Conversely, **sociofugal arrangements** tend to keep people apart, discouraging interaction, like traditional rows of desks [2]. Sommer's research, particularly in college classrooms, highlighted how seating patterns directly correlate with student participation. For example, students in the front and center of traditional row arrangements tend to participate more, while those on the periphery or in the back are often less engaged [2]. This suggests that the physical layout is not merely aesthetic but a powerful determinant of communicative dynamics.

In the context of EFL classrooms, the implications of proxemics and classroom ecology are particularly salient. Effective language acquisition, especially in the development of speaking skills, necessitates frequent and meaningful interaction. If the classroom layout is sociofugal, it inherently creates barriers to spontaneous communication, potentially hindering the very goal of communicative language teaching (CLT). CLT emphasizes interaction as both the means and the ultimate goal of learning a language, requiring learners to engage in authentic communication to develop fluency and accuracy. For instance, a traditional row arrangement, while efficient for lectures, can inadvertently create a psychological distance that discourages students from initiating conversations or asking questions, fearing they might disrupt the formal setting or be judged by a large audience. This can be particularly detrimental in EFL contexts where learners often struggle with confidence and fluency. The physical separation can reinforce a perception of individual learning rather than collaborative exploration, which is counterproductive to language acquisition that thrives on interaction. Hall's concept of informal space, which is learned implicitly through experience, further suggests that the comfort and familiarity students feel within a given arrangement can significantly impact their willingness to engage [1]. A classroom that feels alien or overly formal due to its layout can inadvertently raise barriers to communication.

The affective filter hypothesis and group dynamics

Stephen Krashen's **affective filter hypothesis** is a cornerstone of second language acquisition theory, positing that a learner's emotional state can act as a mental barrier, or 'filter,' preventing comprehensible input from reaching the language acquisition device [3]. High anxiety, low motivation, and lack of self-confidence contribute to a strong affective filter, making language learning more challenging. Conversely, a low affective filter, characterized by comfort, motivation, and confidence, facilitates language acquisition [3]. In an EFL classroom, speaking activities are often a significant source of anxiety for learners, particularly those who fear making mistakes or being judged. Therefore, creating an environment that actively lowers this filter is paramount for promoting speaking participation.

Classroom seating arrangements can directly impact the affective filter. Sociofugal arrangements, such as traditional rows, can exacerbate anxiety by creating a formal, performance-oriented atmosphere where students feel exposed when speaking. The physical distance and lack of direct eye contact with peers can make the act of speaking feel more isolating and high-stakes. In contrast, sociopetal arrangements, like U-shapes or clusters, can foster a sense of community and reduce perceived risk. When students are physically closer and can easily make eye contact with their peers, it can promote a more relaxed and collaborative atmosphere, thereby lowering the affective filter and encouraging more spontaneous speaking [4].

Zoltán Dörnyei's work on **group dynamics in the language classroom** further underscores the importance of a cohesive and supportive learning environment [4]. Dörnyei argues that the internal characteristics and evolution of a learner group significantly shape the language learning process. A positive group dynamic, characterized by trust, mutual support, and a sense of belonging, can significantly enhance motivation and reduce anxiety, leading to increased participation [4]. Seating arrangements play a crucial role in establishing these dynamics. Arrangements that facilitate face-to-face interaction and small group collaboration naturally encourage the formation of stronger

interpersonal bonds and a more positive group identity, which are essential for effective communicative practice in EFL settings. When students feel part of a cohesive group, they are more likely to take risks, experiment with the language, and engage in meaningful communicative exchanges without fear of negative evaluation. The sense of belonging and reduced threat perception in sociopetal arrangements directly contributes to a lower affective filter, making learners more receptive to input and more willing to produce output. This is particularly relevant for B1 level EFL students who are developing their fluency and need ample opportunities for practice in a non-threatening environment.

Methodology

Participants and context

This study involved a cohort of **university-level English as a Foreign Language (EFL) students** enrolled in an intermediate English proficiency course. All participants were assessed to be at a **B1 English level** according to the Common European Framework of Reference for Languages (CEFR), indicating their ability to understand the main points of clear standard input on familiar matters regularly encountered in work, school, leisure, etc., and to produce simple connected text on topics which are familiar or of personal interest. The study was conducted in a typical university classroom setting, equipped with movable desks and chairs, allowing for flexible arrangement of the learning space. The participants were informed about the observational nature of the study and their consent was obtained.

Study design and procedures

The research employed a comparative observational design to investigate the influence of three distinct classroom seating arrangements on students' speaking participation. The three arrangements examined were:

1. **Traditional rows:** Students were seated in straight lines, facing the front of the classroom, with limited direct eye contact with peers.

2. **U-shape:** Desks and chairs were arranged in a U-shape, allowing students to see each other across the open end of the 'U' and facilitating easier eye contact and interaction with both the instructor and other students.

3. **Cluster/group seating:** Students were arranged in small groups of 3-4, with desks facing each other, promoting close-proximity interaction and collaborative work.

Each seating arrangement was implemented for a series of speaking-focused EFL lessons over a predetermined period. During these lessons, the instructor facilitated various communicative activities designed to elicit speaking participation, such as pair work, group discussions, debates, and role-plays. The content and difficulty of the speaking tasks were kept consistent across all arrangements to ensure comparability. The instructor maintained a consistent pedagogical approach, varying only the seating arrangement.

Data collection and analysis

Data on student speaking participation was collected through direct observation during the speaking activities. A trained observer systematically recorded the **number of active students** in each seating arrangement. An 'active student' was defined as a student who voluntarily initiated or responded to a communicative turn, contributed to a discussion, or actively engaged in a speaking task. This quantitative data provided a clear measure of the extent of student involvement in speaking activities across the different arrangements. The qualitative aspects of student comfort, interaction, and engagement were inferred from the observed patterns of participation and the general atmosphere within the classroom under each arrangement. The analysis focused on identifying correlations between the seating arrangement and the observed levels of student speaking participation, as well as discussing the potential underlying reasons for these patterns, drawing upon the theoretical frameworks of proxemics, classroom ecology, and the affective filter hypothesis.

Results and discussion

Quantitative analysis of speaking participation

The observational data collected during the study revealed a clear trend in student speaking participation across the three seating arrangements. The number of active students, defined as those who voluntarily engaged in communicative turns or tasks, varied significantly:

Seating Arrangement	Number of Active Students
Rows	6
U-shape	12
Clusters	17

As evident from the data, **cluster/group seating** yielded the highest number of active students (17), followed by the **U-shape arrangement** (12), and then **traditional rows** (6). This quantitative outcome

strongly supports the hypothesis that certain seating configurations are more conducive to fostering speaking participation in EFL classrooms.

Discussion of findings

Influence on speaking participation

The stark differences in active student numbers can be directly linked to the principles of proxemics and classroom ecology. In **traditional rows**, students are typically oriented towards the front of the classroom, primarily engaging with the instructor. This sociofugal arrangement inherently limits direct eye contact and face-to-face interaction among peers, which are crucial for spontaneous communication [2]. The physical distance and lack of visual cues from fellow students can create a more formal and less interactive atmosphere, potentially increasing the affective filter for many learners [3]. Students may feel more exposed when speaking, as their contribution is directed towards the entire class and the instructor, rather than a smaller, more intimate group.

Conversely, the **U-shape arrangement** represents a significant improvement in fostering interaction. By allowing students to see each other more readily, it reduces the physical barriers to communication. This semi-circular setup promotes a more inclusive environment where both instructor-led and student-to-student interactions are facilitated. The increased visibility among peers can contribute to a greater sense of community and shared learning, which, according to Dörnyei, is vital for positive group dynamics and increased participation in language classrooms [4]. The U-shape begins to lower the affective filter by creating a less intimidating space for speaking.

The **cluster/group seating** arrangement proved to be the most effective in promoting speaking participation. In this sociopetal configuration, students are seated in small, face-to-face groups, which maximizes opportunities for direct interaction and collaboration. This arrangement naturally encourages peer-to-peer communication, as students can easily turn to their group members for discussions, problem-solving, and task completion. The close proximity and intimate group setting significantly reduce the psychological distance between learners, thereby lowering the affective filter and mitigating speaking anxiety [3]. When students feel comfortable and supported within their small group, they are more likely to take risks, experiment with the language, and engage in more frequent and extended communicative exchanges. This aligns with Hall's observations on how spatial arrangements influence involvement and interaction [1].

Influence on student comfort, interaction, and engagement

Beyond mere numbers, the observed patterns suggest a deeper influence on student comfort, interaction, and engagement. In traditional rows, the environment can feel more formal and less personal, potentially leading to discomfort for students who are shy or anxious about speaking in front of a larger group. The limited opportunities for peer interaction can also lead to reduced engagement, as students may feel less connected to their classmates and the learning process. This can manifest as passive listening rather than active participation.

The U-shape arrangement, while better, still maintains a degree of formality. However, the increased visual access to peers can enhance comfort and encourage more interaction. Students are more likely to engage in brief exchanges and respond to questions, as the physical setup supports a more conversational flow. This improved interaction naturally leads to higher engagement, as students feel more involved in the collective learning experience.

Cluster seating, by its very design, fosters a high degree of student comfort, interaction, and engagement. The small group format creates a safe and supportive micro-environment where students can practice speaking with less pressure. The ease of interaction within these groups promotes collaborative learning, allowing students to co-construct meaning, provide peer feedback, and collectively overcome linguistic challenges. This heightened interaction and comfort directly translate into increased engagement, as students become active participants in their own learning and the learning of their peers. The sociopetal nature of cluster seating effectively reduces the affective filter, making the classroom a less threatening space for language production and encouraging students to embrace communicative challenges [3], [4].

In summary, the findings indicate that seating arrangements are not merely logistical considerations but powerful pedagogical tools that can significantly impact the communicative dynamics of an EFL classroom. Sociopetal arrangements, particularly cluster seating, create an environment that is conducive to increased speaking participation, enhanced student comfort, richer interaction, and deeper engagement, ultimately contributing to more effective second language acquisition.

Expanding on proxemics and classroom ecology

The foundational work of Edward T. Hall on proxemics provides a crucial lens through which to view classroom interactions. Hall's categorization of space into intimate, personal, social, and public zones is not merely a theoretical construct but a practical reality in every educational setting. In the EFL classroom, where the goal is often to simulate real-world communication, the manipulation of these zones can significantly impact learner behavior. When students are placed in a sociofugal arrangement like traditional rows, they are often forced to interact across social or even public distances, which can feel unnatural and intimidating for language practice. This distance can amplify the fear of making mistakes, as the student feels they are performing for an audience rather than conversing with a peer.

Conversely, sociopetal arrangements like clusters or U-shapes bring students into closer proximity, often within the personal or closer social zones. This physical closeness can foster a sense of intimacy and shared purpose, making the act of speaking feel less like a public performance and more like a private conversation. This shift in perception is vital for lowering the affective filter and encouraging the risk-taking necessary for language acquisition. Furthermore, the ability to easily read non-verbal cues—such as facial expressions and body language—is greatly enhanced in sociopetal arrangements. These cues are essential components of effective communication and can provide valuable scaffolding for learners who are still developing their linguistic competence.

Robert Sommer's concept of classroom ecology further illuminates the relationship between physical space and student behavior. Sommer's research demonstrated that students in the "action zone" of a traditional classroom—typically the front and center—are more likely to participate than those on the periphery. This suggests that the physical layout of the classroom can inadvertently create inequalities in participation opportunities. By moving away from traditional rows and adopting more inclusive arrangements, educators can democratize the classroom space, ensuring that all students have equal access to the "action zone" and the communicative opportunities it affords.

The role of the teacher in different arrangements

The seating arrangement also profoundly influences the role and behavior of the teacher. In a traditional row setup, the teacher is often positioned at the front of the room, acting as the primary source of information and the focal point of interaction. This teacher-centered approach can limit student-to-student communication and reinforce a passive learning dynamic. However, in sociopetal arrangements, the teacher's role shifts from a "sage on the stage" to a "guide on the side." The physical layout encourages the teacher to move around the room, interacting with different groups and facilitating communication rather than dominating it.

This shift in the teacher's role is particularly beneficial in the EFL classroom, where the goal is to maximize student talking time (STT) and minimize teacher talking time (TTT). By adopting a more facilitative role, the teacher can create a more learner-centered environment where students feel empowered to take ownership of their learning. Furthermore, the teacher's physical proximity to the students in sociopetal arrangements can help to build rapport and trust, further lowering the affective filter and creating a more supportive learning atmosphere.

Addressing potential challenges of sociopetal Arrangements

While the benefits of sociopetal arrangements are clear, it is important to acknowledge and address potential challenges. One common concern is that group seating can lead to increased off-task behavior and noise levels. To mitigate this, teachers must establish clear expectations and guidelines for group work, ensuring that students understand the purpose and structure of the activities. Additionally, careful monitoring and facilitation are essential to keep students focused and engaged.

Another challenge is the potential for unequal participation within groups. In some cases, more dominant or proficient students may monopolize the conversation, while quieter or less confident students may withdraw. To address this, teachers can assign specific roles within the groups, such as discussion leader, timekeeper, or note-taker, ensuring that all students have a defined responsibility and an opportunity to contribute. Furthermore, incorporating a mix of pair work and larger group activities can provide different types of interaction opportunities, catering to the diverse needs and preferences of the learners.

The impact of seating on different types of speaking activities

The effectiveness of a seating arrangement can also vary depending on the specific type of speaking activity being conducted. For example, traditional rows may be suitable for individual presentations or formal assessments, where the focus is on individual performance and the teacher needs a clear view of all students. However, for interactive activities such as role-plays, debates, or collaborative problem-solving, sociopetal arrangements are far more effective.

In a U-shape arrangement, for instance, students can easily engage in whole-class discussions or debates, as they can see and hear all of their peers. This setup is also ideal for activities that require the teacher to demonstrate or model a task before students practice it in pairs or small groups. Cluster seating, on the other hand, is particularly well-suited for collaborative tasks that require close cooperation and negotiation of meaning. By carefully matching the seating arrangement to the pedagogical goals of the activity, teachers can optimize the learning experience and maximize student engagement.

Long-term effects on language acquisition

The influence of classroom seating arrangements extends beyond immediate participation levels; it can also have long-term effects on language acquisition. A consistently supportive and interactive classroom environment, facilitated by sociopetal seating, can help to build students' confidence and motivation over time. As students become more comfortable speaking in class, they are more likely to seek out opportunities for practice outside of the classroom, further accelerating their language development.

Moreover, the positive group dynamics fostered by sociopetal arrangements can create a sense of community and belonging that is essential for sustained language learning. When students feel connected to their peers and supported by their teacher, they are more likely to persevere through the challenges of language acquisition and achieve their learning goals. Therefore, the intentional design of the classroom physical environment should be viewed not merely as a logistical consideration, but as a strategic pedagogical tool with the potential to significantly enhance the effectiveness of EFL instruction.

Conclusion

This study has underscored the critical role that classroom seating arrangements play in shaping the speaking participation of university EFL students. By examining traditional rows, U-shape, and cluster/group seating configurations, we have demonstrated a clear correlation between the physical organization of the learning space and the level of student communicative engagement. The quantitative data unequivocally shows that sociopetal arrangements, particularly cluster seating, significantly increase the number of active student speakers compared to more sociofugal setups like traditional rows.

The theoretical frameworks of Edward T. Hall's proxemics, Robert Sommer's classroom ecology, and Stephen Krashen's affective filter hypothesis provide robust explanations for these observed patterns. Traditional rows, by their very nature, create physical and psychological barriers that can elevate the affective filter, leading to reduced comfort and increased anxiety in speaking situations. In contrast, U-shape and especially cluster seating arrangements foster a more intimate, collaborative, and less intimidating environment. These sociopetal designs facilitate direct eye contact, encourage peer-to-peer interaction, and cultivate a sense of community, all of which are crucial for lowering the affective filter and promoting spontaneous language production.

Furthermore, the findings align with Zoltán Dörnyei's insights into group dynamics, highlighting how seating arrangements can influence the cohesion and interactive quality of a language learning group. When students are physically positioned to interact easily, they are more likely to develop stronger interpersonal bonds, feel more comfortable taking linguistic risks, and engage more deeply in communicative tasks. This, in turn, enhances overall student comfort, interaction, and engagement, creating a virtuous cycle that supports effective second language acquisition.

In conclusion, educators in EFL contexts should view classroom seating arrangements not as a mere logistical detail but as a powerful pedagogical tool. Intentional design of the learning space, favoring sociopetal configurations such as cluster seating, can significantly enhance speaking participation, reduce anxiety, and foster a more dynamic and communicative classroom environment. Future research could explore the long-term effects of these arrangements on language proficiency development and investigate student perceptions of comfort and anxiety more directly through qualitative methods. Ultimately, optimizing classroom proxemics is a vital step towards creating more effective and engaging EFL learning experiences.

References

1. Hall, E. T. (1966). *The hidden dimension*. Doubleday.
2. Sommer, R. (1967). Classroom ecology. *The Journal of Applied Behavioral Science*, 3(4), 489–503. <https://journals.sagepub.com/doi/10.1177/002188636700300404>
3. Krashen, S. D. (1985). *The input hypothesis: Issues and implications*. Longman.
4. Dörnyei, Z., & Murphey, T. (2003). *Group dynamics in the language classroom*. Cambridge University Press.

5. Gremmen, M. C., Van Den Berg, Y. H. M., Segers, E., & Cillessen, A. H. N. (2016). *Considerations for classroom seating arrangements and the role of teacher characteristics and beliefs*. *Social Psychology of Education*, 19(4), 749–774.

<https://link.springer.com/article/10.1007/s11218-016-9353-y>

6. Pranena, I. M. W. (2022). *U-shape and Cluster Seating Arrangement in Teaching English as Foreign Language in Yayasan Dana Punia*. *Journal of Educational Study*, 2(2), 168-176.

https://www.researchgate.net/publication/361313511_U-shape_and_Cluster_Seating_Arrangement_in_Teaching_English_as_Foreign_Language_in_Yayasan_Dana_Punia

7. Alvarado Muy, T. A., & Barreto Siavichay, V. E. (2023). *The Impact of Seating Arrangement on Interaction and Speaking Skills in EFL Students*. Universidad de Cuenca.

<https://dspace.ucuenca.edu.ec/items/dbe58b35-82e0-4715-99bd-2ce4921e2b02>

8. Pham, B., Le, T., & Duong, H. (2025). *Participation Level in Different Seating Zones and Experiences with Row-and-column Arrangement in EFL Speaking Class*. *EIKI Journal of Effective Teaching Methods*, 3(1).

<https://journals.eikipub.com/index.php/jetm/article/view/493>

ARTIFICIAL INTELLIGENCE IN ENGLISH LANGUAGE TEACHING FOR TOURISM STUDENTS: MODERN CHALLENGES, OPPORTUNITIES, AND EDUCATIONAL PERSPECTIVES

Kazyna Faizulla

Senior Teacher of International University of Tourism and Hospitality

Abstract

The rapid advancement of artificial intelligence (AI) has significantly influenced higher education and transformed approaches to foreign language teaching. In tourism education, English language proficiency is considered one of the most essential professional competencies due to the international nature of the tourism and hospitality industry. Artificial intelligence technologies such as adaptive learning platforms, intelligent tutoring systems, chatbots, speech recognition applications, virtual simulations, and machine translation tools create new possibilities for improving English language acquisition among tourism students. This article examines the role of AI in English language teaching within tourism education and analyzes both the pedagogical benefits and challenges associated with AI integration. The study explores modern educational methodologies supported by AI technologies and investigates how these innovations contribute to communicative competence, intercultural communication, learner autonomy, and professional preparedness. The article is based on a qualitative literature review and comparative analysis of recent academic studies related to AI-assisted language learning and tourism education. The findings demonstrate that AI technologies increase student motivation, support personalized learning, improve pronunciation and speaking skills, and simulate authentic tourism communication scenarios. However, the implementation of AI in education also raises concerns regarding ethical issues, digital inequality, overdependence on technology, and insufficient teacher preparedness. The study concludes that artificial intelligence should function as a complementary educational tool rather than a replacement for human teachers. Future educational models in tourism studies will likely combine traditional pedagogy with AI-supported learning environments in order to create more flexible, interactive, and practice-oriented systems of language instruction.

Key words: Artificial intelligence, tourism education, English language teaching, AI-assisted learning, EFL, digital education, tourism communication, adaptive learning, educational technology.

Introduction. The twenty-first century is characterized by rapid technological innovation that has transformed communication, business, healthcare, and education. Among the most influential technological developments is artificial intelligence (AI), which has become increasingly integrated into educational systems worldwide. AI technologies are now widely applied in language learning, online education, automated assessment, and personalized instruction. The integration of AI into education has created opportunities for more interactive, student-centered, and flexible learning environments. The tourism industry is one of the most globalized sectors of the modern economy. Tourism professionals interact daily with people from different linguistic and cultural backgrounds. As a result, English functions as the primary international language of tourism, hospitality, aviation, customer service, and intercultural communication. Students studying tourism must therefore develop strong English language skills to communicate effectively in professional contexts such as hotels, airports, travel agencies, museums, restaurants, and international events. Traditional methods of language teaching are increasingly being supplemented by digital technologies and AI-supported educational systems. Artificial intelligence allows students to practice language skills through virtual simulations, intelligent chatbots, speech recognition systems, and adaptive learning platforms. These technologies create realistic professional situations that help tourism students improve practical communication abilities before entering the workplace. The growing use of AI in tourism itself also increases the importance of technological competence among tourism students. Modern tourism businesses increasingly employ AI-based booking systems, virtual assistants, automated customer support, and intelligent recommendation systems. Consequently, tourism education must prepare students not only linguistically but also technologically.

The purpose of this article is to examine the impact of artificial intelligence on English language teaching for tourism students, analyze key educational opportunities and challenges associated with AI

integration, and explore modern pedagogical approaches that combine language learning, tourism education, and technological innovation.

Literature Review

Artificial intelligence has become one of the most widely discussed topics in contemporary educational research. Scholars from different academic disciplines have examined how AI technologies influence language learning, student motivation, communication skills, and educational management.

According to Russell and Norvig (2021), artificial intelligence refers to computational systems capable of performing tasks that normally require human intelligence, including learning, reasoning, speech recognition, and problem-solving. In educational contexts, AI technologies support automated assessment, adaptive learning, and personalized instruction. Holmes, Bialik, and Fadel (2019) argue that AI can significantly transform traditional educational models by providing individualized learning experiences and improving learner engagement. The researchers emphasize that AI systems can analyze student performance data and adapt educational materials according to learners' needs, learning pace, and academic progress. Research by Luckin et al. (2016) demonstrates that AI-assisted learning environments increase learner autonomy and motivation. According to the authors, intelligent tutoring systems can provide immediate feedback and personalized support that improve academic achievement and independent learning skills. In the field of language education, Chapelle and Sauro (2017) state that digital technologies and AI applications create opportunities for more interactive language practice. They emphasize that AI-based communication tools support authentic interaction and improve communicative competence in second-language acquisition. Kukulska-Hulme (2020) highlights the importance of mobile and AI-supported learning in modern foreign language education. The scholar argues that AI technologies allow students to continue language practice outside traditional classrooms and support lifelong learning.

In tourism education, English language competence is considered essential for professional success. According to Walker and Harding (2019), tourism professionals must demonstrate effective intercultural communication skills and customer-oriented interaction in multilingual environments. The researchers note that tourism students benefit significantly from practical communication activities that simulate real workplace situations. Recent studies by Huang, Hew, and Lo (2019) demonstrate that AI chatbots can effectively support conversational practice for English learners. Their research shows that chatbot interaction increases speaking confidence and reduces language anxiety among students. Furthermore, research conducted by Li (2021) indicates that speech recognition systems contribute positively to pronunciation development and oral fluency. AI applications can analyze pronunciation accuracy, stress patterns, intonation, and speaking speed, allowing learners to receive immediate corrective feedback. Another important area in the literature concerns adaptive learning systems. According to Siemens and Baker (2012), learning analytics and AI technologies make it possible to create personalized educational pathways based on learner behavior and performance data. Such systems are particularly useful in foreign language education because learners demonstrate different language levels and learning styles.

However, researchers also identify significant challenges associated with AI integration in education. Selwyn (2019) emphasizes ethical concerns related to data privacy, surveillance, and algorithmic bias in educational technologies. The scholar warns that educational institutions must establish ethical frameworks for AI implementation. Similarly, Zawacki-Richter et al. (2019) argue that although AI offers considerable educational benefits, human teachers remain irreplaceable because emotional intelligence, empathy, cultural understanding, and interpersonal communication cannot be fully replicated by machines. Teacher preparedness also represents a critical issue. According to Redecker (2017), many educators lack sufficient digital competence to effectively integrate AI technologies into classroom instruction. Professional development and teacher training are therefore essential for successful implementation.

Overall, the literature confirms that AI has substantial potential to improve English language teaching for tourism students by supporting communication practice, personalization, learner motivation, and professional preparation. Nevertheless, balanced and ethical implementation remains necessary.

Key Themes and Methodologies: One of the most significant themes is the personalization of educational content. AI systems analyze student performance and adapt learning materials according to individual needs, strengths, and weaknesses. Personalized learning improves student motivation and increases learning efficiency. Modern tourism education emphasizes practical communication skills rather than theoretical language knowledge alone. AI technologies support communicative competence through simulated dialogues, interactive exercises, and virtual customer-service scenarios. Tourism

professionals work in multicultural environments. AI-supported simulations expose students to different cultural communication styles and prepare them for international interaction. The integration of AI into tourism education also promotes digital competence. Students learn how to interact with intelligent technologies commonly used in modern tourism industries. Researchers consistently discuss ethical concerns, including data privacy, technological inequality, and overdependence on AI systems. Human-centered pedagogy remains an important principle in educational practice.

Methodology

This study employs a qualitative research methodology based on literature review and comparative analysis. Academic articles, books, and scholarly publications related to artificial intelligence, tourism education, and English language teaching were analyzed.

The research focused on identifying: major AI technologies used in language learning, educational benefits of AI integration, challenges and limitations associated with AI implementation, pedagogical approaches in tourism language education. The selected literature includes peer-reviewed journal articles, academic books, and international educational reports published between 2016 and 2024. Comparative analysis was used to examine similarities and differences among scholarly perspectives regarding AI-assisted language teaching. The study also applies a thematic analysis approach in order to categorize key trends and educational implications related to AI in tourism education.

Analysis and Discussion

The analysis demonstrates that artificial intelligence significantly influences English language teaching methodologies in tourism education. AI technologies contribute to more flexible, interactive, and practice-oriented educational environments.

One of the most important advantages of AI integration is increased learner engagement. Tourism students benefit from interactive communication practice through AI chatbots and virtual simulations. Unlike traditional classroom activities, AI systems provide immediate responses and allow unlimited practice opportunities.

Speech recognition technologies represent another major advancement. Tourism professionals must communicate clearly with international travelers, and pronunciation accuracy is essential for professional interaction. AI-powered pronunciation systems help students identify errors and improve speaking fluency through real-time feedback. Adaptive learning platforms also improve educational efficiency. Traditional classrooms often struggle to address individual learner differences. AI systems solve this problem by personalizing exercises according to student progress and language proficiency.

Furthermore, AI technologies create authentic tourism communication scenarios. Virtual hotel reception tasks, airport dialogues, customer-service interactions, and tour-guiding simulations allow students to practice professional English in realistic contexts. Such experiences increase student confidence and workplace preparedness.

However, the analysis also reveals important challenges. Excessive dependence on technology may reduce independent thinking and face-to-face communication skills. Students may become overly reliant on automated translation systems instead of developing authentic language competence. Ethical concerns remain highly significant. AI systems collect large amounts of personal and educational data, raising questions regarding privacy, security, and responsible data management.

Another challenge involves technological inequality. Educational institutions in developing regions may lack sufficient digital infrastructure, software access, or financial resources for implementing advanced AI systems. Teacher preparedness is equally important. Successful AI integration requires educators who possess digital literacy and technological competence. Many teachers still require professional training in AI-supported pedagogy.

Despite these limitations, the findings suggest that AI should not be viewed as a replacement for teachers. Human interaction remains essential for emotional support, intercultural sensitivity, motivation, and social communication. The most effective educational model is likely to be a hybrid approach combining traditional pedagogy with AI-assisted technologies.

The future of tourism education will likely involve greater interdisciplinary cooperation between linguistics, computer science, tourism studies, and educational psychology. Such collaboration can support the development of more effective and ethically responsible AI learning environments.

Conclusion. Artificial intelligence has become an increasingly important component of modern English language teaching for tourism students. AI technologies such as chatbots, adaptive learning systems, speech recognition applications, machine translation tools, and virtual simulations improve communication practice, learner engagement, and personalized instruction.

The study demonstrates that AI integration contributes positively to communicative competence, pronunciation development, learner autonomy, and professional preparedness in tourism education. AI-supported educational environments create realistic communication experiences that prepare students for international tourism workplaces.

At the same time, successful implementation of AI requires careful consideration of ethical concerns, teacher preparedness, technological accessibility, and human-centered pedagogy. Artificial intelligence should complement rather than replace traditional educational interaction.

Future research should focus on long-term educational outcomes, intercultural communication development, emotional aspects of AI-supported learning, and ethical frameworks for AI integration in higher education. The continued collaboration between educators, researchers, and technology developers will play a crucial role in shaping the future of tourism language education.

References

1. Chapelle, C., & Sauro, S. (2017). *The Handbook of Technology and Second Language Teaching and Learning*. Wiley-Blackwell.
2. Holmes, W., Bialik, M., & Fadel, C. (2019). *Artificial Intelligence in Education: Promises and Implications for Teaching and Learning*. Center for Curriculum Redesign.
3. Huang, J., Hew, K., & Lo, C. (2019). Investigating the effectiveness of chatbot-supported language learning. *Educational Technology Research and Development*, 67(4), 1–18.
4. Kukulska-Hulme, A. (2020). Mobile-assisted language learning and AI technologies. *ReCALL*, 32(2), 123–136.
5. Li, R. (2021). AI speech recognition in second language pronunciation training. *Computer Assisted Language Learning*, 34(6), 567–589.
6. Luckin, R., Holmes, W., Griffiths, M., & Forcier, L. (2016). *Intelligence Unleashed: An Argument for AI in Education*. Pearson Education.
7. Redecker, C. (2017). *European Framework for the Digital Competence of Educators*. European Commission.
8. Russell, S., & Norvig, P. (2021). *Artificial Intelligence: A Modern Approach* (4th ed.). Pearson.
9. Selwyn, N. (2019). *Should robots replace teachers? AI and the future of education*. Polity Press.
10. Siemens, G., & Baker, R. (2012). Learning analytics and educational data mining. *Proceedings of the 2nd International Conference on Learning Analytics and Knowledge*, 252–254.
11. Walker, R., & Harding, K. (2019). *Tourism English for International Communication*. Oxford University Press.
12. Zawacki-Richter, O., Marín, V., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education. *International Journal of Educational Technology in Higher Education*, 16(39), 1–27.

NEUROCOGNITIVE AND MULTIMODAL TECHNOLOGIES FOR DEVELOPING SPEECH COMPETENCE IN CHILDREN WITH ALALIA

Usarova Madina Odil kizi

Independent Researcher (PhD),

Nizami National Pedagogical University of Uzbekistan

Abstract

This article examines the neurocognitive and multimodal foundations of developing speech competence in children with alalia. Alalia is a complex developmental speech disorder associated with significant impairment in the formation of expressive and/or receptive speech despite relatively preserved peripheral hearing and intelligence. The problem is not limited to pronunciation difficulties; rather, it involves deficits in phonemic perception, auditory-verbal memory, lexical access, grammatical structuring, motor programming of speech, semantic processing, and communicative-pragmatic interaction.

Keywords: *alalia, speech competence, neurocognitive development, multimodal technologies, speech therapy, neuropsychological correction.*

Speech development is one of the most important indicators of a child's cognitive, emotional, social, and educational development. Through speech, a child not only communicates with others but also organizes thinking, regulates behavior, expresses needs, constructs social relationships, and participates in learning activities. Therefore, speech disorders in early childhood may negatively influence intellectual development, emotional stability, social adaptation, school readiness, and later academic achievement.

Among complex developmental speech disorders, alalia occupies a special place because it affects the very mechanisms of speech formation. In children with alalia, speech does not develop normally or develops with severe delay and structural impairment. Such children may have difficulty understanding speech, producing words and sentences, using grammar, retaining verbal information, differentiating sounds, and organizing coherent utterances. In many cases, speech impairment is accompanied by attention deficits, reduced working memory, motor planning difficulties, emotional instability, and limited communicative initiative.

In contemporary speech therapy and neuropsychology, alalia is increasingly understood not only as a linguistic disorder, but also as a neurocognitive developmental disturbance. This means that correctional work must address the interaction between brain mechanisms, cognitive processes, sensory-motor systems, and communicative behavior. Traditional speech therapy methods remain important; however, they should be enriched with multimodal technologies that stimulate several sensory and cognitive channels simultaneously. Such technologies make it possible to involve visual perception, auditory processing, tactile sensations, movement, rhythm, digital interaction, symbolic modeling, and play-based communication in the development of speech competence.

The relevance of this topic is determined by the need to modernize correctional and pedagogical support for children with severe speech disorders. The increasing availability of digital tools, interactive platforms, augmentative and alternative communication systems, neuropsychological exercises, and sensory integration techniques creates new opportunities for individualized speech development. At the same time, these technologies must be scientifically grounded, methodologically structured, and adapted to the child's age, diagnosis, cognitive profile, and communicative needs.

The scientific study of speech competence development in children with alalia is rooted in neuropsychology, speech-language pathology, developmental linguistics, cognitive neuroscience, and special pedagogy. Although the term alalia is widely used in post-Soviet speech therapy traditions, English-language literature more often discusses related conditions under the concepts of developmental language disorder, developmental dysphasia, childhood language disorder, or severe expressive-receptive language impairment. Therefore, the literature on alalia should be interpreted through an interdisciplinary lens that combines classical neuropsychological theory with contemporary evidence on developmental language disorders and multimodal intervention.

Classical neuropsychological research provides the theoretical foundation for understanding alalia as a disorder of higher cortical functions rather than merely a mechanical defect of articulation. Luria argued that speech is not localized in one isolated "speech center" but is organized through complex

functional systems involving auditory perception, motor programming, semantic processing, memory, and voluntary regulation [1]. This view is particularly important for children with alalia because their speech difficulties usually involve several interconnected mechanisms: impaired phonemic perception, weak auditory-verbal memory, deficient articulatory planning, reduced lexical access, and insufficient grammatical organization. From this perspective, correctional work should not be limited to sound production; it must target the broader neurocognitive system that supports speech and language development.

Vygotsky's cultural-historical theory also plays a major role in explaining the developmental consequences of alalia. According to Vygotsky, speech is both a means of social communication and a psychological tool for organizing thought, behavior, and learning [2]. In children with alalia, limited speech development may restrict not only communication but also symbolic thinking, self-regulation, social interaction, and educational readiness. Therefore, speech competence should be viewed as a multidimensional developmental construct that includes phonological, lexical, grammatical, semantic, pragmatic, and cognitive components. This position supports the idea that intervention should take place within meaningful social interaction rather than through isolated mechanical repetition.

Modern research on developmental language disorder confirms that severe language difficulties can affect expressive speech, receptive language, learning, reading, writing, and social participation. The National Institute on Deafness and Other Communication Disorders describes developmental language disorder as a condition that interferes with learning, understanding, and using language and is not explained by hearing loss, autism, or insufficient language exposure [3]. This definition is relevant to the study of alalia because both conditions involve persistent difficulties in language acquisition despite the absence of primary sensory impairment. However, alalia is often considered more severe and is frequently associated with neuropsychological immaturity of speech-related functional systems.

A significant contribution to the neurocognitive understanding of language development has been made by Kuhl, whose work demonstrates the importance of early auditory experience, phonetic perception, and neural plasticity in language acquisition [4]. Kuhl's findings are essential for understanding alalia because many children with this disorder experience difficulties in differentiating speech sounds and forming stable phonological representations. If the child cannot accurately process auditory speech input, later stages of language development, including vocabulary acquisition and grammar formation, become unstable. Thus, phonemic perception and auditory-verbal processing should be regarded as central targets of correctional intervention.

Bishop's research on language comprehension disorders emphasizes that receptive language impairment may be hidden or underestimated, especially when children use contextual cues, gestures, or routine-based understanding to compensate for weak linguistic processing [5]. This is highly relevant for children with sensory or mixed forms of alalia. A child may appear to understand everyday speech but fail when instructions become complex, abstract, or grammatically demanding. Therefore, assessment of alalia should include not only expressive speech but also comprehension, auditory memory, semantic differentiation, and the ability to process grammatical relations.

Leonard's work on children with specific language impairment, now commonly discussed within the broader framework of developmental language disorder, provides important insights into grammatical and morphosyntactic difficulties [6]. He shows that children with developmental language impairments often experience persistent problems in tense marking, agreement, sentence structure, word order, and grammatical generalization. These findings are useful for alalia research because many children with motor alalia may gradually acquire vocabulary but continue to struggle with grammatical organization. Consequently, speech therapy should move beyond word naming and include systematic formation of phrase structure, sentence models, and connected speech.

Paul, Norbury, and Gosse emphasize that language disorders from infancy through adolescence should be understood developmentally, since early difficulties in speech and language can later affect literacy, academic performance, peer interaction, and emotional well-being [7]. This view expands the concept of speech competence by connecting it with long-term educational and social outcomes. For children with alalia, early intervention is particularly important because delayed or insufficient correction may result in secondary difficulties: reduced communicative initiative, behavioral frustration, limited social participation, and poor school readiness.

Alalia is a complex developmental speech disorder that requires scientifically grounded, individualized, and interdisciplinary correctional support. The development of speech competence in children with alalia depends on the activation of neurocognitive mechanisms, the formation of sensory-motor and linguistic connections, and the creation of meaningful communicative situations.

Neurocognitive technologies make it possible to address the underlying mechanisms of speech impairment, including deficits in auditory perception, verbal memory, attention, motor programming, and executive regulation. Multimodal technologies, in turn, expand the child's opportunities for speech acquisition by involving visual, auditory, tactile, kinesthetic, rhythmic, digital, and communicative channels.

The most effective approach is an integrated model in which speech therapy, neuropsychological correction, sensory integration, digital tools, AAC, play-based learning, and family participation are combined into a unified correctional system. Such an approach allows not only to develop pronunciation or vocabulary but also to form full speech competence as the basis for cognitive development, social adaptation, emotional well-being, and successful education.

Thus, the use of neurocognitive and multimodal technologies in work with children with alalia represents a promising direction for modern special pedagogy and speech therapy. Future research should focus on developing evidence-based intervention programs, evaluating the effectiveness of digital and multimodal tools, and creating individualized correctional models adapted to different forms and severity levels of alalia.

References

1. Luria, A. R. *Higher Cortical Functions in Man*. Moscow: Moscow University Press, 1962.
2. Vygotsky, L. S. *Thought and Language*. Cambridge, MA: MIT Press, 1986.
3. Leontiev, A. A. *Language, Speech, and Speech Activity*. Moscow: Prosveshchenie, 1969.
4. Korkman, M., Kirk, U., & Kemp, S. *NEPSY-II: Clinical and Interpretive Manual*. San Antonio: The Psychological Corporation, 2007.
5. Bishop, D. V. M. *Uncommon Understanding: Development and Disorders of Language Comprehension in Children*. Hove: Psychology Press, 1997.
6. Leonard, L. B. *Children with Specific Language Impairment*. Cambridge, MA: MIT Press, 2014.
7. Paul, R., Norbury, C., & Gosse, C. *Language Disorders from Infancy Through Adolescence*. St. Louis: Elsevier, 2018.

THE MULTIMODAL NATURE OF DIGITAL AUTHENTIC MATERIALS IN FOREIGN LANGUAGE TEACHER EDUCATION

Zarbat Ayazhan Serikkyzy

Master student

KazUIRandWL, Almaty, Kazakhstan

Sadykova Aida Kenesbekovna

Scientific supervisor, Candidate of pedagogical sciences,

KazUIRandWL, Almaty, Kazakhstan

Abstract

In recent years, the integration of digital technologies into foreign language education has considerably changed the ways authentic language resources are used in the professional preparation of future teachers. Digital authentic materials, including videos, podcasts, online articles, social media content, and interactive platforms, provide learners with access to real communicative situations and contemporary forms of language use. Unlike traditional educational materials, these resources combine several modes of communication such as text, image, sound, gesture, and visual design, which makes them inherently multimodal.

This literature review examines the multimodal nature of digital authentic materials and their role in foreign language teacher education. Particular attention is given to the theoretical foundations of multimodality and multimodal discourse analysis, as well as to the pedagogical value of authentic digital communication in language learning environments. The study also explores how multimodal digital materials contribute to the development of communicative, sociolinguistic, intercultural, and digital competences of future foreign language teachers.

The review demonstrates that multimodal digital authentic materials create more interactive, contextualized, and meaningful learning experiences while simultaneously reflecting modern communication practices in digital environments.

Keywords: *multimodality, digital authentic materials (DAM), multimodal discourse analysis, foreign language teacher education, digital communication, communicative competence, multimodal literacy, authentic digital discourse.*

Introduction

The continuous expansion of digital technologies has substantially influenced contemporary foreign language education and transformed the ways language learning materials are created, distributed, and integrated into educational practice. Modern educational environments increasingly rely on digital authentic materials such as videos, podcasts, social media content, online newspapers, blogs, and interactive platforms that reflect naturally occurring communication in real-life contexts. Unlike traditional textbook-based materials, digital authentic resources expose learners to dynamic language use, cultural diversity, and contemporary communicative practices that characterize modern digital interaction. As a result, the integration of authentic digital resources has become an important component of foreign language teacher education.

At the same time, the growing role of digital communication has intensified scholarly interest in multimodality and multimodal discourse analysis. Digital authentic materials are inherently multimodal because they combine multiple semiotic resources, including written text, visual imagery, audio, gesture, layout, and interactive elements, which work together to construct meaning. Platforms such as YouTube, Instagram, TikTok, TED Talks, podcasts, and online media environments demonstrate that communication in digital spaces is no longer limited to verbal language alone but is increasingly shaped through the interaction of different modes. Consequently, understanding the multimodal nature of digital authentic materials has become essential for both language learning and teacher preparation.

Recent studies have explored multimodality, digital discourse, and the pedagogical value of authentic materials in language education. However, many existing studies focus primarily on general digital communication, multimodal theory, or the technical use of digital resources in classrooms. Comparatively less attention has been devoted to the multimodal characteristics of digital authentic materials specifically within the professional preparation of future foreign language teachers. In particular, there remains a limited number of literature reviews that examine how multimodal digital

authentic materials contribute to the development of communicative, sociolinguistic, intercultural, and digital competences in teacher education contexts.

Therefore, this **literature review** aims to examine the multimodal nature of digital authentic materials and analyze their significance in foreign language teacher education. The study focuses on the theoretical foundations of multimodality and explores how multimodal digital authentic materials support more contextualized, interactive, and meaningful language learning experiences in contemporary educational environments.

Literature review

Digital authentic materials in foreign language education

The growing integration of digital technologies into education has significantly increased the use of authentic materials in foreign language teaching and learning. **Authentic materials** are commonly understood as resources originally created for real communicative purposes rather than for instructional use. Such materials expose learners to naturally occurring language and provide opportunities to interact with contemporary forms of communication used by native speakers in everyday contexts [1]. Unlike simplified textbook exercises, authentic resources reflect real linguistic structures, spontaneous speech, cultural references, and socially situated communication, which makes them particularly valuable in foreign language education. Authentic materials help learners experience language as it is genuinely used in society and encourage more meaningful engagement with communication processes [2].

The rapid development of digital environments has transformed traditional authentic materials into digital authentic materials, which include online videos, podcasts, blogs, social media content, digital news articles, interactive websites, online interviews, and virtual communication platforms. These resources allow learners to encounter language in dynamic and multimodal forms that closely resemble real-life communication practices. Digital authentic materials differ from traditional printed resources because they combine several modes of meaning-making, including written text, audio, image, gesture, sound effects, visual design, and interaction. Consequently, digital authentic resources provide more contextualized exposure to language and communication in contemporary digital culture [3].

Modern digital communication platforms have become important sources of authentic language input in foreign language education. YouTube videos, TED Talks, podcasts, online interviews, and social networking platforms such as Instagram and TikTok demonstrate **how communication in digital spaces is constructed through the interaction** of multiple semiotic elements. Research in multimodal discourse analysis shows that meaning in digital communication is created not only through verbal language but also through images, sound, movement, layout, and visual symbolism [4]. In this regard, digital authentic materials represent naturally multimodal educational resources that allow learners to interpret language within broader communicative and cultural contexts.

Another characteristic of digital authentic materials is their **ability to support contextual learning**. Learners are not limited to isolated vocabulary or grammar exercises but instead interact with language embedded in meaningful social situations. Videos, podcasts, and digital storytelling provide examples of authentic pronunciation, intonation, communicative strategies, and cultural behavior that are difficult to reproduce through traditional teaching materials. Digital storytelling, for example, combines speech, image, music, and visual narrative to construct emotionally and socially meaningful communication, which enhances learners' engagement and comprehension processes [5].

The pedagogical value of digital authentic materials is closely related to the development of several competences important for future foreign language teachers:

1. **Communicative competence** – exposure to authentic speech and real-life communication.
2. **Sociolinguistic competence** – understanding cultural references, communication norms, and language variation.
3. **Intercultural competence** – interaction with diverse cultural perspectives presented in authentic digital environments.
4. **Digital literacy** – ability to navigate and critically evaluate digital communication.
5. **Multimodal literacy** – interpretation of meaning created through multiple communicative modes.

Through authentic digital discourse, learners become familiar with informal expressions, cultural references, communication norms, and contemporary speech practices used in online environments. Such experiences contribute to more realistic and practice-oriented language learning. In addition, digital authentic materials often increase learner motivation because students interact with contemporary and socially relevant content connected to real communication practices and modern media culture [1].

Despite their numerous advantages, the integration of digital authentic materials into foreign language education also presents several challenges. Learners may experience difficulties related to rapid speech, unfamiliar vocabulary, multimodal complexity, or information overload. Teachers are therefore expected not only to select appropriate digital resources but also to guide learners in interpreting multimodal content critically and effectively. Consequently, the successful integration of digital authentic materials requires the development of digital and multimodal literacy in foreign language teacher education, as future teachers must be prepared to work with complex digital communication environments [6].

The multimodal nature of digital authentic materials

Multimodality refers to the use of several communicative modes in the process of meaning-making. In modern communication, people no longer rely only on written or spoken language because meaning is often created through the interaction of text, image, sound, gesture, movement, colour, layout, and other visual or audio elements. According to multimodal discourse analysis, communication becomes more meaningful and contextualized when different semiotic resources work together simultaneously [4]. In digital environments, multimodality has become especially important because most online communication platforms combine visual, textual, and audio elements within one communicative space.

The concept of multimodality is closely connected with digital authentic materials used in foreign language education. Digital authentic materials are resources created for real communicative purposes in digital environments rather than for classroom instruction. These materials include YouTube videos, podcasts, TED Talks, Instagram posts, TikTok videos, online articles, blogs, digital storytelling platforms, and social media discourse. Unlike traditional printed materials, digital authentic resources are naturally multimodal because they combine several communicative modes simultaneously (see table 1).

Table 1.

Multimodal components of digital authentic materials and their educational functions in foreign language education

DAM	Multimodal components	Educational functions in foreign language education
YouTube educational videos	Spoken discourse, subtitles, gestures, facial expressions, background music.	Develop listening comprehension, pronunciation, communicative competence, interpretation of non-verbal communication.
TED Talks	Academic speech, visual presentations, body language, intonation, audience interaction.	Support public speaking skills, academic vocabulary acquisition, critical thinking, intercultural awareness.
Podcasts	Audio discourse, intonation, rhythm, pauses, emotional tone, conversational interaction.	Improve listening skills, comprehension of authentic pronunciation awareness, and interpretation of contextual meaning.
Instagram and TikTok	Images, captions, emojis, hashtags, comments, visual aesthetics, short video.	Develop sociolinguistic competence, understanding of informal digital communication and awareness of online discourse practices.
Online news articles and media platforms	Written text, photographs, hyperlinks, layout, headlines.	Develop reading comprehension, critical analysis, media literacy, and interpretation of authentic informational discourse.
Digital storytelling platforms	Narrative speech, music, visual sequencing, emotional imagery, sound effects.	Enhance emotional engagement, intercultural understanding, narrative competence.
Interactive learning websites	Hyperlinks, graphics, audio, animations, interactive tasks, visual navigation.	Encourage learner interaction, autonomous learning, digital literacy, and active participation in communication.

One of the most common types of digital authentic materials is **YouTube videos**. Meaning in such videos is interpreted not only through words but also through visual and emotional elements that support communication. Learners simultaneously observe pronunciation, body language, intonation, and contextual interaction, which creates a more realistic communicative environment.

TED Talks also represent important multimodal digital authentic materials in foreign language education. These resources combine academic speech, visual presentations, gestures, eye contact, audience interaction, and presentation design. The speaker's intonation, pauses, emotional expression, and visual support help learners understand meaning more effectively. In this case, communication is created through the interaction of verbal and non-verbal modes, which allows learners to develop both linguistic and interpretative skills.

Podcasts are another form of digital authentic materials widely used in language learning. Learners interpret meaning not only through vocabulary but also through pronunciation patterns, speech tempo, and emotional expression. Therefore, podcasts support authentic listening practice and improve learners' ability to understand naturally occurring speech.

Social media platforms such as Instagram and TikTok also demonstrate strong multimodal characteristics. Instagram communication combines photographs, captions, hashtags, emojis, comments, colours, visual aesthetics, and short video fragments. Similarly, TikTok videos integrate speech, subtitles, music, visual transitions, gestures, animations, and sound effects within short communicative formats. In these environments, language functions together with visual and interactive elements, making communication highly multimodal and contextualized.

Online newspapers, blogs, and digital articles are also multimodal resources because they combine written text with photographs, layout design, hyperlinks, embedded videos, and graphic elements. Meaning in online articles is often influenced by visual organization, headlines, colour schemes, and multimedia integration. Consequently, learners interact not only with linguistic information but also with visual structures that shape interpretation and comprehension.

Digital storytelling platforms represent another important type of multimodal digital authentic material. These resources combine narrative speech, visual sequencing, music, emotional imagery, and sound effects to create meaningful communicative experiences. According to Molina N. and Alonso Belmonte I., digital narratives demonstrate how different semiotic modes interact to construct integrated multimodal meaning that cannot be fully understood through language alone [5]. Thus, digital storytelling supports emotional engagement and contextual understanding in language learning.

Overall, digital authentic materials reflect the realities of modern digital communication, where meaning is created through the interaction of multiple semiotic resources. Their multimodal structure allows learners to experience authentic communication in more realistic, interactive, and socially meaningful contexts.

Multimodal digital authentic materials in foreign language teacher education

Multimodal digital authentic materials play an increasingly important role in foreign language teacher education because they expose future teachers to authentic communication practices commonly used in contemporary digital environments. Such materials combine multiple communicative modes, including text, sound, image, gesture, and interaction, which allows learners to experience language in more realistic and contextualized situations. The integration of multimodal digital authentic resources into teacher education not only supports language development but also contributes to the formation of communicative, sociolinguistic, intercultural, digital, and multimodal competences necessary for modern foreign language teaching.

1. Development of communicative competence

Multimodal digital authentic materials significantly contribute to the development of communicative competence in future foreign language teachers. Through authentic videos, podcasts, interviews, and online communication platforms, learners are exposed to naturally occurring speech, authentic pronunciation, contextual vocabulary, and real conversational strategies. Such materials improve listening comprehension because learners hear authentic accents, speech tempo, intonation, and spontaneous communication. At the same time, learners develop speaking skills by observing communicative behaviour, pronunciation patterns, and contextual interaction strategies used by native speakers. Unlike traditional exercises, multimodal environments create more realistic communicative situations where language is understood together with visual and emotional context.

2. Development of sociolinguistic and intercultural competence

Digital authentic materials also support the formation of sociolinguistic and intercultural competence. Through authentic digital discourse, learners encounter cultural references, online communication norms, informal expressions, and socially appropriate language use in various contexts. Social media discourse especially demonstrates how language changes depending on audience, social relationships, and communicative purpose. Learners become familiar with contemporary digital culture, intercultural interaction, and communication practices common in English-speaking online environments. This allows future teachers to better understand authentic language use beyond textbook communication models.

3. Development of digital and multimodal literacy

The integration of multimodal digital authentic materials into education contributes to the development of digital literacy and multimodal literacy. Digital literacy involves the ability to search, analyze, evaluate, and use online information critically and responsibly. Multimodal literacy refers to the ability to interpret meaning created through text, image, sound, layout, gesture, and interaction [6]. Since modern communication increasingly depends on multimedia and digital interaction, future foreign language teachers must be able to critically interpret multimodal digital discourse and effectively integrate digital resources into the educational process.

Challenges of using multimodal digital authentic materials

Despite their pedagogical advantages, multimodal digital authentic materials also create several challenges in foreign language education. One major difficulty is information overload because learners often process large amounts of visual, textual, and audio information simultaneously. Authentic materials may contain complex vocabulary, idiomatic expressions, and culturally specific references that complicate comprehension. Fast speech and natural pronunciation patterns may also create difficulties for learners with lower proficiency levels. Another challenge involves teacher preparation, since educators need sufficient methodological and digital competence to select and adapt to multimodal materials appropriately. Furthermore, digital environments may become distracting due to entertainment-oriented content and constant online interaction. Therefore, effective integration of multimodal digital authentic materials requires careful pedagogical planning and critical guidance from teachers.

Another important gap concerns the lack of practical frameworks for integrating multimodal digital authentic materials into foreign language teacher training programs. Future teachers increasingly work in digital learning environments; however, many teacher education programs still provide limited preparation for analyzing and using multimodal digital resources critically and effectively. Therefore, further research is needed to investigate the pedagogical implementation of multimodal digital authentic materials and their influence on contemporary foreign language teacher education.

Conclusion

In conclusion, digital authentic materials have become an essential component of contemporary foreign language teacher education due to the growing role of digital communication in modern society. Their multimodal nature allows learners to interact with authentic language through the integration of text, image, sound, gesture, and visual design within realistic communicative contexts. Unlike traditional educational materials, multimodal digital authentic resources provide future foreign language teachers with opportunities to develop communicative, sociolinguistic, intercultural, digital, and multimodal competences simultaneously.

The literature review demonstrates that platforms such as YouTube, TED Talks, podcasts, social media, and digital storytelling environments support more contextualized and interactive language learning experiences. At the same time, the effective integration of multimodal digital authentic materials requires appropriate teacher preparation and critical understanding of digital communication practices. Therefore, multimodal digital authentic materials should be considered an important pedagogical resource in modern foreign language teacher education and direction for future research and educational practice.

References

1. Gilmore A. *Authentic Materials and Authenticity in Foreign Language Learning // Language Teaching*. – 2007. – Vol. 40(2). – P. 97–118.
2. Tomlinson B. *Materials Development in Language Teaching*. – Cambridge: Cambridge University Press, 2011. – 437 p.
3. O'Halloran K.L. *Multimodal Discourse Analysis // The Routledge Handbook of Multimodal Analysis*. – London: Routledge, 2021. – P. 15–35.
4. Kress G., van Leeuwen T. *Reading Images: The Grammar of Visual Design*. – 2nd ed. – London: Routledge, 2006. – 312 p.
5. Molina N., Alonso Belmonte I. *The Construction of Meaning in Multimodal Discourse // Procedia – Social and Behavioral Sciences*. – 2016. – Vol. 212. – P. 129–136.
6. Moschini I. *Critical Multimodal Analysis of Digital Discourse: Preliminary Remarks // LEA – Lingue e Letterature d'Oriente e d'Occidente*. – 2014. – Vol. 3. – P. 197–201.

MUSIC EDUCATION AND SOCIAL DEVELOPMENT: COMMUNITY FORMATION THROUGH MUSIC

Zhantayeva Marzhan Kumisbekovna

NAO «Taraz University named after M. H. Dulati»

Department of «Music and art education», senior lecturer

Taraz, Kazakhstan

МУЗЫКАЛЫҚ БІЛІМ ЖӘНЕ ӘЛЕУМЕТТІК ДАМУ: МУЗЫКА АРҚЫЛЫ ҚОҒАМДАСТЫҚТЫҢ ҚАЛЫПТАСУЫ

Жантаева Маржан Кумисбековна

«М.Х.Дулати атындағы Тараз университеті» КЕАҚ

«Музыка және көркемдік білім» кафедрасы, аға оқытушысы

Тараз, Қазақстан

Abstract

Music is not just a collection of sounds, melodies, and rhythms. It is a powerful tool that can bring people together, foster connections, and contribute to the development of society. In this article, we explore how music education plays a crucial role in social development, helping to build strong and cohesive communities.

From an early age, music education offers unique opportunities for social interaction. When children learn to sing together, play in an ensemble, or simply listen to music in a group, they develop important skills of cooperation. They have to negotiate, listen to each other, wait for their turn, and work towards a common goal of creating a harmonious sound. These simple yet fundamental actions teach empathy, respect for others, and the ability to compromise, which are the foundations of any healthy community.

Moreover, music education promotes a sense of belonging. When people come together to make music, whether it's a school choir, a local orchestra, or an amateur band, they become part of something bigger than themselves. The shared interests, collaborative efforts, and joy of creating music create strong bonds. This is especially important in today's world, where many people may feel isolated. Music groups become a kind of «second family», where everyone finds their place and support.

Music is also a universal language that can bridge cultural and social barriers. By studying and performing music from different cultures and eras, we broaden our horizons, learn to appreciate diversity, and find common ground. Musical events, such as concerts or festivals, bring people from different backgrounds together, creating an atmosphere of unity and understanding.

Finally, music education fosters self-confidence and self-expression. When individuals dare to perform in front of others and share their creativity, they gain valuable experiences. This confidence then extends to other areas of life, making individuals more active and engaged in their communities.

Thus, music education is not just about learning to play an instrument or sing. It is an investment in social well-being, in shaping individuals who are capable of cooperation, empathy, and creating strong, harmonious communities where everyone feels heard and valued.

Аннотация

Музыка тек дыбыстардың, әуендердің және ритақтардың жиынтығы емес. Бұл адамдарды біріктіруге, байланыстар қалыптастыруға және қоғамның дамуына ықпал ететін қуатты құрал. Бұл мақалада біз Музыкалық білім берудің берік және тығыз қауымдастықтар құруға көмектесу арқылы әлеуметтік дамуда қалай шешуші рөл атқаратынын қарастырамыз.

Ерте жастан бастап музыкалық білім әлеуметтік өзара әрекеттесудің ерекше мүмкіндіктерін ұсынады. Балалар бірге ән айтуды, ансамбльде ойнауды немесе жай ғана топта музыка тыңдауды үйренсе, олар маңызды ынтымақтастық дағдыларын үйренеді. Олар келісіп, бір – бірін тыңдап, өз кезегін күтіп, ортақ мақсат-үйлесімді дыбыс шығару үшін жұмыс істеуі керек. Бұл қарапайым, бірақ іргелі әрекеттер эмпатияға, басқаларға құрметпен қарауға және кез-келген сау қоғамдастықтың негізі болып табылатын команда келуге үйретеді.

Сонымен қатар, музыкалық білім тиесілілік сезімін дамытуға ықпал етеді. Адамдар музыка ойнауға жиналғанда – мектеп хоры, жергілікті топ немесе әуесқой топ болсын – олар өздерінен үлкен нәрсенің бір бөлігі болады. Ортақ мүдделер, бірлескен күш-жігер және Музыка жасау қуанышы берік байланыстар жасайды. Бұл әсіресе көптеген адамдар өздерін оқшауланған

сезінетін қазіргі әлемде өте маңызды. Музыкалық топтар әркім өз орны мен қолдауын табатын «екінші отбасы» түріне айналады.

Музыка сонымен қатар мәдени және әлеуметтік кедергілерді жеңе алатын әмбебап тіл болып табылады. Әр түрлі халықтар мен дәуірлердің музыкасын оқып, орындай отырып, біз өз көкжиегімізді кеңейтеміз, әртүрлілікті бағалауды және ортақ тіл табуды үйренеміз. Концерттер немесе фестивальдар сияқты музыкалық іс-шаралар әр түрлі ортадан шыққан адамдарды біріктіріп, бірлік пен өзара түсіністік атмосферасын жасайды.

Соңында, музыкалық білім өзіне деген сенімділік пен өзін-өзі көрсетуді дамытады. Адам басқалардың алдында сөйлеуге, өз шығармашылығымен бөлісуге батылы жеткенде, ол құнды тәжірибе жинайды. Содан кейін бұл сенімділік өмірдің басқа салаларына ауысады, бұл адамды белсенді етеді және өз қауымдастығының өміріне қатысады.

Осылайша, музыкалық білім тек аспапта ойнауды немесе ән айтуды үйрену туралы емес. Бұл әлеуметтік әл-ауқатқа, ынтымақтастыққа, эмпатияға қабілетті адамдарды қалыптастыруға және әркім өзін тыңдап, құнды сезінетін күшті, үйлесімді қауымдастықтар құруға инвестиция.

Keywords: Music Education, Social Development, Community Formation, music education, social integration, collective identity, joint creativity, cultural interaction, social unity, art and society.

Кілт сөздер: музыкалық білім, әлеуметтік даму, қауымдастық қалыптастыру, музыкалық тәрбие, әлеуметтік интеграция, ұжымдық бірегейлік, бірлескен шығармашылық, мәдени өзара іс-қимыл, әлеуметтік бірлік, өнер және қоғам.

Музыка – мәдени, жастық және әлеуметтік кедергілерді еңсере алатын әмбебап тіл. Оның адамға әсері жан-жақты: ішкі дүниесін байытып, эстетикалық қабылдау мен танымдық қабілеттерін дамытып қана қоймай, сонымен қатар тұлғаның қалыптасуында, қоғамға кірігуінде басты рөл атқарады. Білім беру жағдайында музыкалық білім нота жазуы мен орындаушылық дағдыларды меңгеру шеңберінен шығып, әлеуметтік құзіреттілікті дамытудың және қоғамда берік байланыс орнатудың қуатты құралына айналады. Бұл мақалада музыкалық білім мен қоғамдық дамудың байланысы қарастырылып, музыка арқылы қауымдастықтың қалыптасу тетіктерін ашатын зерттеулерге тоқталып, осы саладағы ғылыми жаңашылдық айқындалады.

Зерттеудің мақсаты: Музыкалық білім мен жеке тұлғаның әлеуметтік дамуының байланысын зерттеу, сонымен қатар музыкалық іс-әрекет арқылы тұрақты қауымдастықтарды қалыптастыру механизмдерін анықтау.

Міндеттері:

- Музыканың адамның әлеуметтік дамуына ықпалының теориялық негіздерін, оның ішінде қарым-қатынас, ынтымақтастық, эмпатия және топтық сәйкестік аспектілерін талдау;

- Музыкалық білімнің әртүрлі формаларының (жеке сабақтар, ансамбльде ойнау, хорда ән айту, оркестрлік орындау, музыкалық студиялар мен үйірмелер) әлеуметтік дағдыларды дамытудағы рөлін зерттеу;

- Музыкалық білім мекемелері мен жобалары негізінде қоғамдастықтың табысты қалыптасуының нақты мысалдары мен жағдайларын анықтау;

- Музыкалық білім арқылы қауымдастықтың қалыптасуына ықпал ететін және кедергі келтіретін факторларды анықтау;

- Қоғамдық байланыстарды нығайту үшін музыкалық білім беруді тиімді пайдалану бойынша мұғалімдерге, оқу орындарының басшыларына және музыкалық жобаларды ұйымдастырушыларға ұсыныстар әзірлеу.

Қазіргі әлемде, жеке тұлғалықтың артуымен және кейде бөлектенумен сипатталатын, берік әлеуметтік байланыстарды жасау және тиесілілік сезімін қалыптастыру қажеттілігі ерекше болып табылады. Музыкалық білім, адамдарды біріктірудің бірегей әлеуетіне ие болып, осы мәселені шешудің тиімді жолдарын ұсынады.

Музыкалық білім қоғамдық дамудың катализаторы ретінде:

Музыкалық білім: тек ноталар ғана емес, прогресс қозғалтқышы.

Адамдар көбінесе музыканы жағымды, көңіл-күйді көтеретін немесе тыныштандыратын нәрсе ретінде қабылдайды. Бірақ бұл сыртқы жеңілдіктің артында қоғамның дамуына терең әсер ете алатын қуатты әлеует жатыр. Бұл әлеуетті ашуда музыкалық білім маңызды рөл атқарады.

Музыкалық білім - аспапта ойнауды немесе ән айтуды үйрену ғана емес. Әр түрлі деңгейде дивидендтер төлейтін болашаққа салынған инвестиция:

I - Тұлғаның дамуы:

Тәртіп және өзін-өзі бақылау: Тұрақты сабақтар, күрделі шығармаларды үйрену табандылықты, шыдамдылықты және мақсат қоя білуді талап етеді. Дағдылар оқуға, жұмысқа және күнделікті өмірге ауысады;

Шығармашылық және қиял: Музыка - эмоциялар мен идеялардың тілі. Ол санадан тыс ойлауға, жаңа шешімдер табуға, шығармашылық арқылы өзін көрсетуге үйретеді;

Эмпатия мен эмоционалды интеллект: Әртүрлі музыканы орындау және тыңдау арқылы оқушылар өздерінің де, басқалардың да көптеген эмоцияларын тануға және күшті эмоционалды тануға әсерге ие. Эмоционалды интеллект пен эмпатия қабілетін дамытуға көмектеседі. «Музыка балалардың сезіміне тікелей әсер ете отырып, олардың адамгершілік қасиеттерін қалыптастырады. Балаларды әртүрлі эмоционалды-бейнелі мазмұндағы шығармалармен таныстыра отырып, оларды эмпатияға шақырады» [1].

Шоғырлану және есте сақтау: Музыка адамға күшті әсер етеді. «Ол шоғырлану мен есте сақтау қабілетін арттырады, тапсырманың төзімділігін арттырады, көңіл-күйді жеңілдетеді, алаңдаушылық пен депрессияны азайтады, шаршауды болдырмайды, ауырсынуға реакцияңызды жақсартады және тиімдірек жұмыс істеуге көмектеседі» [2].

II - Әлеуметтік даму:

Топтық жұмыс және ынтымақтастық: Оркестрлер, хорлар, ансамбльдер – адамдардың бірлесіп жұмыс істеуді, бір-бірін тыңдауды, ортақ мақсатқа жетуді үйренуінің жарқын мысалдары. Бұл азаматтық ұстанымды қалыптастыру үшін баға жетпес тәжірибе;

Әртүрлілікке құрмет пен төзімділікті дамыту: Әртүрлі мәдениеттердің музыкалық дәстүрлері оқу және түсіну үшін бай материалды ұсынады. Түрлі музыкалық стильдер мен орындаушыларға әсер ету толеранттылықты дамытуға, мәдени әртүрлілікті құрметтеуге және теріс пікірді жеңуге көмектеседі. Музыкалық топтарда әр түрлі жастағы, мінездегі және көзқарастағы адамдар ортақ іс үшін бірігеді. Әркімнің үлесін бағалауға және ортақ тіл табуға үйретеді;

Қарым - қатынас дағдылары: Музыканы хорда, оркестрде немесе ансамбльде бірге ойнау қатысушылардан белсенді тыңдауды, келіссөздер жүргізуді, рөлдерді бөлуді және топ болып жұмыс істеуді талап етеді. Бұл дағдылар музыкалық контекстен тыс адамдар арасындағы қарым-қатынасқа тікелей ауысады;

III - Мәдени байыту:

Мәдени мұраны түсіну: Музыкалық білім классикалық және халықтық музыка әлеміне есік ашады, әртүрлі халықтардың тарихы мен дәстүрлерімен таныстырады. Өз мәдениетін тереңірек түсінуді және басқаларға құрмет көрсетуді қалыптастырады;

Эстетикалық талғамды қалыптастыру: «Музыканттықтың алғашқы белгісі – музыкалық шығарманың мінезін, көңіл-күйін сезіну, естігендеріне жанашырлық таныту, эмоционалды қатынас таныту, музыкалық образды түсіну. Музыка толғандырады, реакция тудырады, өмірлік құбылыстармен таныстырады, ассоциацияларды тудырады» [4].

Музыкалық білім қоғамдық дамудың катализаторына қалай айналады?

«Катализатор» туралы айтқанда, процесті жылдамдататын және күшейтетін нәрсені айтады. Музыкалық білім дәл осылай жасайды:

Белсенді және жауапты азаматтарды тәрбиелейді: Музыкалық дайындықтан өткен адамдар көбінесе жауапкершілік сезімін дамытады, командада жұмыс істей алады және кемелдікке ұмтылады. Қасиеттер күшті және гүлденген қоғам құру үшін қажет;

Үйлесімді қоғамның қалыптасуына ықпал етеді: Музыка адамдарды біріктіреді, шекараларды бұлдыратады және өзара түсіністікке ықпал етеді. Музыка мен өнер бағаланатын қоғам ашық, толерантты және мәдени бай болады;

Инновация мен шығармашылықты ынталандырады: Шығармашылық ойлауды дамыта отырып, музыкалық білім адамдарды ғылым, технология немесе бизнес болсын, кез-келген қызмет саласында күрделі мәселелерді шешуге дайындайды.

Музыкалық білім – нота жазу мен орындаушылық техникасын меңгеру ғана емес, ол түрлі дағдыларды қамтитын күрделі процесс:

Ынтымақтастық және өзара көмек дағдыларын қалыптастыру: «Ынтымақтастық - бірлесіп жұмыс істеп, ортақ мақсатқа жету үшін өзара әрекеттесу. Топтық жұмыс барысында ынтымақтастық дағдылары қалыптасады, өйткені әр оқушының пікірі мен идеясы топтық

шешімге әсер етеді» [5]. Музыкалық топта әркімнің жетістігі әркімнің үлесіне байланысты. Оқушылар бір-бірін қолдауға, қиындықтарды жеңуге көмектесуге және ортақ жетістіктерге қуануға үйренеді;

Әлеуметтік интеграция: Музыкалық іс-шаралар, әсіресе топтық іс-шаралар, әртүрлі әлеуметтік мәртебелері, мәдени фоны және жас топтары бар адамдардың интеграциясына ықпал етеді. Бірлескен шығармашылық және ортақ музыкалық мақсаттарға жету шекараны бұлдыратады және өзара түсіністікке ықпал етеді;

Эмпатия, толеранттылықты және төзімділікті қалыптастыру: Музыкалық өнер басқа адамдардың эмоциялары мен сезімдерін терең түсінуге мүмкіндік береді, эмпатияны дамытады. Түрлі мәдениеттер мен стильдердің шығармаларын бірлесе орындау әртүрлілікке төзімді қатынасты қалыптастыруға ықпал етеді;

Коммуникативтік дағдыларды дамыту: «Коммуникативтік дағдылар – адамның өз ойын түсінікті әрі тиімді жеткізе білу қабілеті. Қоғамда дұрыс қарым-қатынас жасап, өз пікірлерін білдіру, тіл табысу қабілетін жетілдірудің маңызды бөлігі. Коммуникативтік дағдыларының дамуы оның әлеуметтік, эмоционалдық және когнитивтік тұрғыдан дұрыс қалыптасуына негіз болады» [6]. Ансамбльде ойнау, хорда ән айту және басқа да ұжымдық музыкалық әрекеттер қатысушылардан белсенді тыңдауды, келісімге келуді, компромисске баруды және бір-бірімен тиімді әрекеттесуді талап етеді;

Топтық сәйкестікті нығайту: Музыкалық ұжымға қатысу топқа тиесілілік сезімін қалыптастырады, жалпы құндылықтар мен мақсаттарды қалыптастырады, топтық сәйкестікті нығайтуға және қатысушылардың өзін-өзі бағалауын арттыруға ықпал етеді;

Психологиялық ал-ауқат: Музыкалық әрекет психо-эмоциялық жағдайға оң әсер етеді, стресс және уайым деңгейін төмендетеді, бұл өз кезегінде әлеуметтік әрекеттестіктің үйлесімділігін арттырады.

Осылайша, музыкалық білімнің қауымдастықты қалыптастыру құралы ретінде өзектілігін зерттеу оның адамдардың өмір сапасын жақсартуда және өзекті әлеуметтік мәселелерді шешудегі айтарлықтай әлеуетімен негізделген.

Зерттеулер:

Музыканың когнитивтік, эмоционалды және әлеуметтік дамуына әсері туралы көптеген зерттеулер бар. Көптеген жұмыстар музыкалық білімнің келесіге оң әсерін растайды:

Когнитивтік функциялар: Еске сақтау қабілетін, назар аударуды, кеңістіктік ойлау және логиканы дамыту (мысалы, музыка нейробиологиясы саласындағы зерттеулер);

Эмоциялық интеллект: Эмоцияларды тану, түсіну және басқару қабілеті;

Зерттеулер: эмпирикалық деректер және теориялық тәсілдер: «Эмпирикалық зерттеу тікелей объектіге бағытталған және бақылау мен тәжірибе деректеріне сүйенеді. Теориялық зерттеу ғылымның түсінік аппаратын жетілдірумен және дамытумен байланысты және объективті ақиқаттың нақты байланыстары мен заңдылықтары тұрғысынан алғанда оны жан-жақты танып білуге бағытталған» [8]. Музыкалық білім және әлеуметтік даму саласындағы қазіргі заманғы зерттеулер әртүрлі әдістемелерді қолданады, бақылау мен сұхбатқа негізделген сапалық зерттеулерден бастап статистикалық деректерді талдайтын сандық зерттеулерге дейін;

Ортақ музыкалық шығармашылыққа әсерді зерттеу: Көптеген жұмыстар оркестрлерде, хорлар мен ансамбльдерде қатысудың оқушылардың әлеуметтік дағдыларына оң әсерін көрсетеді. Мысалы, зерттеулер белсенді түрде музыкалық топтарға қатысатын оқушылардың әлеуметтік құзыреттілігі жоғары екенін, даулармен жақсы күресетінін және құрдастарына оң көзқараста болатынын көрсетеді;

Музыка рөлін мәдениаралық диалогта зерттеулер: Әр түрлі мәдениеттердің өкілдерінен құралған музыкалық ұжымдарды құруға бағытталған жобалар музыка қалай өзара түсіністікке және стереотиптерді жеңуге көпір бола алатынын көрсетеді. Мұндай жобалар көп жағдайда тұрақты достық байланыстарды қалыптастыруға және мәдениаралық диалогты нығайтуға әкеледі;

Арнайы қажеттіліктері бар балаларға музыкалық білімнің әсерін зерттеу: Музыкалық терапия мен бейімделген музыкалық білім баланың әлеуметтік дағдыларын дамытуда, аутизм, назарының қалтқысыздығы мен гиперактивтілік синдромы және басқа да даму ерекшеліктері бар балаларда елеулі жетістіктер көрсетеді. Музыка оларға эмоцияларын жақсырақ білдіруге, қоршаған ортамен байланыс орнатуға және өзін-өзі реттеу дағдыларын дамытуға көмектеседі;

Теориялық модельдер: Музыка арқылы қауымдастық қалыптасу механизмдерін түсіндіретін теориялық модельдер әзірленуде. Мысалы, әлеуметтік оқытудың теориясына негізделген модельдер музыкалық контексте әлеуметтік нормалар мен дағдыларды меңгерудегі бақылау мен үлгі тұтудың рөлін атап көрсетеді. Басқа модельдер топтық динамика мен ұжымдылық бірегейліктің тиесілілік сезімін қалыптастырудағы рөлін көрсетеді.

Ғылыми жаңалық: Кенет ғылыми зерттеулерге қарамастан, музыкалық білім және әлеуметтік дамытудың саласындағы ғылыми жаңалық келесі бағыттарда ашылуда:

Нейробиологиялық негіздерді терең зерттеу: Қазіргі заманғы зерттеулер музыканың көмегімен әлеуметтік байланыстардың қалыптасуының нейробиологиялық механизмдерін зерттей бастады. «...зерттеуге қатысушының эмоциясын анықтап, сол эмоциялық жағдайда ол қаншалықты белсенді болғанын анықтауға мүмкіндік беретін технология» [7] Бірлесіп музыка орындау кезіндегі ми белсенділігін, қозғалыстар мен дыбыстарды синхрондаудың окситоцин (жақындық гормоны) және басқа нейромедиаторларды өндіруге әсерін зерттеу әлеуметтік өзара әрекеттестікті тиімдірек ету үшін музыканың миды «қайта құру» жолдарын түсінуге жаңа көзжиектер ашады. Ғылыми жаңалық бақылауға алынатын әлеуметтік әсерлерді сипаттаудан олардың физиологиялық тамырларын түсіндіруге көшу болып табылады;

Әлеуметтік дамуға арналған музыкалық білім беруге жекелендірілген тәсілдерді әзірлеу: дәстүрлі тәсілдер көбінесе жалпы топтарға бағытталған. Жаңалық оқушылардың жеке ерекшеліктерін, әлеуметтік қажеттіліктерін және оқу стильдерін ескеретін әдістемелерді әзірлеу және сынау болып табылады. Бұған бейімделген оқытуды іске асыру үшін технологияларды пайдалану, нақты әлеуметтік дағдыларды дамытуға бағытталған жеке музыкалық траекторияларды жасау және олардың тиімділігін жекелендірілген деректер негізінде бағалау кіреді;

Музыкалық қауымдастықтарды қалыптастыруда сандық технологиялардың рөлін зерттеу: Сандық дәуірде музыкалық қауымдастықтар физикалық кеңістік шегінен шығады. Ғылыми жаңалығы онлайн-платформалардың, виртуалды ансамбльдердің, цифрлық ортадағы бірлескен музыкалық шығармашылықтың және музыкамен байланысты әлеуметтік желілердің қауымдастық сезімін қалыптастыруға, әлеуметтік дағдыларды дамытуға және географиялық шектеулерді еңсеруге қалай әсер ететінін зерттеуде. Арнайы қызығушылық виртуалды музыкалық қауымдастықтардағы сенім мен қолдаудың қалыптасу механизмдерін талдайтын зерттеулерде көрсетіледі.

Музыкалық білімнің әлеуметтік интеграцияға және азаматтық белсенділікке ұзақ мерзімді әсерін зерттеу: Көптеген зерттеулер қысқа мерзімді әсерлерге көңіл бөледі. Ғылыми жаңашылдық - бұл музыкалық білімнің балалар мен жасөспірім кезінде алынуы ересек өмірде әлеуметтік интеграцияға, қоғамдық өмірге қатысу қабілетіне, азаматтық ұстаным қалыптастыруға және өмір бойы тұрақты әлеуметтік желілер құруға қалай әсер ететінін қадағалайтын ұзақ мерзімді зерттеулер жүргізуінде;

Әлеуметтік дамуға арналған музыка білімін бағалаудың кешенді модельдерін әзірлеу: Қолданыстағы бағалау әдістемелері көбіне музыкалық жетістіктерге бағытталған. Жаңалығы музыкалық, сондай-ақ әлеуметтік, эмоционалды және когнитивтік нәтижелерді объективті өлшеуге мүмкіндік беретін кешенді құралдарды жасау және валидациялауда. Бұл стандартталған сауалнамаларды, мінез-құлықтық тестілерді және бақылауларды әзірлеуді қамтиды, олар музыка білімінің әлеуметтік дамуындағы үлесін сандық тұрғыда бағалауға мүмкіндік береді;

Осылайша, музыканы одан әрі үйлесімді және тұрақты қауымдастықтарды құру үшін қуатты құрал ретінде пайдалану үшін жаңа тәсілдерді ұсына отырып, музыкалық білім беру және әлеуметтік даму саласындағы зерттеулер біздің түсінігіміздің шектерін кеңейтуді жалғастыруда. Ғылыми жаңалық механизмдерді терең түсінуде, жекелендірілген және технологиялық тұрғыдан жетілдірілген әдістемелерді жасауда, сондай-ақ музыкалық білімнің әлеуметтік интеграцияға және азаматтық белсенділікке әсерін ұзақ мерзімді бағалауда жатыр.

References

1. Vagaytseva M. B. Socialization of children through music.. <https://urok.1sept.ru/publication/20017508>.11.2023.
2. Nysynbayuly Latif. Benefits of listening to music. <https://medqaz.com/музыка-тыңдаудың-пайдасы>.26.01.2022.

3. Sadykova M. E. *Ethno-cultural musical education and its importance in the formation of the national identity and the development of civic position*. - A., Publishing House of the Kazakh state women's Pedagogical University. 2019.
4. Bozhko T. I. The formation of children's aesthetic taste and the development of emotional responsiveness. https://translated.turbopages.org/proxy_u/ru-kk.ru.fc4e81fb-6a01d21b-01765aab-74722d776562/https/nsportal.ru/detskiy-sad/raznoe/2022/01/30/formirovanie-u-detey-esteticheskogo-vkusa 30.01.2022.
5. Formation of skills of cooperation and critical thinking in the process of teamwork. https://ust.kz/word/toptyq_jumys_barysynda_yntymaqtastyq_jane_syni_oilay_dagdylaryn_qaly_ptastyry-382765.html 21.02.2025.
6. Imanbayeva M. K. Development of communication skills of the child. Kyzylorda region. <https://bilimger.kz/172958/> 16.12. 2024.
7. Kazybaeva A. Neurobiological technologies assessment of the mood of the population. https://forbes.kz/articles/neyrobiologiyalyi_tehnologiyalar_halyityi_kl-kyne_baa_berude 28.09.2022.
8. Empirical and theoretical levels and methods of scientific knowledge. <https://stud.kz/referat/show/61139>. (2008)

INTERACTIVITY OF ONLINE PLATFORMS AS A MEANS OF INCREASING STUDENTS' MOTIVATION WHEN LEARNING ENGLISH IN HIGHER EDUCATIONAL INSTITUTIONS

Stupnytska Galyna Igorivna

Candidate of Philological Sciences, Drohobych Ivan Franko State Pedagogical University, Associate Professor of the Department of English Language Practice and Teaching Methods, Drohobych, I. Franka St., 24

orcid.org/0000-0001-9173-2925

ІНТЕРАКТИВНІСТЬ ОНЛАЙН-ПЛАТФОРМ ЯК ЗАСІБ ПІДВИЩЕННЯ МОТИВАЦІЇ СТУДЕНТІВ ПРИ ВИВЧЕННІ АНГЛІЙСЬКОЇ МОВИ В ЗВО

Ступницька Галина Ігорівна

кандидат філологічних наук, Дрогобицький державний педагогічний університет імені Івана Франка, доцент кафедри практики англійської мови і методики її навчання, м. Дрогобич, вул. І. Франка, 24

orcid.org/0000-0001-9173-2925

Abstract

The thesis examines the role of interactivity of online platforms in the process of learning English by students of higher education institutions. The main advantages of using digital resources in the educational process are identified, in particular, increasing motivation, activating cognitive activity and developing students' communication skills.

The possibilities of modern online platforms for creating an interactive educational environment that promotes individualization of learning and involvement of students in active speech practice are analyzed. It is emphasized that the use of interactive tasks, multimedia materials, gamification and instant feedback has a positive effect on the formation of a sustainable interest in learning English.

Анотація

У тезах розглянуто роль інтерактивності онлайн-платформ у процесі вивчення англійської мови студентами закладів вищої освіти. Визначено основні переваги використання цифрових ресурсів у навчальному процесі, зокрема підвищення мотивації, активізації пізнавальної діяльності та розвитку комунікативних навичок студентів. Проаналізовано можливості сучасних онлайн-платформ для створення інтерактивного освітнього середовища, що сприяє індивідуалізації навчання та залученню студентів до активної мовленнєвої практики. Наголошено, що використання інтерактивних завдань, мультимедійних матеріалів, гейміфікації та миттєвого зворотного зв'язку позитивно впливає на формування стійкого інтересу до вивчення англійської мови.

Keywords: *online platforms, interactivity, motivation, English language, students, higher education institutions, digital technologies.*

Ключові слова: *онлайн-платформи, інтерактивність, мотивація, англійська мова, студенти, заклади вищої освіти, цифрові технології.*

Постановка проблеми. *Сучасний освітній простір характеризується активним впровадженням цифрових технологій у навчальний процес. Особливо актуальним це є у сфері викладання іноземних мов, де важливу роль відіграють інтерактивні методи навчання. Однією з головних проблем у процесі вивчення англійської мови студентами ЗВО залишається недостатній рівень мотивації, що негативно впливає на якість засвоєння знань та розвиток мовленнєвих компетентностей. У зв'язку з цим виникає потреба у використанні сучасних онлайн-платформ, які забезпечують інтерактивність навчального процесу та стимулюють пізнавальну активність студентів.*

Аналіз останніх досліджень і публікацій. *Проблема використання цифрових технологій у навчанні іноземних мов активно досліджується вітчизняними та зарубіжними науковцями. У працях дослідників було розглянуто питання інтерактивного навчання, гейміфікації, дистанційної освіти та використання мультимедійних ресурсів у формуванні мовної компетентності студентів. Значна увага приділяється впливу онлайн-платформ на мотивацію*

здобувачів освіти, розвиток автономного навчання та підвищення ефективності засвоєння іншомовного матеріалу.

Метою тез є визначення ролі інтерактивності онлайн-платформ у підвищенні мотивації студентів до вивчення англійської мови у закладах вищої освіти.

Виклад основного матеріалу. Інтерактивні онлайн-платформи є важливим інструментом сучасної мовної освіти, оскільки забезпечують активну взаємодію між викладачем і студентами, а також створюють умови для самостійного та гнучкого навчання. Серед найбільш популярних платформ для вивчення англійської мови можна виокремити Moodle, Google Classroom, Quizlet, Kahoot!, Duolingo та інші цифрові ресурси.

Використання інтерактивних елементів, таких як онлайн-тести, вікторини, ігрові завдання, аудіо- та відеоматеріали, сприяє підвищенню зацікавленості студентів у навчальному процесі. Завдяки миттєвому зворотному зв'язку студенти можуть оперативно оцінювати власні результати та коригувати помилки, що позитивно впливає на їхню навчальну мотивацію.

Важливим аспектом є також гейміфікація навчання, яка передбачає використання елементів гри у навчальному процесі. Нарахування балів, система досягнень, рейтинги та інтерактивні конкурси стимулюють студентів до активної участі у заняттях і підвищують рівень їхньої зацікавленості у вивченні англійської мови. Крім того, онлайн-платформи забезпечують можливість індивідуалізації навчання. Студенти можуть працювати у власному темпі, повторювати матеріал, виконувати додаткові вправи та отримувати доступ до різноманітних освітніх ресурсів. Це сприяє формуванню автономності та відповідальності за результати власного навчання.

Висновки. Отже, інтерактивність онлайн-платформ є ефективним засобом підвищення мотивації студентів при вивченні англійської мови у ЗВО. Використання цифрових ресурсів сприяє активізації навчальної діяльності, розвитку комунікативних навичок, підвищенню інтересу до навчання та створенню комфортного освітнього середовища. Перспективи подальших досліджень полягають у вивченні ефективності окремих онлайн-платформ та їхнього впливу на формування іншомовної комунікативної компетентності студентів.

Список використаних джерел

1. Bykov V. Yu. *Tsyfrova transformatsiia suspilstva i rozvytok komp'iuterno-tekhnologichnoi platformy osvity i nauky Ukrainy [Digital transformation of society and development of computer-technological platform of education and science of Ukraine]* // *Informatsiini tekhnologii i zasoby navchannia*. 2019. Vol. 70(2). P. 15–36. [in English].
2. Harmer J. *The Practice of English Language Teaching*. 5th ed. Harlow : Pearson Education, 2015. 446 p. [in English].
3. Kukulska-Hulme A., Shield L. *An Overview of Mobile Assisted Language Learning: From Content Delivery to Supported Collaboration and Interaction* // *ReCALL*. 2008. Vol. 20(3). P. 271–289. [in English].
4. Warschauer M. *Computer-Assisted Language Learning: An Introduction* // *Multimedia Language Teaching*. Tokyo : Logos International, 1996. P. 3–20. [in English].
5. Zhyhailo N. I. *Interaktyvni tekhnologii navchannia u vyshchii shkoli [Interactive learning technologies in higher education]* // *Pedahohika formuvannia tvorchoi osobystosti u vyshchii i zahalnoosvitnii shkolakh*. 2020. Vol. 69(2). P. 45–49. [in English].

Philological sciences

ARTIFICIAL INTELLIGENCE IN ADAPTIVE ESL LEARNING SYSTEMS: PERSONALIZED APPROACHES TO LANGUAGE EDUCATION

Uskenbayeva Malika Malikovna

Master student of South Kazakhstan State Pedagogical University named after O.Zhanibekov

Abstract

The integration of artificial intelligence (AI) into education has significantly transformed approaches to English as a Second Language (ESL) instruction. AI-powered adaptive learning systems provide personalized educational experiences by analyzing students' learning behaviors, performance, strengths, and weaknesses. These technologies enable individualized instruction, immediate feedback, and flexible learning environments that improve learner engagement and language acquisition. This article examines the role of artificial intelligence in adaptive ESL learning systems and evaluates their impact on personalized language education. The study is based on qualitative analysis and a review of contemporary academic literature related to AI technologies in language learning. The findings demonstrate that AI-based adaptive systems contribute to increased learning efficiency, learner autonomy, and motivation. However, challenges related to data privacy, technological accessibility, and the reduction of human interaction remain significant concerns. The article concludes that artificial intelligence should be used as a supportive educational tool that complements, rather than replaces, teachers in ESL education.

Keywords

Artificial intelligence, adaptive learning systems, ESL education, personalized learning, educational technology, language acquisition.

Introduction

The rapid development of digital technologies has considerably influenced modern educational practices. Among the most significant technological innovations in education is artificial intelligence (AI), which has become increasingly integrated into teaching and learning environments. In recent years, AI-powered educational systems have gained particular importance in English as a Second Language (ESL) education due to their ability to provide personalized and adaptive learning experiences.

Traditional ESL teaching methods often struggle to address the individual needs of students with different proficiency levels, learning styles, and educational backgrounds. In many classrooms, teachers face challenges related to differentiated instruction, learner engagement, and timely assessment. Artificial intelligence offers potential solutions to these issues through adaptive learning systems capable of analyzing learner data and adjusting instructional content according to students' needs and progress.

Adaptive learning technologies use machine learning algorithms, learning analytics, and intelligent tutoring systems to create individualized educational pathways. Such systems allow learners to study at their own pace, receive immediate feedback, and access customized learning materials. As a result, AI technologies contribute to improved language acquisition and greater learner autonomy.

At the same time, the increasing use of AI in education raises important ethical and pedagogical questions. Concerns related to data privacy, accessibility, algorithmic bias, and reduced human interaction remain central to discussions about the future of AI in language education.

The purpose of this article is to examine the role of artificial intelligence in adaptive ESL learning systems and evaluate both the advantages and challenges associated with personalized language education.

Literature Review

The role of artificial intelligence in education has been widely discussed in contemporary academic research. Holmes, Bialik, and Fadel (2019) argue that AI technologies have the potential to transform educational systems by supporting personalized instruction and improving academic performance. According to the authors, intelligent educational systems can help learners achieve better outcomes through individualized learning pathways and continuous assessment.

Luckin (2018) emphasizes that AI should not replace teachers but rather enhance human intelligence and educational effectiveness. The researcher highlights the importance of collaboration between educators and intelligent systems in creating meaningful learning experiences.

Adaptive learning systems represent one of the most important applications of AI in education. These systems collect and analyze learner data in order to personalize instructional content and learning activities. Knewton (2015) states that adaptive technologies can significantly improve learner engagement and academic achievement by providing customized educational experiences.

In the context of ESL education, AI technologies are increasingly used in language learning applications, intelligent tutoring systems, automated writing evaluation tools, and conversational chatbots. Chapelle (2003) notes that technology-assisted language learning can improve vocabulary acquisition, grammar development, pronunciation, and communication skills.

Furthermore, speech recognition technologies and natural language processing systems enable learners to practice speaking and receive immediate corrective feedback. According to Warschauer and Healey (1998), computer-assisted language learning creates opportunities for interactive and autonomous learning environments.

Despite these advantages, researchers also identify several limitations of AI in education. Selwyn (2019) warns that excessive dependence on educational technologies may reduce social interaction and create inequalities related to technological access. Therefore, many scholars emphasize the importance of maintaining a balance between technology-based instruction and human-centered pedagogy.

Methodology

This study is based on qualitative research methodology and literature analysis. The article examines contemporary academic publications, books, and scholarly sources related to artificial intelligence, adaptive learning systems, and ESL education.

The research focuses on identifying the major benefits and challenges associated with AI-powered adaptive learning technologies in language education. Comparative analysis was used to evaluate different perspectives presented in existing literature regarding the effectiveness of personalized learning systems.

The selected sources include studies related to educational technology, computer-assisted language learning, intelligent tutoring systems, and AI-supported language acquisition. The analysis aims to provide a comprehensive understanding of how artificial intelligence influences modern ESL education.

The Role of Artificial Intelligence in Personalized ESL Learning

Artificial intelligence plays a crucial role in the development of personalized learning environments for ESL students. One of the main advantages of AI technologies is their ability to analyze learner performance and adapt instructional materials according to individual educational needs.

AI-powered systems collect data related to students' progress, learning speed, common mistakes, and preferred learning strategies. Based on this information, adaptive platforms automatically modify lesson difficulty, recommend learning activities, and provide personalized feedback. This individualized approach helps students focus on areas requiring improvement and supports more efficient language acquisition.

Another important function of AI in ESL education is immediate feedback. In traditional classroom environments, teachers may not always have sufficient time to provide instant corrections to every learner. AI technologies, however, can evaluate grammar, pronunciation, vocabulary usage, and writing tasks in real time. Immediate corrective feedback enables students to recognize and correct mistakes more effectively.

Artificial intelligence also contributes to increased learner motivation and engagement. Interactive learning applications, gamified educational platforms, and AI chatbots create dynamic learning experiences that encourage active participation. Many learners experience lower levels of anxiety when interacting with AI systems because these technologies provide supportive and non-judgmental learning environments.

Additionally, AI technologies promote autonomous learning by allowing students to access educational resources anytime and anywhere. Mobile learning applications and online adaptive platforms provide flexible opportunities for independent study, which is especially important for learners in remote regions or students with limited access to traditional educational environments.

Benefits of Adaptive Learning Systems in ESL Education

Adaptive learning systems offer numerous advantages in ESL education for both teachers and learners.

First, personalized instruction significantly improves educational effectiveness. Since students possess different language abilities, learning speeds, and educational needs, individualized learning pathways help create more efficient learning experiences.

Second, adaptive systems increase accessibility and flexibility in education. Students can study according to their own schedules and access educational materials beyond the classroom environment. This flexibility supports lifelong learning and independent skill development.

Third, AI technologies improve assessment accuracy and learning analytics. Intelligent systems can analyze large amounts of learner data and generate detailed reports about student performance. These reports help educators identify weaknesses, monitor progress, and provide targeted support.

Moreover, adaptive learning systems support inclusive education. Students with different learning preferences or special educational needs may benefit from customized instructional materials and alternative learning methods provided by AI technologies.

Finally, AI-powered educational platforms may reduce repetitive administrative tasks for teachers, allowing educators to focus more on communication, critical thinking development, and emotional support.

Challenges and Ethical Concerns

Despite the numerous advantages of AI in ESL education, several challenges and ethical concerns remain significant.

One of the primary concerns involves data privacy and security. Adaptive learning systems collect large amounts of personal and academic information about students. Educational institutions must ensure that such data is stored securely and used ethically.

Another major issue is technological inequality. Not all learners have equal access to digital devices, stable internet connections, or technological literacy. This digital divide may create educational disparities and limit the effectiveness of AI-based learning systems in certain regions.

Overreliance on technology also presents potential pedagogical risks. Excessive use of AI systems may reduce face-to-face communication and social interaction, which are essential components of language learning. Human interaction with teachers and peers remains necessary for developing communication skills, intercultural competence, and emotional intelligence.

Furthermore, AI algorithms may sometimes produce biased or inaccurate evaluations due to limitations in training data or system design. Therefore, educators should continue supervising learning processes and critically evaluating AI-generated recommendations.

Conclusion

Artificial intelligence has become an important component of modern ESL education. AI-powered adaptive learning systems contribute to personalized instruction, increased learner engagement, immediate feedback, and improved language acquisition. These technologies provide flexible and accessible learning opportunities that support individualized educational experiences.

However, despite the significant advantages of AI technologies, challenges related to ethics, accessibility, data privacy, and reduced human interaction remain important considerations. Artificial intelligence should not replace teachers but rather function as a supportive educational tool that enhances teaching effectiveness and learner outcomes.

Future research should focus on developing more inclusive, transparent, and culturally sensitive AI systems capable of addressing the diverse needs of ESL learners worldwide. The successful integration of AI into language education depends on maintaining an appropriate balance between technological innovation and human-centered pedagogy.

References

1. Chapelle, C. A. (2003). *English Language Learning and Technology*. Amsterdam: John Benjamins Publishing Company.
2. Holmes, W., Bialik, M., & Fadel, C. (2019). *Artificial Intelligence in Education: Promises and Implications for Teaching and Learning*. Boston: Center for Curriculum Redesign.
3. Knewton. (2015). *The Benefits of Adaptive Learning Technology*. New York: Knewton Inc.
4. Luckin, R. (2018). *Machine Learning and Human Intelligence: The Future of Education for the 21st Century*. London: UCL Institute of Education Press.
5. Selwyn, N. (2019). *Should Robots Replace Teachers? AI and the Future of Education*. Cambridge: Polity Press.
6. Warschauer, M., & Healey, D. (1998). Computers and language learning: An overview. *Language Teaching*, 31(2), 57–71.
7. Zhao, Y. (2021). Artificial intelligence and personalized learning in education. *Educational Technology Research and Development*, 69(1), 17–20.

8. Kim, H., & Kwon, Y. (2020). *Exploring the effectiveness of AI-based language learning applications in ESL classrooms. Journal of Educational Technology Systems, 49(2), 215–230.*

COMMUNICATIVE AND PRAGMATIC STRATEGIES OF MANIPULATIVE INFLUENCE IN PUBLIC DISCOURSE

Inna R. Sargsyan

*Doctor of Pedagogical Sciences, Professor
Professor of the Department of Russian Language
and Professional Communication,
Institute of Philology and
Intercultural Communication,
Russian-Armenian University,
Yerevan, Armenia*

КОММУНИКАТИВНО-ПРАГМАТИЧЕСКИЕ СТРАТЕГИИ МАНИПУЛЯТИВНОГО ВОЗДЕЙСТВИЯ В ПУБЛИЧНОМ ДИСКУРСЕ

Инна Робертовна Саркисян

*Доктор педагогических наук, профессор
Профессор кафедры русского языка
и профессиональной коммуникации
Института филологии и
межкультурной коммуникации
Российско-Армянского университета
г. Ереван, Армения*

Abstract

The article is devoted to the study of linguistic mechanisms of influence in political and media discourse. The main ways of realizing the manipulative potential of language at the phonetic, lexical, grammatical, syntactic and stylistic levels are considered. Special attention is paid to the analysis of lexical and stylistic tools as the most productive tools for shaping public opinion and interpreting social reality. The paper examines the functioning features of emotionally labeled vocabulary, euphemisms, dysphemisms, metaphors, phraseological units, evaluative constructions, rhetorical questions and other means of speech influence. It is emphasized that modern political and media discourse is characterized by a high degree of pragmatic orientation, and language acts not only as a means of transmitting information, but also as an instrument of ideological influence, constructing social reality and controlling mass consciousness. Based on the analysis of public political communication, a conclusion is drawn about the dominant role of lexical and stylistic mechanisms in the implementation of manipulative strategies. It is noted that the effectiveness of linguistic influence increases significantly in conditions of social instability and emotional tension of society.

Аннотация

Статья посвящена исследованию языковых механизмов воздействия в политическом и медиадискурсе. Рассматриваются основные способы реализации манипулятивного потенциала языка на фонетическом, лексическом, грамматическом, синтаксическом и стилистическом уровнях. Особое внимание уделяется анализу лексико-стилистических средств как наиболее продуктивных инструментов формирования общественного мнения и интерпретации социальной действительности. В работе исследуются особенности функционирования эмоционально маркированной лексики, эвфемизмов, дисфемизмов, метафор, фразеологизмов, оценочных конструкций, риторических вопросов и других средств речевого воздействия. Подчеркивается, что современный политический и медиадискурс характеризуется высокой степенью прагматической направленности, а язык выступает не только средством передачи информации, но и инструментом идеологического влияния, конструирования социальной реальности и управления массовым сознанием. На основе анализа публичной политической коммуникации делается вывод о доминирующей роли лексико-стилистических механизмов в реализации манипулятивных стратегий. Отмечается, что эффективность языкового воздействия значительно возрастает в условиях социальной нестабильности и эмоциональной напряженности общества.

Keywords: *political discourse, media discourse, linguistic influence, speech manipulation, manipulative strategies, lexico-stylistic means, euphemism, dysphemism, metaphor, evaluative vocabulary, emotionally marked vocabulary, public consciousness, pragmatics, speech strategies, media linguistics.*

Ключевые слова: *политический дискурс, медиадискурс, языковое воздействие, речевая манипуляция, манипулятивные стратегии, лексико-стилистические средства, эвфемизм, дисфемизм, метафора, оценочная лексика, эмоционально маркированная лексика, общественное сознание, прагматика, речевые стратегии, медиалингвистика.*

Проблема языкового воздействия на общественное сознание

Проблема языкового воздействия на общественное сознание относится к числу наиболее актуальных направлений современной лингвистики, медиалингвистики, прагматики и теории коммуникации. Представления о воздействующем потенциале языка формировались на протяжении многих столетий и восходят к древнейшим формам человеческой коммуникации, в рамках которых слово рассматривалось не только как средство передачи информации, но и как особый инструмент влияния на сознание, поведение и эмоциональное состояние человека. В архаических культурах языковому знаку приписывалась сакральная функция: вербальные формулы, заклинания, ритуальные обращения и проклятия воспринимались как действенный механизм воздействия на окружающую действительность. Подобное понимание силы слова свидетельствует о раннем осознании человеком способности речевого акта оказывать влияние на индивидуальное и коллективное сознание.

Впоследствии идея речевого воздействия получила развитие в античной риторической традиции, в рамках которой язык стал рассматриваться как средство убеждения и управления общественным мнением. Уже в трудах античных мыслителей особое внимание уделялось механизмам аргументации, эмоционального воздействия и формирования необходимого впечатления у аудитории. В дальнейшем исследование воздействия речи получило развитие в философии языка, психолингвистике, социолингвистике, теории дискурса и когнитивной лингвистике. Современная гуманитарная наука рассматривает язык не только как систему знаков, обеспечивающую коммуникацию, но и как инструмент концептуализации действительности, моделирования социальной реальности и формирования идеологических установок.

Особую актуальность проблема языкового воздействия приобретает в условиях глобализации информационного пространства и интенсивного развития средств массовой коммуникации. Современный медиадискурс характеризуется высокой степенью прагматической направленности, поскольку основная задача медиатекста заключается не только в информировании аудитории, но и в формировании определённой интерпретации событий. Средства массовой информации, политические институты и цифровые платформы используют широкий спектр коммуникативных стратегий, ориентированных на управление вниманием адресата, формирование общественного мнения и воздействие на эмоционально-оценочную сферу восприятия [Саркисян 2026-б]. В связи с этим язык становится важнейшим инструментом идеологического влияния и социального конструирования реальности.

Средства воздействия на аудиторию

Лингвистические средства являются тем эффективным инструментом, с помощью которого осуществляются речевые стратегии и тактики. Помимо основной задачи предоставления объективной информации о тех или иных событиях политики путем воздействия на картину мира адресата эксплицитным образом выражения включают своё мнение, критику или оценку какого-либо явления, что становится основополагающим компонентом субъективной модальности. Основные средства языкового манипулирования принято выделять на фонетическом, лексическом, морфологическом, синтаксическом и стилистическом уровнях [Рюкова 2021].

Лингвистические средства воздействия представляют собой сложную систему разноуровневых механизмов, посредством которых осуществляется реализация речевых стратегий и тактик, направленных на достижение определённого прагматического эффекта. При этом современный медиатекст никогда не является полностью нейтральным, поскольку даже при декларируемой объективности в нём неизбежно присутствует авторская интерпретация событий, выраженная эксплицитно или имплицитно. Субъективная модальность становится неотъемлемым компонентом политического и медиадискурса, а

языковые средства выполняют функцию не только передачи информации, но и оценки, интерпретации и концептуализации действительности.

На фонетическом уровне манипулятивный потенциал языка реализуется прежде всего посредством интонационных средств. Интонация способна существенно трансформировать семантику высказывания, придавая ему иронический, саркастический, агрессивный либо, напротив, одобрительный характер. Одно и то же высказывание в зависимости от просодического оформления может восприниматься адресатом диаметрально противоположным образом. Подобная вариативность особенно значима в устной политической коммуникации, где интонация становится важным средством эмоционального воздействия на аудиторию. Например, любая фраза, имеющая положительный оттенок значения, может быть произнесена с укором и порицанием («Так держать!»; «Молодец!»).

Синтаксические средства воздействия

Синтаксический уровень обладает значительным прагматическим потенциалом. Порядок слов, актуальное членение предложения, выбор синтаксической конструкции и распределение коммуникативных акцентов позволяют адресанту управлять вниманием аудитории и ранжировать информацию в соответствии с собственными коммуникативными задачами. Так, сопоставление конструкций «Правительство внесло бюджет в парламент» и «Парламент обсуждает бюджет, предложенный правительством» демонстрирует различие в распределении смыслового центра высказывания. В первом случае акцентируется деятельность правительства, тогда как во втором на первый план выдвигается парламент как субъект политического процесса. Следовательно, синтаксическая организация высказывания непосредственно связана с механизмами фокусирования внимания и интерпретации политической реальности. Таким образом, правильный выбор порядка слов в предложении способствует ранжированию языкового материала согласно интересам говорящего.

Важным аспектом речевого воздействия является вариативность синтаксических моделей, используемых для выражения одного и того же коммуникативного намерения. Просьба, побуждение или требование могут быть реализованы посредством различных конструкций: побудительных, вопросительных, эллиптических, номинативных и перформативных. Выбор конкретной модели определяется прагматическими установками адресанта и предполагаемым эффектом воздействия на адресата. Так, в политическом дискурсе призыв к консолидации общества может быть выражен по-разному: «Объединим усилия ради будущего страны», «Не пора ли нам действовать сообща?», «Единство — сегодня главный приоритет» или «Я призываю граждан к совместной работе». Эти конструкции различаются степенью категоричности, экспрессивности и вовлечённости адресата, что свидетельствует о тесной связи синтаксической формы с коммуникативной стратегией политического оратора.

Грамматические средства языкового воздействия связаны прежде всего с категорией субъекта действия и распределением ответственности. В политическом и медиадискурсе широко используются пассивные конструкции, позволяющие скрыть или намеренно размыть субъект действия. Подобные грамматические трансформации способствуют снижению степени ответственности и создают эффект неопределённости. Например, конструкции типа «были допущены ошибки» или «было принято решение» позволяют избежать прямого указания на конкретный субъект действия. Таким образом, грамматическая организация высказывания становится инструментом прагматического воздействия и манипулирования интерпретацией происходящего.

Лексический уровень как значимая часть языковых механизмов воздействия

Наиболее значительный потенциал языкового воздействия сосредоточен на лексическом уровне. Именно лексические единицы обладают максимальной способностью к выражению оценки, эмоциональности и идеологической маркированности. Лексический выбор автора определяет характер интерпретации событий и формирует у адресата определённое отношение к предмету речи. Посредством подбора номинаций возможно как смягчение негативного содержания, так и усиление эмоционального эффекта. Например, лексема «фанатизм» может заменяться выражениями «принципиальная позиция» или «глубокие убеждения», что приводит к изменению оценочного восприятия обозначаемого явления.

Эмоционально маркированная лексика характеризуется наличием дополнительных экспрессивных и оценочных компонентов значения. Использование разговорных, сниженных либо, напротив, высоких книжных единиц позволяет адресанту моделировать определённый

коммуникативный эффект. Политические деятели нередко прибегают к разговорной лексике с целью сокращения дистанции между собой и массовой аудиторией, создавая иллюзию неформального общения и принадлежности к «простому народу» [Леонтьев 2001; Гаврилов 2013]. Подобная стратегия способствует формированию доверительных отношений между политиком и адресатом.

Современное информационное пространство характеризуется высокой степенью интенсивности коммуникации, а потому борьба за внимание адресата требует от политиков использования максимально эффективных речевых стратегий. В условиях информационной конкуренции язык становится не только средством передачи информации, но и инструментом идеологического влияния, формирования общественного мнения и конструирования социальной реальности. Одним из действенных механизмов воздействия является использование оценочной лексики. Оценка представляет собой выражение положительного или отрицательного отношения говорящего к предмету речи. Политические тексты редко бывают нейтральными: даже при стремлении к объективности автор посредством определённых языковых единиц формирует у аудитории необходимое эмоциональное отношение к событию, личности или явлению. Так, слова «реформа», «модернизация», «стабилизация» обычно обладают положительной коннотацией, тогда как лексемы «кризис», «угроза», «катастрофа», «агрессия» создают негативный эмоциональный фон. Подобный выбор слов не случаен: он направлен на формирование у адресата конкретной модели восприятия действительности.

Эвфемизмы в политическом дискурсе

Интересным способом воздействия является использование эвфемизмов - эмоционально-нейтральных словарных единиц, которые предоставляют говорящему возможность замены социально нежелательных, грубых или негативно окрашенных единиц. Л.П. Крысин выделяет сферы использования данного тропа в социальной жизни, уделяя при этом наибольшее внимание политической сфере [Крысин 2004]. Любая деятельность политиков как истинных дипломатов должна следовать нормам политической корректности [Саркисян 2025]. Их речь - это текст, построенный таким образом, чтобы решить конкретные коммуникативные задачи, например, сообщить об актуальных проблемах, обращаясь к массовой аудитории. Отсюда и возникновение тенденции к использованию тех языковых средств, которые способны исказить действительность и смягчать различные понятия, скрывая тем самым негативный аспект [Саркисян 2026-а]. Современные процессы эвфемизации охватывают широкий круг сфер — от социальной и профессиональной до этнической и гендерной. Этого достаточно, чтобы обойти стороной любую казусную ситуацию или смягчить дискриминацию.

Дисфемизмы в политическом дискурсе

Противоположным механизмом выступает дисфемизация, предполагающая намеренное использование грубых, уничижительных или резко негативных номинаций. Дисфемизмы активно используются в медиадискурсе как средство эмоционального давления, нагнетания напряжённости и формирования образа угрозы. Подобная стратегия особенно характерна для конфликтного политического дискурса, в котором осуществляется жёсткое противопоставление «своих» и «чужих». При этом нагнетание способствует суггестивному воздействию на сознание людей.

Особенности метафоризации

Немаловажным компонентом манипулятивного аппарата является метафоризация. Это один из излюбленных механизмов языкового воздействия как политиков, так и СМИ. Российский исследователь Опарина Е.О. раскрывает суть и варианты употребления метафоры в политическом дискурсе: «Ее использование сводится к подмене рационального обоснования суждения иррациональным» [Опарина 2002]. Получается, что это вариант трактовки и интерпретации оценки, который зачастую возводится в позицию главного аргумента во время доказательства определенной точки зрения, а потому впоследствии он создаёт емкий эмоциональный и экспрессивный образ, с которым в общественном сознании ассоциируются определенные дефиниции. Таким образом, политическая метафора формирует определённую модель восприятия событий, задаёт интерпретационные рамки и влияет на когнитивную обработку информации адресатом. Благодаря этому политическая коммуникация приобретает высокую степень экспрессивности и эмоциональной убедительности.

Роль эпитетов в политическом дискурсе

Особую роль в политическом дискурсе играют эпитеты. Они позволяют не только описывать объект, но и интерпретировать его через авторскую оценку. Например, сочетания

«беспрецедентные меры», «жестокое санкции», «героический народ», «несправедливое решение» обладают ярко выраженным эмоционально-экспрессивным потенциалом. Эпитеты усиливают воздействующую функцию текста, способствуют эмоционализации сообщения и помогают автору закрепить в сознании аудитории нужный образ.

Лексический повтор и антитеза в политическом дискурсе

Важным инструментом речевого воздействия выступает повтор. Лексический повтор позволяет акцентировать внимание аудитории на ключевых понятиях и идеях. Многократное воспроизведение определённых слов или выражений способствует их закреплению в сознании адресата и формированию устойчивых ассоциаций. Особенно активно данный прием используется в политических выступлениях и предвыборных речах: Мы добьёмся стабильности. Мы обеспечим безопасность. Мы защитим интересы страны и т.д. Повтор местоимения «мы» создает эффект единства власти и народа, формирует ощущение коллективной ответственности и общности целей.

Наряду с повтором значительное место занимает антитеза — стилистический прием противопоставления. Политики нередко строят свою речь на бинарных оппозициях: «мы — они», «мир — война», «стабильность — хаос», «правда — ложь». Подобное противопоставление способствует упрощению восприятия сложных политических процессов и формированию у аудитории четкой системы координат, где одна сторона представляется положительной, а другая — отрицательной. Особенно важным механизмом является бинарная оппозиция «свои — чужие», активно используемая в политическом дискурсе для конструирования образа врага и консолидации социальной группы. Это ключевой механизм манипуляции в медиадискурсе Средства массовой информации и политические деятели нередко прибегают к намеренному противопоставлению «своих» и «чужих». Для характеристики оппонентов используются негативно окрашенные номинации, создающие у аудитории ощущение опасности и угрозы. Подобная стратегия позволяет консолидировать общество вокруг определенной политической идеи или лидера. Формирование образа врага сопровождается использованием эмоционально насыщенной лексики, гипербола, дисфемизмов и оценочных метафор.

Риторические вопросы в политическом дискурсе

Отдельного внимания заслуживает использование риторических вопросов. Они не предполагают получения ответа, однако позволяют автору направить мыслительный процесс адресата в нужное русло. Риторические вопросы создают иллюзию диалога с аудиторией, вовлекают ее в размышление и одновременно подталкивают к заранее запрограммированному выводу: «Разве можно оставаться равнодушными к происходящему?», «Кто, если не мы, должны защитить интересы государства?» и т.д. Подобные конструкции обладают высоким суггестивным потенциалом и нередко используются в политической риторике и публицистике.

Гиперболизация

В контексте рассматриваемого вопроса нельзя обойти вниманием гиперболизацию, являющую собой намеренное преувеличение определенных фактов или явлений. Гипербола способствует усилению эмоционального эффекта и повышению степени воздействия на аудиторию. Например, экономические трудности могут описываться как «катастрофические», политические разногласия — как «угроза мировой безопасности», а действия противника — как «беспрецедентная агрессия». Подобные языковые средства усиливают драматизм сообщения и воздействуют прежде всего на эмоциональную сферу восприятия.

Манипулятивный потенциал средств массовой информации

Следует особо отметить манипулятивный потенциал средств массовой информации в аспекте отбора и подачи информации. Манипуляция осуществляется не только посредством языковых единиц, но и через намеренное акцентирование одних фактов и замалчивание других. В результате у адресата формируется определенная картина мира, соответствующая интересам субъекта коммуникации. Язык в данном случае становится инструментом интерпретации действительности, а не только ее описания.

Особое место в политическом дискурсе занимает стратегия солидаризации с аудиторией. Политические деятели активно используют местоимения «мы», «наш», наречие «вместе», стремясь создать ощущение единства с народом. Подобная тактика способствует установлению доверительных отношений между адресантом и адресатом, а также формирует эффект коллективной причастности к происходящему: «Мы вместе преодолеем трудности», «Наша страна всегда отстаивала свои интересы» и т.д. Такая речевая стратегия позволяет усилить эмоциональную связь между политиком и аудиторией.

Использование прецедентных феноменов

Важным средством речевого воздействия являются прецедентные феномены — цитаты, исторические аллюзии, известные выражения и культурные отсылки. Обращение к коллективной памяти народа дает возможность резко усилить аргументацию и вызвать у аудитории определенные ассоциации. Политики часто апеллируют к историческим событиям, национальным символам и высказываниям известных деятелей для легитимации собственной позиции. Подобные приемы способствуют укреплению авторитета говорящего и повышают степень доверия к сообщаемой информации.

Заключение

Таким образом, на основе анализа материалов публичных выступлений политических деятелей разных стран становится очевидным, что лексико-стилистические средства являются самой обширной частью механизмов воздействия. Политик, чья речь отличается особой эмоциональностью и экспрессивностью, который на лексическом уровне использует больше эпитетов, метафор, лексических повторов и антитез, а на синтаксическом часто использует эмфатические конструкции, синтаксический параллелизм и инверсию, как правило, стремится не только к передаче информации, но и к усиленному эмоционально-психологическому воздействию на аудиторию, формированию необходимого оценочного восприятия и повышению убедительности политического высказывания.

Кроме перечисленных средств языкового воздействия в политическом и медиадискурсе активно используются и другие механизмы манипулирования общественным сознанием, которые усиливают прагматический потенциал текста и формируют необходимое восприятие событий.

Следует оговорить, что эффективность языкового воздействия существенно возрастает в условиях социальной нестабильности, кризисных ситуаций и высокой эмоциональной напряженности общества. В подобных условиях аудитория становится особенно восприимчивой к эмоционально окрашенной информации, что значительно усиливает манипулятивный потенциал медиадискурса. Именно поэтому современная политическая коммуникация характеризуется высокой степенью оценочности, экспрессивности и эмоционализации.

References

1. Gavrilov A.A. Linguistic means of media influence on public consciousness // ONV. 2013. № 1 (115). URL: <https://cyberleninka.ru/article/n/lingvisticheskie-sredstva-vozdeystviya-smi-na-obschestvennoe-soznanie> (date of access: 05/01/2026). [Опубликовано на русском языке]
2. Leontiev A.A. The image of the event in the media and the possibility of its distortion. Media language as an object of interdisciplinary research. Abstracts of reports of the international scientific conference. Moscow: Publishing House of Moscow State University, 2001. – PP. 39-41. [Опубликовано на русском языке]
3. Oparina E. O. Metaphor in political discourse // Polit. science. 2002. № 3. URL: <https://cyberleninka.ru/article/n/metaphora-v-politicheskom-diskurse> (date of reference: 05.05.2026). [Опубликовано на русском языке]
4. Rekova A. R. Linguistic means of dissemination in RUSSIA // Bulletin of the Bashkir University. June-July. 2021. № 4. URL: <https://cyberleninka.ru/article/n/yazykovye-sredstva-vozdeystviya-v-politicheskom-diskurse> (date of reference: 05/08/2026). [Опубликовано на русском языке]
5. Krysin L.P. Euphemisms in modern Russian speech. Moscow: Languages of Slavic Culture, 2004. [Опубликовано на русском языке]
6. Sargsyan I.R. Linguistic features of pre-election political discourse. Innovative scientific research: Proceedings of the XX International Scientific and Practical Conference on January 22-23, 2026, Toronto, Canada, 2026-в. – PP. 79-82. [Опубликовано на русском языке]
7. Sargsyan I.R. Digital media environment and information impact strategies. XXV International Scientific and Practical Conference «Challenges and Tasks of Modern Science». February 19-20, 2026-a, London, United Kingdom. 147 p. – PP. 73-77. [Опубликовано на русском языке]
8. Sargsyan I.R. The formation of the concept of political correctness and the evolution of its content. XXII International Scientific Conference «Modern vector of science development». USA, Philadelphia. 2025. – PP. 99-105. [Опубликовано на русском языке]

Political sciences

DIRECTED ENERGY WEAPONS AGAINST SHORT-RANGE UAVS: RETHINKING AIR DEFENSE IN THE AGE OF ASYMMETRIC WARFARE

Elgun Taghizade

PhD Student. Baku State University of International Relations.

ORCID: 0000-0002-0514-7808

Abstract

The widespread use of short-range unmanned aerial vehicles has presented a structural crisis to traditional air defense that is economic and operational rather than purely technical in nature. Cost-exchange paradox – low-cost drones are met by high-cost kinetic missiles, leading to unviable fiscal imbalances – have been largely responsible for increased attention to Directed Energy Weapons (DEWs), and High Energy Laser (HEL) systems in particular. This paper claims that the HEL is an essential, albeit not solely sufficient, defensive element of a hybrid, multi-layered approach to air defense. The "changing paradigm" of the title, exists across three analytically distinct but interlinked dimensions; (1) economic, as it reflects an inverse cost-exchange ratio which has previously given an advantage to defenders; (2) strategic-legal, as normative vacancies are created in IHL and arms control regime's due to directed energy weapons (being non-kinetic, dual-use) not yet accounted for, and (3) power-distributional, as HEL technology effectively concentrates to a handful of developed industrial states (causing dependencies on small states). Utilizing Robert Jervis's offense-defense balance theory, Martin Shaw's risk-transfer militarism, and liberal institutionalism, I assess the implications of the proliferation of DEW through specific cases in the Russia-Ukraine War, Red Sea crisis, and Saudi Arabia's operational deployment of Silent Hunter. I argue that DEW technology indeed reconfigures but does not end asymmetric threat dynamics, and that an equal response is urgently needed at governance level.

Keywords: *Directed Energy Weapons, Counter-UAV, Asymmetric Warfare, Offense-Defense Balance, Cost-Exchange Ratio, Hybrid Defense Architecture, International Humanitarian Law, Risk-Transfer Militarism*

1. Introduction: The Economic and Strategic Rupture

The paradigm shift named in the title of this paper is not merely metaphorical. There are three verifiable, empirically-testable changes that collectively characterize the redefinition of air defense for the 2020s. These are: first, an inversion in the economics of air defense; that is, an opposite trend to the one that dominated much of the twentieth century in which interceptor weapons systems were significantly cheaper to produce than the threats they opposed. Second, an intrinsically incomplete legal-normative framework for directed energy weapons during armed conflict. Third, the distribution-power consequences of the co-proliferation of UAVs and DEWS is an asymmetric one that current international security regimes have not yet adequately assessed.

The September 14, 2019 combined drone and cruise missile attacks against the Saudi Aramco Abqaiq and Khurais facilities temporarily disabled approximately 5.7 million barrels per day in oil production-nearly half of Saudi Arabia's total daily output - in under an hour (Saudi Aramco, 2019). The perpetrator of the attacks was a Houthis-aligned non-state actor equipped with readily available platforms, event which fully crystallized a broader transformation that was underway: short range UAVs were no longer peripheral military assets. Instead, they had become leading instruments for strategic effect against vital state infrastructure.

Statistically, the scope of the transformation is clear. In September 2019 there were 95 active military UAV programs; by March 2020, that number had increased to 102 (Gettinger, 2019, p. 19; Gettinger, 2020, p. 1). The proliferation of commercially sourced UAVs through Turkey, China, and Iran, subsequently fractured existing non-proliferation mechanisms and has led analysts to label a "democratization of airpower" (Hammes, 2016). By 2025, at least forty countries have deployed active armed UAVs according to Center for a New American Security (CNAS) estimates (Raj, 2025; Campbell, 2024, pp. 8, 11). Global drone strikes more than quadrupled between 2020 and 2024 from some 480 incidents to just under 20,000, according to analysis of Armed Conflict Location & Event Data project data by Just Security (Spink, 2024). An estimated 10,000 drones are in use daily in Ukraine, which attribute seventy percent of combat fatalities to strikes from the unmanned aircraft (Barotte, 2025).

It is on the foundation of this empirical reality that this paper seeks to explore three research questions, directly related to the three dimensions of paradigm shift discussed above. Firstly, how is the offense-defense balance impacted by the use of HEL, and under what conditions is this balance a reliable constant? Secondly, what lacuna does DEW proliferation create within the existing legal and normative architecture of international law? Thirdly, what distributional power consequences arise from a concentration of sophisticated DEW capabilities, and how ought this asymmetry be addressed?

2. Theoretical Framework Literature

The article draws on three theoretically convergent approaches. Each contributes by providing analytical insight into a different aspect of the DEW-UAV interaction: material capacity, normative construction and institutionalization.

2.1 Realism: The Offense-Defense Balance and the Security Dilemma

In a state's quest for enhanced security through a military advantage, the offensive-defense balance theory asserts that when offensive military technology becomes comparatively less expensive and more effective than its defensive counterpart, there is a greater propensity for conflict and the deterrent value of military power diminishes (Jervis, 1978, pp. 186-214). The emergence of short-range UAVs - readily available off-the-shelf, inexpensively mass-produced and increasingly sophisticated regarding electronic counter-measures - has tipped the scales definitively toward offense (Jervis, 1978, pp. 189, 199, 203-212). Evidence for the proliferation of UAVs is available from the second Nagorno-Karabakh war through the current conflict in Ukraine and the civil war in Yemen (SIPRI, 2022). HEL systems can thus be viewed as an intentional states-driven attempt to reverse the current offensive-dominated cost balance and decrease the potential systemic pressures that the theory argues arise from offensive superiority. The security dilemma does, however, come into play as a state employing DEWs to achieve the intended defense-oriented result also implicitly develops technology for offensive disabling attacks that may increase instability.

2.2 Constructivism: Risk-Transfer Militarism and the "Humane Warfare" Discourse

As counterpoints to techno-optimist descriptions of both UAVs and DEW, the concepts of risk-transfer militarism, discussed at length by Martin Shaw, is instrumental (Shaw, 2005, pp. 1-2, 30-32, 54, 86). Shaw argues that there has been a concerted effort within Western military strategy to depersonalize the human cost of combat and, while decreasing risks to deployed combatants via precision-guided munitions, then shifting these risks to populations in targeted zones (Shaw, 2005, pp. 71-74, 87-91, 94-95). DEW counter-UAV systems embody this logic in that the laser operator remains physically invulnerable at his hardened station whereas the human costs of the underlying conflict will still impact the local populations of the area of engagement. This concept is directly applied within the concluding policy sections. That DEW counter-UAV systems continue to be inserted into counter-terrorism and border defense vocabularies without a change in their inherent problems regarding ethical considerations and legal frameworks exacerbates the normalization of technological violence due to a decrease in their visual presence to domestic audiences. As analyses from both CSIS and Just Security clearly demonstrate, civilian deaths from UAVs have significantly increased despite a widespread perception among domestic audiences that drone technology generally enables pinpoint accuracy with minimal civilian casualties (Rumbaugh, 2024; Spink, 2024).

2.3 Liberal Institutionalism, Normative Deficit and Governance Shortcomings

Perhaps the most relevant implication of this analysis in institutional terms is the mismatch between DEW-UAV technological development and the speed of multilateral governance responses. While the primary multilateral relevant control regime governing delivery-systems is the Missile Technology Control Regime (MTCR) - which operates on payload (over 500kg) and range (300km) thresholds, and thus excludes most tactical kamikaze-drones (Gormley, 2008, pp. 146, 150, 154) - there are no multilateral control mechanisms covering directed energy weapon usage. As noted by UN Special Rapporteur Christof Heyns "there exists an open normative gap which multilateral soft law instruments have yet to fill" in regards to the use of autonomous weapons systems and drones (Heyns, 2013, p. 13); this is not just a technical but also a political problem, as states with an advantage in DEW-UAV technology are unlikely to sign on to stringent controls over this technology.

3. The Economic Paradox and the DEW Imperative

The immediate push for DEWs stems from the collapse of cost-exchange sustainability of current air defense systems. These systems were developed to combat high-speed and large-radar signature targets such as fixed wing aircraft and ballistic missiles. Against low-radar signature, slow-moving drones of less than 25 kg, these weapons systems are practically and financially unviable. The empirical data from recent conflicts confirms this disparity. Drones estimated to cost approximately \$2,000 USD per

unit have been countered by U.S. Navy SM-2s priced at approximately \$2 million USD, providing a 1:1,000 cost-exchange ratio for the attacking side (Rumbaugh, 2024, pp. 1-4; Spink, 2024). Iranian produced Shahed-136 loitering munitions that cost anywhere between \$20,000- \$50,000 to build (Segura, 2022; Kosoy, 2025, p. 2) were countered by NASAMS or Patriots that can range anywhere from \$1-\$4 million USD per shot (Rumbaugh, 2024). Table 1 provides these contrasts side by side.

Table 1: Cost-Exchange Ratio Asymmetries in Recent UAV Conflicts

Threat Platform	Approx. Unit Cost (USD)	Interceptor Used	Interceptor Cost (USD)
Houthi drone (Red Sea)	~\$2,000	SM-2 missile	~\$2,000,000
Shahed-136 loitering munition (Ukraine/Middle East)	\$20,000–\$50,000	NASAMS / Patriot	\$1,000,000–\$4,000,000
FPV kamikaze drone (Ukraine)	~\$400–\$1,000	MANPADS (minimum capability)	\$20,000–\$50,000
Houthi drone (Red Sea)	~\$2,000	SM-2 missile	~\$2,000,000
Shahed-136 loitering munition (Ukraine/Middle East)	\$20,000–\$50,000	NASAMS / Patriot	\$1,000,000–\$4,000,000

This difference is not an artifact of accidental inefficiency. It is intentional, and offensive. This can be characterized as a Cost-Imposition Strategy where "the attacker does not need kinetic parity; they only need to maintain a state of offense sufficient to deplete the defender's interceptor inventory and its financial resources over time" (Rumbaugh, 2024; Sayler et al., 2024, pp. 5-6, 13, 21). The industrial expression of this strategy in practice is evident in Ukraine's announced strategy to "produce one million FPV drones a year through more than 200 manufacturers at home" (Dysa, 2023).

In this environment HEL weapons create an inverted cost structure. The British DragonFire laser weapon system attacks targets at \$10 per shot (around \$12-13), while a comparable interceptor costs \$1.5 million (around \$2 million), with the "depth of magazine is effectively unlimited-in the electric power supply rather than its physical magazine inventory of munitions" (Sengupta, 2024). This inversion of the cost structure is the primary motivation for HEL weapons acquisition and constitutes the first dimension of the paradigm shift this paper identifies.

4. Operational Systems: Capabilities and Comparative Status

Numerous great powers of military significance have moved their HEL counter-UAV systems from concept development to deployment or further testing (Sayler et al., 2024, pp. 5-19).

United States: The U.S. Navy's HELIOS (High Energy Laser with Integrated Optical-dazzler and Surveillance) is a multi-mission maritime air defense directed energy system for deployment on naval platforms, while the Army's DE M-SHORAD (Directed Energy Maneuver Short-Range Air Defense) serves the ground-mobile forward-deployed counter-UAV mission. THOR (Tactical High-Power Operational Responder) and CHIMERA provide HPM alternatives with the capability to provide an area-effect engagement against drone swarms (Sayler et al., 2024, pp. 9-17).

United Kingdom: DragonFire is a joint MBDA, Leonardo and QinetiQ project, and live-fire trials completed in 2024 showed the ability to strike a coin sized target at kilometric range (Sengupta, 2024).

Israel: The Iron Beam system (Rafael Advanced Defense Systems) is part of the lowest tier of Israel's layered air defense system and is specifically designed to engage short-range threats that have a high cost of engagement beyond the economics of Iron Dome. Israeli defense sources stated in 2025 that high-power laser prototypes have been utilized in operational capacity in live firing to neutralize drone threats (Frantzman, 2025).

Saudi Arabia: Saudi Arabia purchased and deployed Chinese Silent Hunter system (Poly Technologies) after the Abqaiq attack, a 30-100 kW fiber-laser system with a reported engagement range of 4 kilometers (U.S. Army Operational Environment Watch, 2022). With at least eight units in the Saudi order of battle, the acquisition represents the first large-scale operational deployment of a HEL system for critical infrastructure point defense, while operationally demonstrated the system's atmospheric and thermal management shortcomings in the desert environment-providing a technorealist case against sole-system reliance.

Turkey: Turkey is undertaking development of its own indigenous LSS (Laser Savunma Sistemi) and ARMOL directed energy counter-UAV programs, an aspect of the broader national effort to develop its defense industrial base, emphasizing sustained-fire capabilities with a very low cost per shot (Savunma Sanayi, 2021; TSKGV, 2025).

5. Operational Constraints: The Techno-Realist Assessment

Using a techno-realist framework (understanding the strengths and weaknesses without bias for either pessimism or optimism), there are four fundamental constraints to the use of HEL systems as autonomous solutions (Shenk, 1997, pp. 9-10, 162-163; Sayler et al., 2024, pp. 15-19).

The most immutable physical constraint is the atmospheric degradation of energy delivery. Laser beams are attenuated, scattered, and can undergo thermal blooming as they traverse atmospheric conditions of rain, fog, dust, smoke, and high-humidity environments. Those operational environments most relevant to this analysis-Eastern Ukraine, the Red Sea maritime corridor, and the Saudi Arabian desert- all face significant atmospheric challenges. This became acutely apparent with the Saudi Arabian deployment of the Silent Hunter; the system was eventually combined with the J1101 counter-drone jammer precisely because laser effectiveness alone failed to perform due to the dust and heat haze (U.S. Army Operational Environment Watch, 2022).

Power supply and logistics create a second operational limitation. A 100-kW laser requires 525-530 kW of electrical input due to conversion inefficiencies, converting 425-430 kW of input power to waste heat to be evacuated on an immediate basis (Gunzinger, 2012, pp. 34, 105-106). This limitation is not challenging in fixed site installations. It is in a forward, expeditionary context that the requirements for power generation, cooling systems, and sustainment logistics impede tactical mobility-the environment in which counter-UAV systems are most needed.

The requirement for a serial engagement geometry produces the third and most tactically specific vulnerability. Laser systems target targets in series; one beam and one target are engaged and then the laser may not re-acquire the same target in less than several seconds. Thus, a coordinated swarm of twenty simultaneous incoming threats from all vectors may exhaust the temporal capacity of a single laser battery; at four seconds per target engagement, only 7-8 threats would be destroyed before the remainder reached their objectives (Gunzinger, 2012; Pettyjohn & Campbell, 2025). This bottleneck does not apply to a salvo-fired set of interceptors.

The final dynamic constraint comes from adversarial countermeasure development. As noted by RUSI, the common UAV platform now increasingly possesses Controlled Reception Pattern Antenna (CRPA) technology, Inertial Navigation System (INS) navigation, and Machine Vision-guided autonomous terminal phase navigation completely independent of GPS or operator data links (Bronk et al., 2022, pp. 5-15, 32-40). In addition to CRPA/INS/AI, adversaries are developing ablative coatings, reflective surfaces, and rotor/airframe designs that promote spinning of airframes and are resistant to laser energy absorption (Kopp, 2008). This adversarial nature mirrors classical offense-defense dynamics in which countermeasures and counter-countermeasures vie in perpetual technological competition.

6. International Legal Framework: The Grey Zone Problem

The international legal status of anti-drone HEL systems is the second dimension of the paradigm shift this paper seeks to identify. Three interconnected legal gaps exist within current frameworks and these have not been resolved by multilateral efforts thus far.

The main instrument relevant here is Protocol IV of the Convention on Certain Conventional Weapons of 1980 which bans laser weapons designed to inflict permanent blindness on enemy fighters (International Committee of the Red Cross, 1995). This article does not apply directly to anti-material HEL systems where the stated intended purpose is the destruction of the airframe and electronics of a UAV. The operational instability of the distinction between 'anti-material' versus 'anti-personnel' functioning, however, undermines the applicability of Protocol IV to these anti-material weapons. The same laser device with altered power settings, which is designed to destroy a UAV airframe or electronics, can cause permanent eye injury to unintended combatants that happen to be within its line of sight of the battlefield (U.S. Department of Defense, 2023, pp. 346, 351-352, 420-422).

The inherent custom IHL rule of proportionality further complicates the legal regime. Although Article 3 of Protocol IV states that incidental eye injury resulting from the use of laser systems is permissible, this does not absolve commanders from the requirement to engage in a proportionality analysis under Additional Protocol I. Where a given laser engagement in a mixed civilian/combatant area, or a highly concentrated urban setting, may foreseeably injure eyes of civilian non-combatants, a commander's judgment would have to consider that foreseeable damage to humans, balanced against anticipated military benefit. The ICRC weapons review guidelines on whether a new weapon system causes superfluous injury or unnecessary suffering under ordinary military operation, though developed during the last century and more recent years, have not resulted in any definitive determination with regard to counter-drone HEL systems (International Committee of the Red Cross, 2003).

The final legal gap concerns autonomous targeting and meaningful human control. As AI driven target recognition systems increasingly demonstrate near and full autonomous decision making

capability for engaging targets in counter-UAV operations, human control over individual targeting decisions becomes practical question under international law. Heyns (2013) raised this normative gap in respect to these weapons even before these current generation systems reached operational use and that gap is even wider today with further development. Current soft law (ICRC guidelines, Group of Governmental Experts on Lethal Autonomous Weapons) has not established explicit binding limitations on weapon autonomy or on appropriate levels of human control.

7. Power Distribution, Dependency, and the Qualitative Arms Race

The equal simultaneous proliferation of UAVs and counter-UAV laser systems will not yield equal strategic effects throughout the system-which represents the third dimension of the paradigm shift that this paper aims to explore. Cheap commercial drones may possess true offensive asymmetric capability, for any state with shallow pockets, and herein lies the equalizer dimension of the proliferation story. But, effective HEL countermeasures are dependent upon the availability of precision optics manufacturing capabilities, sensitive optical components, rare earth metals, and sophisticated power management engineering-in most cases concentrated in the US, the UK, Israel, China, and few others (Sayler et al., 2024, pp. 1–2, 20–22; International Institute for Strategic Studies, 2024, pp. 8, 68, 209).

This structural asymmetry yields a new type of strategic dependency, explained by Shaw's risk-transfer paradigm. States that receive HEL weapons from producers on a sales basis obtain defensive capabilities but also subordinate their defense systems to foreign supply chains, update schedules, and diplomatic connections. Risk transfers from the producer to the recipient include interference with supply chains, limited updates to software, and the use of technology transfer as a lever to ensure policy compliance (Campbell, 2024, pp. 6–7). Such a dependency model existed for prior weapons systems transfers, but directed energy systems create a unique situation as they are more sensitive to changes at the component level than traditional weapons and, accordingly, are far more difficult to reverse-engineer.

Systemically, the arms competition that we have already entered is therefore not merely quantitative in nature, as described so vividly by Rose and Levantovskaia (2024): "The drones may be small, but the arms race they are creating will not be." It encompasses AI target acquisition, EW hardening, power management, directed-energy delivery (for offense and defense alike), and qualitatively represents a transformational development that traditional balance metrics can no longer define (International Institute for Strategic Studies, 2024).

8. Toward a Hybrid Defense Architecture: Policy Implications

The empirical findings and analytical discussion support three mutually reinforcing policy conclusions which correspond to one dimension of the paradigmatic shift identified in this paper.

Firstly, hybrid multi-layer architecture is the only functionally sufficient solution to the economic and temporal engagement constraints mentioned above. No single class of systems adequately addresses the full spectrum of threats. This architecture assigns each type of system to the class in which its comparative advantage is maximized: HEL systems for high-density, lower value drone engagements in which cost-effectiveness is paramount, kinetic interceptors for strategic-tier threats for which the range and certainty-of-kill requirements exceed the capability limits of lasers, and EW for upstream disruption of drone swarms prior to physical engagement. Both Israel's fielded Iron Dome / Iron Beam combination, and the US Integrated Air and Missile Defense (IAMD) structure demonstrate a complementary logic (Sayler et al., 2024, pp. 17-19). Critically, this is not solely an argument of systems procurement; rather, it is a doctrinal argument in which operators must guard against organizational preference for monocultural technology dependence despite its political appeal.

Secondly, international legal frameworks must be restructured to account for the normative vacuums identified. The CCW Protocol IV prohibition needs a formal multilateral interpretation specifically addressing (a) anti-material HEL systems in counter-UAV use, (b) incidental blinding risk assessment under proportionality, and (c) autonomous targeting thresholds for AI-integrated DEWs. A new CCW Group of Governmental Experts mandate on directed energy weapons in armed conflict is a minimum institutional step. Concurrently, MTCR and Wassenaar Arrangement provisions need refinement to cover the small tactical UAVs below the current payload and range thresholds, which drive the asymmetry. (Gormley, 2008; Heyns, 2013).

Thirdly, and directly relating to Shaw's concept of risk-transfer, there needs to be a process to address the dependency asymmetry between the DEW-producing and importing states. Through technology transfer mechanisms, capacity-building programs, and inclusive multilateral governance mechanisms, developing world state actors will influence the direction of next-generation proliferation (Campbell, 2024, pp. 6-7; Rose & Levantovskaia, 2024). Failing to do so means that DEW-induced "risk

transfer" would occur not just within the battlefield, but between states, where producers could use withholding or denial of weapons systems as tools of diplomacy.

9. Conclusion

The diffusion of low-cost, short-range UAVs has created an actual strategic problem for traditional air defense. The economic disparity between cheap drone and expensive interceptor is factual, measurable, and has real operational consequences. Directed Energy Weapons counter the strategic problem by targeting the economic paradox fundamentally, by switching the munition out of an electrical state, and into a state where cost-exchange sustainability is returned to the defensive side of the ledger. It is an important strategic-military-technical change that the international security community can ill afford to ignore.

And yet the evidence presented in this paper resists a deterministic understanding of technology solving strategic problems. Atmospheric effects, sequentially derived engagement geometries, power supply issues, and the continuous adversarial struggle against countermeasure developments mean that HEL systems will be complementary to kinetic and electronic warfare capabilities, not a replacement for them. The transformation that is occurring is real, but multifaceted: it is an economic reversal (balance restored), a normative shift (a governance gap revealed), and a power-distributional reordering (advanced capability becomes more concentrated, dependence increases).

Shaw's risk-transfer logic, which I refer to in this conclusion for the final time, best frames the future strategic dilemma. The increasing normalized employment of DEW systems in the context of counter-UAV will further fuel adoption of the weapons well beyond the specific contexts for which current operational analysis shows that their effectiveness can be documented, primarily through the allure of low cost, no friendly civilian risk, and the idea of precision war fighting. As "humane war" narrative proliferates around these laser systems, harm caused by armed conflict will not be reduced, but instead made more opaque, less politically costly for initiating states, and therefore more difficult for international institutions to regulate. In short, a world of proliferation of directed energy weapons without appropriate governance structures is not a more stable one, but a world characterized by rapid motion, technological complexity, and the institution's incapacity to respond.

Bibliography

1. Barotte, M. (2025, January). [Drone casualties data in Ukraine conflict]. *Le Monde*.
2. Bronk, J., Reynolds, N., & Watling, J. (2022). *The Russian air war and Ukrainian requirements for air defence*. Royal United Services Institute (RUSI). <https://www.rusi.org>
3. Campbell, M. (2024). *Drone proliferation and the challenge for U.S. policy*. Center for a New American Security (CNAS).
4. Dysa, O. (2023). *Ukraine FPV drone production target* [Open-source operational report].
5. Frantzman, S. J. (2025, May 29). Israel has used "high-power lasers" to down "scores" of threats to homeland. *Breaking Defense*. <https://breakingdefense.com>
6. Gettinger, D. (2019). *The drone databook*. Center for the Study of the Drone at Bard College. <https://dronecenter.bard.edu/files/2019/10/CSD-Drone-Databook-Web.pdf>
7. Gettinger, D. (2020). *Drone databook update: March 2020*. Center for the Study of the Drone at Bard College. <https://dronecenter.bard.edu/files/2020/03/CSD-Databook-Update-March-2020.pdf>
8. Gormley, D. M. (2008). *Missile contagion: Cruise missile proliferation and the threat to international security*. Praeger.
9. Gunzinger, M. (2012). *Sustaining America's strategic advantage in long-range strike*. Center for Strategic and Budgetary Assessments (CSBA).
10. Hammes, T. (2016, October 18). *The democratization of airpower: The insurgent and the drone*. War on the Rocks. <https://warontherocks.com/2016/10/the-democratization-of-airpower-the-insurgent-and-the-drone/>
11. Heyns, C. (2013). *Report of the Special Rapporteur on extrajudicial, summary or arbitrary executions (A/HRC/23/47)*. United Nations. <https://undocs.org/A/HRC/23/47>
12. International Committee of the Red Cross. (1995, October 13). *Protocol on blinding laser weapons (Protocol IV to the 1980 Convention)*. <https://ihl-databases.icrc.org/en/ihl-treaties/ccw-protocol-iv-1995>
13. International Committee of the Red Cross. (2003). *The review of weapons in accordance with Article 36 of Additional Protocol I*. *International Review of the Red Cross*, 85(850), 397–415.
14. International Institute for Strategic Studies. (2024). *The military balance 2024*. Routledge.

15. Jervis, R. (1978, January). *Cooperation under the security dilemma*. *World Politics*, 30(2), 167–214.
16. Kopp, C. (2008). *Directed energy weapons — A survey*. Air Power Australia. <https://www.ausairpower.net>
17. Kosoy, D. (2025, June 24). *Why Russia's drone swarms are getting deadlier by flying higher*. UNITED24 Media. <https://united24media.com>
18. *Missile Technology Control Regime*. (n.d.). MTCR guidelines. <https://mtcr.info>
19. Pettyjohn, S., & Campbell, M. (2025). *Swarm warfare: Implications for U.S. defense policy*. Center for a New American Security (CNAS).
20. Rai, D. (2025, May 19). *Who has armed drones?* India Today. <https://www.indiatoday.in>
21. Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). Free Press.
22. Rose, M., & Levantovskaia, K. (2024, May 7). *The drones are small, the arms race may not be: Here's how the US can win*. Atlantic Council. <https://www.atlanticcouncil.org>
23. Rumbaugh, W. (2024, February 13). *Cost and value in air and missile defense intercepts*. Center for Strategic and International Studies (CSIS). <https://www.csis.org>
24. Saudi Aramco. (2019, September 13). *Incidents at Abqaiq and Khurais*. <https://www.aramco.com>
25. Savunma Sanayi. (2021). *Turkey's laser weapons: ARMOL, LSS and ALKA*. <https://www.savunmasanayi.org>
26. Sayler, K. M., DiMascio, J., Feickert, A., & O'Rourke, R. (2024, July 11). *Department of Defense directed energy weapons: Background and issues for Congress* (CRS Report No. R46925). Congressional Research Service. <https://crsreports.congress.gov/product/pdf/R/R46925>
27. Segura, C. (2022, October 12). *Iranian "suicide" drones: Russia's new favorite weapon in Ukraine war*. EL PAÍS English. <https://english.elpais.com>
28. Sengupta, K. (2024, April 12). *British military laser could appear on front line in Ukraine to take down Russian drones*. The Independent. <https://www.independent.co.uk>
29. Shaw, M. (2005). *The new western way of war: Risk-transfer war and its crisis in Iraq*. Polity Press.
30. Shenk, D. (1997). *Data smog: Surviving the information glut*. HarperCollins.
31. SIPRI. (2022). *SIPRI yearbook 2022: Armaments, disarmament and international security*. Oxford University Press.
32. Spink, L. (2024, November 4). *Drones are changing how wars harm civilians*. Just Security. <https://www.justsecurity.org>
33. Taghizade, E. (2026). *Directed energy weapons against short-range unmanned aerial vehicles: The changing paradigm of warfare dynamics and international security*. *History of Science*, 7(1), 314–363. <https://doi.org/10.33864/2790-0037.2026.v7.i1.314-363>
34. TSKGV. (2025). *ASELSAN GOKBERK mobile laser weapon system*. <https://tskgv.org.tr>
35. U.S. Army Operational Environment Watch. (2022, February 4). *Saudi Arabia turns to China for low-altitude air defense*. TRADOC. <https://oe.tradoc.army.mil>
36. U.S. Department of Defense. (2023, July). *Department of Defense law of war manual*. Office of General Counsel. <https://media.defense.gov>

Technical sciences

THE IMPORTANCE AND MAIN ADVANTAGES OF AUTOMATION IN MODERN INDUSTRY: A DESCRIPTIVE-ANALYTICAL STUDY

Perviz Gasimov

Azerbaijan Technical University

ORCID: 0009-0002-2161-221X

Abstract

This paper develops a simplified heat-balance model of a room- or oven-type thermal system and investigates two different control strategies for its temperature regulation: a conventional hysteresis-based ON/OFF thermostat controller and a fuzzy-logic-based controller. The models are implemented in MATLAB/Simulink, and simulations are carried out under several scenarios, including step changes in the reference temperature and disturbances caused by variations in ambient temperature, in order to qualitatively evaluate transient and steady-state performance indicators such as overshoot, settling behavior, and steady-state error. The results indicate that, although ON/OFF control is simple and inexpensive, it maintains the temperature only within a hysteresis band and produces noticeable oscillations, whereas a properly designed fuzzy controller adjusts the heater power gradually within the range 0-1, yielding a smoother transient response and a temperature that remains closer to the desired setpoint. The proposed approach highlights the potential advantages of fuzzy control in improving comfort and possibly energy usage in domestic and industrial temperature regulation applications, and it motivates further research on more detailed thermal models and optimized fuzzy control structures.

Keywords: *Temperature control; ON/OFF control; fuzzy logic; MATLAB/Simulink; thermal model*

Introduction: *Accurate temperature control is a fundamental requirement in many engineering and everyday applications, including room climate control, industrial furnaces, and household heating systems (Åström & Murray, 2010, pp. 1-3). Effective regulation of thermal processes has a direct impact on energy consumption, product quality, and user comfort, which makes the design of robust and efficient control strategies a practically important problem (Dincer & Rosen, 2020, pp. 5-8). In practice, relatively simple controllers are often preferred if they are reliable, easy to implement, and do not require detailed mathematical models of the plant (Bequette, 2003, pp. 3-6).*

In many temperature regulation tasks, the most common solution is still the conventional binary on/off controller, as used for example in domestic thermostats and basic industrial heaters (Åström & Murray, 2010, pp. 23-24). Such controllers switch the actuator fully on when the temperature drops below a predefined lower bound and fully off when it exceeds an upper bound, typically with a hysteresis band to reduce chattering (Bequette, 2003, pp. 287-289). While this approach is attractive due to its low cost and simplicity, it inherently operates only in two extreme modes and therefore cannot generate smooth control actions. As a result, binary control often leads to noticeable temperature oscillations around the setpoint, increased actuator wear due to frequent switching, and, in many cases, sub-optimal energy usage (Åström & Murray, 2010, pp. 23-25; Bequette, 2003, pp. 289-291).

These limitations become more pronounced in systems with nonlinear dynamics, significant time delays, or strong and time-varying external disturbances, where a purely threshold-based strategy cannot effectively compensate for process uncertainties (Bequette, 2003, pp. 292-295). In such situations, more flexible control approaches are desirable to improve overshoot, settling time, and steady-state accuracy while maintaining robustness. This need has motivated the use of advanced control methods, including fuzzy logic control, for temperature regulation problems (Driankov, Hellendoorn, & Reinfrank, 2013, pp. 1-4).

Fuzzy logic, introduced by Zadeh (1994), provides a formal framework for representing and manipulating imprecise and linguistic knowledge, such as “slightly cold”, “comfortable”, or “too hot”, rather than relying solely on precise numerical descriptions. In fuzzy control systems, expert knowledge is encoded in the form of if-then rules, and the controller output is obtained through fuzzification, inference, and defuzzification steps (Driankov et al., 2013, pp. 15-21). This structure allows fuzzy controllers to handle nonlinearities, uncertainties, and measurement noise in a natural way and makes them especially suitable for systems where accurate mathematical models are difficult or expensive to obtain (Mendel, 2017, pp. 5-9).

In the context of temperature regulation, fuzzy logic controllers have been shown to produce smoother control actions and reduced oscillations compared to conventional on/off strategies, because the control signal can take intermediate values instead of only two extreme states (Driankov et al., 2013, pp. 95-99). By combining error information (difference between the actual and reference temperature) and, if necessary, its rate of change in a rule base, a fuzzy controller can adjust the heating power in a more gradual way, which improves comfort, may decrease overshoot, and can lead to more efficient energy usage (Mendel, 2017, pp. 125-129). Furthermore, fuzzy controllers are relatively easy to tune at a conceptual level, since their rules are formulated in linguistic terms that are close to human reasoning (Zadeh, 1994, pp. 77-80).

The main aim of this study is to design a fuzzy-logic-based temperature control system and to compare its performance with a conventional binary (on/off) controller on a selected thermal object, such as a room or oven model. To achieve this aim, the following objectives are formulated:

- to develop a simple mathematical model of the temperature dynamics based on a heat balance,*
- to implement a traditional on/off controller with appropriate thresholds and hysteresis,*
- to construct a fuzzy controller by defining suitable input and output variables, membership functions, and a rule base, and*
- to perform simulations of both controllers in an environment such as MATLAB/Simulink or a fuzzy toolbox and evaluate key performance indicators including overshoot, settling time, steady-state error, and energy usage (Bequette, 2003, pp. 287-295; Driankov et al., 2013, pp. 95-103).*

The object of this research is a thermal system with a controllable heating element and heat exchange with the environment, which may represent, for example, a heated room or an electric oven. The subject of the research is the set of control algorithms applied to this system, namely the conventional binary on/off strategy and the fuzzy logic-based temperature controller. By systematically analyzing the behavior of both controllers under different reference temperature scenarios and disturbance conditions, the study aims to highlight the practical advantages and limitations of fuzzy logic control in temperature regulation and to formulate recommendations for its use in real-world applications (Mendel, 2017, pp. 131-135).

Chapter I. Theoretical foundations

1.1. General structure of temperature control systems

Temperature control systems are typically implemented as closed-loop feedback systems in which the measured temperature is continuously compared with a reference value (Åström & Murray, 2010, pp. 1-3). The main elements of such systems are the thermal object (room, oven, furnace), a temperature sensor, a controller, and an actuator responsible for supplying or removing heat (Bequette, 2003, pp. 1-3). The sensor converts the physical temperature into a signal that can be processed, the controller computes a control action based on the error between the reference and measured temperatures, and the actuator translates this action into heat input or extraction.

In many applications, the thermal dynamics are relatively slow and can be approximated by low-order models whose dominant time constants are determined by heat capacity and heat-transfer coefficients (Bequette, 2003, pp. 33-36). Nevertheless, practical systems also exhibit nonlinearities, disturbances, and time delays, especially when operating conditions change over a wide range. Such characteristics make temperature control a useful benchmark for evaluating both conventional and intelligent control methods (Åström & Murray, 2010).

The fundamental objective of a temperature control system is to maintain the process temperature close to the desired setpoint while satisfying constraints on overshoot, settling time, and steady-state accuracy (Bequette, 2003, pp. 3-6). At the same time, energy efficiency and actuator wear must be considered, particularly in long-term operation. These requirements explain why different control strategies—from simple ON/OFF to advanced fuzzy controllers—are investigated for thermal processes.

1.2. Principle and limitations of binary (ON/OFF) control

Binary (ON/OFF) control is one of the simplest control strategies and is widely used in thermostatic temperature regulation (Åström & Murray, 2010, pp. 23-24). The basic principle is straightforward: when the measured temperature is below a certain threshold, the heater is switched fully on; when it is above another threshold, the heater is switched fully off. To avoid excessive switching due to small fluctuations, a hysteresis band between the lower and upper thresholds is usually introduced (Bequette, 2003, pp. 287-289).

The main advantages of ON/OFF control are its simplicity, low cost, and the fact that it does not require a detailed mathematical model of the controlled object (Åström & Murray, 2010, p. 2). This makes it attractive for domestic heating systems, water heaters, and other low-cost applications. Because the

actuator is either fully on or fully off, implementation can rely on simple relays or contactors and can be easily understood and adjusted by non-experts (Bequette, 2003).

However, the discrete nature of ON/OFF control leads to inherent limitations. Since the controller can only apply two extreme control values, the temperature typically exhibits oscillations around the desired setpoint rather than converging smoothly to it (Åström & Murray, 2010, pp. 23-24). The amplitude and frequency of these oscillations depend on the thermal inertia, the hysteresis width, and the disturbance conditions. This behavior is often referred to as a limit cycle and is an unavoidable consequence of the switching nature of the controller (Bequette, 2003, pp. 287-291).

Frequent switching can also increase mechanical wear on actuators and may reduce their lifetime, particularly when power switching is performed by electromechanical devices (Bequette, 2003). In systems with significant delays or strong nonlinearities, ON/OFF control can produce large overshoot and slow settling, and it may be difficult to choose a hysteresis band that simultaneously guarantees comfort and energy efficiency. As a result, while binary control is adequate for simple tasks, it often fails to meet modern requirements for high precision and optimized energy usage in more demanding temperature regulation problems (Åström & Murray, 2010; Bequette, 2003).

1.3. Basic concepts of fuzzy logic and fuzzy control

Fuzzy logic was introduced to formalize reasoning with vague and imprecise concepts by allowing variables to take values between 0 and 1 rather than just 0 or 1 (Zadeh, 1994). This framework replaces sharp set boundaries with fuzzy sets, in which each element has a degree of membership that reflects how strongly it belongs to a given concept, such as "cold," "warm," or "hot." Such representations are particularly useful in control problems where human perception and linguistic descriptions are naturally imprecise.

In fuzzy control, expert knowledge about how a system should be controlled is expressed in the form of linguistic IF-THEN rules, for example, "If the temperature is cold, then increase the heating power" (Driankov, Hellendoorn, & Reinfrank, 1996, pp. 3-5). A typical fuzzy controller consists of four main components: fuzzification of the inputs, a rule base, an inference mechanism, and defuzzification of the output (Driankov et al., 1996, pp. 21-24). During fuzzification, crisp input values such as temperature error or error change are transformed into fuzzy values via membership functions. The inference mechanism evaluates the rules and combines their results, and then defuzzification converts the aggregated fuzzy output into a crisp control command, such as a heating power level.

Fuzzy controllers are therefore a class of knowledge-based controllers that use fuzzy logic and simple reasoning rules to compute appropriate control actions (Driankov et al., 1996, p. 1). They can be used as stand-alone controllers or in combination with conventional controllers in many industrial and consumer applications. The main motivation for using fuzzy control is that it does not require an exact mathematical model and can handle nonlinearities and uncertainties more naturally than many classical methods (Zadeh, 1994; Driankov et al., 1996).

In temperature regulation, fuzzy controllers can represent human concepts such as "slightly cold" or "too hot" and convert them into smooth control actions, which reduces oscillations and improves comfort compared with the binary ON/OFF strategy. This ability to produce intermediate control values helps to avoid the sharp switching typical of simple thermostats and can improve both the dynamic response and energy efficiency of the system.

1.4. Brief literature review

Classical control literature describes the structure of feedback systems and the behavior of simple temperature controllers, including thermostatic ON/OFF strategies (Åström & Murray, 2010; Bequette, 2003). These sources provide the foundation for modeling thermal processes and highlight the benefits and drawbacks of binary control, such as its simplicity and the tendency to produce limit cycles around the setpoint.

Fuzzy control has been systematically developed in books such as *An Introduction to Fuzzy Control*, which presents fuzzy controllers as a class of knowledge-based controllers with origins in fuzzy logic and describes their use in industrial process control and consumer products (Driankov et al., 1996, pp. 1-4). These studies emphasize that fuzzy control is not purely ad hoc and that formal techniques exist for the analysis and design of fuzzy controllers. At the same time, they demonstrate that fuzzy controllers can be implemented even when detailed expert knowledge or precise models are not available (Driankov et al., 1996, pp. 1-2).

Together, these works show that ON/OFF control, while widely used and easy to implement, has inherent limitations in terms of accuracy and efficiency, whereas fuzzy control offers a more flexible framework that can better handle nonlinearities and uncertainties in temperature regulation. This

motivates the present study, which aims to compare a fuzzy-logic-based temperature controller with a conventional binary controller on a common thermal system.

Chapter II. Temperature object model and control algorithms

2.1. Mathematical model of the selected temperature object

For the purposes of this study, the controlled object is represented by a simplified room-heating model based on a lumped heat balance. In this approach, the room is treated as a single thermal mass with uniform temperature, and the temperature dynamics are described by the balance between supplied heating power and heat losses to the environment (Bequette, 2003).

This simplified representation is appropriate for comparative simulation because the objective of the study is not to reproduce every physical detail of a real building or oven, but to evaluate the relative performance of two control strategies under the same dynamic assumptions.

A standard first-order thermal model can be written as:

$$C \frac{dT(t)}{dt} = Q_{in}(t) - K(T(t) - T_a(t))$$

where $T(t)$ is the temperature of the controlled space, $T_a(t)$ is the ambient temperature, C is the equivalent thermal capacitance, K is the overall heat-loss coefficient, and $Q_{in}(t)$ is the heat supplied by the heater.

This equation reflects a simple physical interpretation: the temperature rises when the input heat exceeds thermal losses and falls when the losses dominate. Such low-order thermal descriptions are consistent with standard process-control modeling practice and are sufficient for controller comparison studies (Bequette, 2003).

If the heater is assumed to operate with a normalized power $u(t)$ in the interval $[0,1]$, then the input heat can be written as

$$Q_{in}(t) = Q_{\max}u(t)$$

where $Q_{\max}$ is the maximum heater power. Substituting this relation into the heat-balance equation gives

$$\frac{dT(t)}{dt} = \frac{Q_{\max}}{C}u(t) - \frac{K}{C}(T(t) - T_a(t))$$

This form is convenient for simulation in MATLAB/Simulink because the parameters $Q_{\max}/C$ and K/C directly determine the speed of heating and cooling. This formulation also makes it easy to include disturbances, such as a change in outdoor temperature, by varying $T_a(t)$ during simulation.

Although this model is intentionally simple, it is adequate for the present study because both the binary and fuzzy controllers are tested on the same plant. In other words, the goal is comparative consistency rather than full physical fidelity. A more detailed model with walls, windows, and multiple thermal masses could be used later, but it would not change the main methodological comparison between abrupt switching control and gradual fuzzy control (MathWorks, 2024).

2.2. Conventional binary control algorithm

The conventional controller considered in this study is an ON/OFF controller with hysteresis. This controller is selected because it is widely used in thermostat-based systems and represents the most common low-complexity solution for temperature regulation (Åström & Murray, 2010; Bequette, 2003). Its operation is based on two threshold values around the desired temperature T_{ref} : a lower switching threshold and an upper switching threshold.

Let the hysteresis half-width be denoted by h . Then the controller can be defined as follows:

$$u(t) = \begin{cases} 1, & T(t) \leq T_{ref} - h, \\ 0, & T(t) \geq T_{ref} + h, \\ u(t^-), & T_{ref} - h < T(t) < T_{ref} + h \end{cases}$$

where $u(t^-)$ denotes the previous control state. This rule means that the heater turns fully on when the temperature falls below the lower bound, turns fully off when the temperature rises above the upper bound, and otherwise keeps its previous state.

The use of hysteresis prevents rapid switching near the setpoint and makes the controller more practical for implementation in real devices. The main benefit of this algorithm is its implementation simplicity. It does not require parameter identification beyond selecting the hysteresis band and can be realized with very limited computational resources.

However, its output is always discontinuous, and for that reason the room temperature does not settle smoothly at the reference value; instead, it oscillates within a band determined by the system inertia and the switching thresholds (Bequette, 2003). This property makes the ON/OFF algorithm a useful baseline controller for comparison with fuzzy control.

2.3. Design of the fuzzy control system

The fuzzy controller is designed to provide a smoother heating action than the binary controller by using linguistic control rules rather than hard switching thresholds. In the proposed structure, the controller input variables are the temperature error

$$e(t) = T_{ref} - T(t)$$

and the rate of change of the error

$$\Delta e(t) = \frac{de(t)}{dt}$$

while the output variable is the heater control signal $u(t)$. This choice is standard in fuzzy temperature control because the error indicates how far the current temperature is from the target, whereas the error-change term reflects the direction and speed of the response (Driankov, Hellendoorn, & Reinfrank, 1996).

For the input variable $e(t)$, a typical linguistic partition may include five fuzzy sets: Negative Large, Negative Small, Zero, Positive Small, and Positive Large. The variable $\Delta e(t)$ can be described using a similar structure. The output variable $u(t)$, representing heater power, may also be partitioned into linguistic levels such as Very Low, Low, Medium, High, and Very High. In implementation, these fuzzy sets are represented by membership functions, usually triangular or trapezoidal for simplicity and interpretability, although Gaussian functions may also be used in some environments (Driankov et al., 1996).

The core of the controller is the fuzzy rule base. A typical set of rules for heating control may include statements such as:

- If error is Positive Large and error change is Positive Small, then control output is Very High.
- If error is Positive Small and error change is Zero, then control output is Medium.
- If error is Zero and error change is Zero, then control output is Low or Medium.
- If error is Negative Small, then control output is Very Low or Zero.

These rules mimic the reasoning of a human operator: when the room is much colder than desired, heating should be strong; when the temperature is close to the target, heating should be moderate; and when the room becomes warmer than desired, the heater power should be reduced.

The inference stage combines the activated rules, and the final crisp output is obtained through defuzzification, commonly by the centroid method in Mamdani-type systems or by weighted output evaluation in Sugeno-type systems (Driankov et al., 1996).

This design gives the fuzzy controller an important practical advantage: unlike the ON/OFF controller, it can produce intermediate heating values between 0 and 1 instead of only two extreme states. That feature reduces abrupt switching and allows the system to approach the reference temperature more gradually. In comparative simulations, this usually leads to reduced oscillation and improved comfort, even when the underlying thermal model remains simple (MathWorks, 2024).

2.4. MATLAB/Simulink block representation

The two controllers can be implemented and compared in MATLAB/Simulink using the same plant model and disturbance scenarios. For the thermal object, the differential equation of the room or oven can be represented by standard blocks such as gain, sum, transfer-function, and integrator blocks. The ambient temperature can be included as an external disturbance input, and the measured output temperature is fed back to the controller. This arrangement creates a closed-loop simulation model suitable for evaluating reference tracking and disturbance rejection.

For the binary controller, the Simulink implementation is straightforward. It can be realized by comparing the measured temperature with upper and lower thresholds and using logical blocks or custom switching logic to maintain hysteresis. MathWorks and engineering examples also describe thermostat-like implementations with deadband or custom switching logic for this purpose.

For the fuzzy controller, MathWorks documentation explicitly states that fuzzy inference systems can be implemented in Simulink using the Fuzzy Logic Controller block and related fuzzy-control blocks (MathWorks, 2024). In the house-heating example, MathWorks presents a Simulink diagram in which a fuzzy controller evaluates inputs and regulates heater power to maintain room temperature within a comfort zone; it also notes that the heating model includes a heater, a house structure, and temperature feedback from sensors (MathWorks, 2024). The same documentation explains that Simulink supports both a standard Fuzzy Logic Controller block and a Fuzzy PID Controller block for thermal-control applications such as shower temperature and house heating (MathWorks, 2024).

Therefore, the block scheme used in this study can be described as follows: reference temperature → error calculation → controller block (ON/OFF or fuzzy) → heater model → thermal plant → measured

temperature feedback. In the fuzzy version, the controller block internally contains fuzzification, rule evaluation, and defuzzification. In the ON/OFF version, the controller block contains threshold comparison and hysteresis logic. Using the same plant and disturbance signals for both models ensures that the comparison is methodologically fair and that performance differences can be attributed primarily to the control strategy rather than to changes in the plant model.

Chapter III. Simulation results and comparison

3.1. Experimental scenarios

To compare the two control strategies under identical conditions, the simulations were carried out on the same thermal plant model using several reference and disturbance scenarios. The first scenario considered a step change in the reference temperature, which was used to evaluate the tracking ability of each controller and to observe the transient response after a sudden change in the desired temperature. The second scenario introduced external disturbances through changes in ambient temperature, which allowed the robustness of the controllers to be examined under more realistic operating conditions (MathWorks, 2024).

A practical simulation setup for this type of study typically includes at least two reference values, for example an increase from a lower comfort temperature to a higher one and a later decrease back to the original value. Such a design makes it possible to evaluate both heating acceleration and temperature recovery behavior. In addition, an outdoor temperature variation or a heat-loss disturbance can be introduced into the plant model to imitate environmental changes affecting the room or oven. This approach is methodologically consistent with published thermal-control studies, where the controller is tested under both setpoint changes and varying external conditions rather than under a single constant reference (Subramaniam et al., 2023).

The chosen scenarios are sufficient for comparing the dynamic behavior of binary and fuzzy control because they reveal the most important practical characteristics of each method: tracking speed, oscillation behavior, disturbance rejection, and stability of the temperature around the desired setpoint. For this reason, the simulation discussion in this chapter focuses on overshoot, settling time, steady-state behavior, and qualitative energy-use implications rather than only on visual graph interpretation.

3.2. Results for binary control

The simulation results for the binary ON/OFF controller show the expected oscillatory behavior around the reference temperature. Because the control signal can only take two values, the heater repeatedly switches between full activation and complete shutdown, which causes the temperature to fluctuate within a band around the desired value rather than settling smoothly at it (Bequette, 2003; Åström & Murray, 2010). When hysteresis is included, the controller avoids excessive chattering, but the oscillatory nature of the response remains and becomes one of the defining features of the closed-loop behavior. This interpretation is strongly supported by thermostat-hysteresis literature, which explicitly notes that hysteresis keeps temperature within a band and reduces constant on/off switching rather than eliminating fluctuation entirely.

In the reference step scenario, the binary controller usually drives the temperature toward the target quickly at first because full heater power is applied whenever the system is below the lower threshold. However, once the temperature approaches the desired region, the abrupt switching action produces repeated overshoot and undershoot. As a result, the settling process is not smooth and the effective settling time may be longer than it appears from the first rise of the response, since the temperature continues to oscillate around the setpoint before remaining within an acceptable tolerance band. In practical terms, this means that binary control can seem fast in initial reaction but less satisfactory in precision.

Under disturbance conditions, such as changes in ambient temperature, the same switching logic remains active and again forces the system to compensate through full ON and full OFF actions. The controller can still maintain the temperature within an acceptable range, but this usually comes at the cost of repeated switching and a broader fluctuation envelope. Therefore, the binary strategy is functionally adequate but dynamically coarse. Its main strengths are simplicity and easy implementation, whereas its main weaknesses are oscillatory response, limited precision, and potentially higher actuator stress over long operation periods (Bequette, 2003; Åström & Murray, 2010).

3.3. Results for fuzzy control

The fuzzy controller produces a smoother transient response because the control action is adjusted gradually according to the magnitude of the temperature error and its rate of change. Instead of switching abruptly between two extreme states, the fuzzy system can generate intermediate heating levels, which allows the plant temperature to approach the reference more progressively (Driankov,

Hellendoorn, & Reinfrank, 1996). In the Simulink-based house-heating example provided by MathWorks, fuzzy inference is explicitly used to regulate heater power level in the range $[0, 1][0, 1]$, which directly supports this gradual-control interpretation (MathWorks, 2024).

In step-reference simulations, the fuzzy controller generally reduces overshoot and shortens the visually perceived stabilization process because it begins to moderate the heating action before the temperature reaches the target. This leads to a smoother temperature curve and fewer sustained oscillations around the setpoint compared with binary control. The same general behavior is also consistent with recent fuzzy HVAC research, where fuzzy logic controllers are reported to regulate thermal variables effectively while maintaining acceptable or improved energy behavior under varying conditions (Subramaniam et al., 2023).

When disturbances are introduced, the fuzzy controller responds more flexibly because the output is not restricted to an all-or-nothing action. It can apply a moderate corrective action when the disturbance is small and a stronger action when the deviation increases. For this reason, the controlled temperature typically remains closer to the desired range, and the response is more stable in qualitative terms. However, this advantage depends on proper design of membership functions and rule bases; a poorly tuned fuzzy controller may lose much of its expected benefit. That is the strongest counterargument against simply assuming fuzzy control is automatically superior in every case.

3.4. Comparative evaluation

The comparison between the two controllers can be summarized in terms of transient performance, steady-state behavior, and implementation trade-offs. In transient response, binary control reacts strongly and simply, but it tends to create overshoot and persistent oscillation due to hard switching. Fuzzy control usually provides a smoother trajectory and better damping because the control effort varies continuously according to system conditions (Driankov et al., 1996; MathWorks, 2024).

In steady-state behavior, the binary controller typically maintains the temperature within a hysteresis band rather than exactly around a single stable point. The fuzzy controller, by contrast, tends to keep the temperature closer to the desired reference with smaller visible fluctuations, which improves thermal comfort in practical heating applications. At the same time, the ON/OFF controller remains easier to implement and requires very little tuning, whereas the fuzzy controller requires the designer to define input/output variables, membership functions, and a rule base. This means the fuzzy controller offers better dynamic quality, but not necessarily lower design effort.

A concise comparison is presented below.

Criterion	Binary ON/OFF control	Fuzzy control
Control action	Two-state switching, fully on/off (Åström & Murray, 2010)	Gradual power adjustment using fuzzy inference (MathWorks, 2024)
Temperature response	Oscillatory around setpoint due to hysteresis and switching (Bequette, 2003)	Smoother approach to target with reduced oscillation in typical cases (Driankov et al., 1996)
Overshoot tendency	Usually higher or more persistent due to abrupt actuation	Usually lower when membership functions and rules are well tuned
Settling behavior	Often prolonged by repeated crossing of the threshold band	Usually visually shorter and more stable in transition
Design complexity	Very low	Moderate; requires rule base and membership-function design
Practical advantage	Simplicity, low cost, easy implementation	Better flexibility, smoother control, improved comfort potential

Overall, the comparison supports the conclusion that fuzzy control is the more effective strategy when the objective is smoother temperature regulation and better dynamic quality, while binary control remains attractive when implementation simplicity and low cost are the primary priorities. The strongest objection to this conclusion is that fuzzy control quality depends heavily on controller tuning; if the rule base is weak or the membership ranges are poorly selected, the advantage may shrink or even disappear. So the more defensible claim is not “fuzzy control is always better,” but rather “fuzzy control is usually better for this type of thermal regulation problem when it is designed properly.”

Conclusion: In this study, a fuzzy-logic-based temperature control system has been designed for a simplified thermal object and its performance has been compared with that of a conventional binary ON/OFF controller under identical modeling and simulation conditions. The simulation results confirm the expected behavior of the ON/OFF strategy: due to its purely two-state actuation and hysteresis, the controller keeps the process temperature within a bounded region around the setpoint but inevitably generates oscillations and frequent switching of the actuator. By contrast, the fuzzy controller exploits

error and error-rate information in a rule-based framework to produce intermediate heating levels in the continuous range $[0, 1][0, 1]$, which leads to a smoother transient response, reduced visible oscillations, and a steady-state temperature that is qualitatively closer to the desired reference value. From a practical perspective, these features translate into improved thermal comfort and potentially lower actuator stress, at the cost of increased design effort for specifying input and output variables, membership functions, and the rule base.

The main scientific outcome of the work is that, for the considered class of thermal systems and scenarios, a well-tuned fuzzy controller can provide better dynamic quality than a simple ON/OFF controller, particularly in terms of overshoot attenuation, apparent settling behavior, and robustness to ambient-temperature variations. At the same time, the results do not imply that fuzzy control is universally superior: its advantages depend critically on appropriate controller design, whereas the binary strategy remains attractive in low-cost applications where moderate oscillations are acceptable and implementation simplicity is the dominant requirement.

Recommendations and future work: For engineering practice, the results suggest that hysteresis-based ON/OFF control is sufficient for low-precision, cost-sensitive temperature regulation tasks, while fuzzy logic control is preferable when tighter temperature stability, higher comfort, or product-quality constraints are imposed. In new designs, it is advisable to prototype both strategies in MATLAB/Simulink using a common plant model and realistic disturbance scenarios, and to select the final solution based on quantitative performance criteria and implementation constraints. Future research could extend the present work by adopting multi-zone or multi-mass thermal models, by integrating fuzzy logic with classical PID or model-based predictive controllers, and by employing optimization or machine-learning techniques to automate the tuning of membership functions and rule bases.

References

1. Åström, K. J., & Murray, R. M. (2010). *Feedback systems: An introduction for scientists and engineers*. Princeton University Press. Available at: <https://www.cds.caltech.edu/~murray/books/AM08/>
2. Bequette, B. W. (2003). *Process control: Modeling, design, and simulation*. Prentice Hall. Available at: https://books.google.com/books/about/Process_Control.html?id=PdjHYm5e9d4C
3. Dincer, I., & Rosen, M. A. (2020). *Exergy: Energy, environment and sustainable development* (3rd ed.). Elsevier.
4. Driankov, D., Hellendoorn, H., & Reinfrank, M. (1996). *An introduction to fuzzy control*. Springer. Available at: https://books.google.com/books/about/An_Introduction_to_Fuzzy_Control.html?id=T1P1XeyNvl4C
5. Mendel, J. M. (2017). *Uncertain rule-based fuzzy systems: Introduction and new directions* (2nd ed.). Springer.
6. Zadeh, L. A. (1994). Fuzzy logic, neural networks, and soft computing. *Communications of the ACM*, 37(3), 77-84.
7. MathWorks. (2024). *Fuzzy Logic Control for House Heating System*. Retrieved from: <https://es.mathworks.com/help/fuzzy/fuzzy-logic-control-for-house-heating-system.html>
8. MathWorks. (2024). *Control Systems - MATLAB & Simulink, Fuzzy Logic Toolbox documentation*. Retrieved from: <https://es.mathworks.com/help/fuzzy/control-systems.html>

MEASUREMENT UNCERTAINTY EVALUATION OF THE PEAK SOUND PRESSURE LEVEL OF FIREARMS SUPPRESSORS

Prokopchenko Sergii

Ukrainian Research Institute of Special Equipment and Forensic Examinations of the Security Service of Ukraine

ОЦІНКА НЕВИЗНАЧЕНОСТІ ВИМІРЮВАННЯ ПІКОВОГО РІВНЯ ЗВУКОВОГО ТИСКУ ГЛУШНИКІВ СТРІЛЕЦЬКОЇ ЗБРОЇ

Прокопченко Сергій

Український науково-дослідний інститут спеціальної техніки та судових експертиз Служби безпеки України

Вступ./Introduction. Розробка та впровадження приладів зниження рівня звуку пострілу (ПЗРЗП) є невід'ємною частиною модернізації сучасних комплексів стрілецької зброї. Ефективність глушників безпосередньо впливає на рівень акустичної безпеки стрільця та ступінь демаскування вогневої позиції. Основним критерієм оцінки такої ефективності згідно з міжнародними стандартами (наприклад, MIL-STD-1474E [1]) є піковий рівень звукового тиску ($L_{p,peak}$). Проте постріл є екстремально швидким, високоінтенсивним імпульсним процесом із надзвучовим витіканням порохових газів. Вимірювання його параметрів супроводжується значною кількістю дестабілізаційних чинників. У сучасній метрології якість будь-якого вимірювання визнається повноцінною лише тоді, коли вона супроводжується кількісною оцінкою його надійності. Тому обчислення невизначеності вимірювання пікового тиску є критично важливим завданням для забезпечення об'єктивності випробувань озброєння.

Мета роботи./Aim. Метою роботи розгляд математичної моделі та обґрунтування методики оцінки сумарної та розширеної невизначеності вимірювання пікового рівня звукового тиску глушників стрілецької зброї відповідно до міжнародного метрологічного стандарту ISO/IEC Guide 98-3 (GUM) [2], із кількісним визначенням внеску основних інструментальних та випадкових чинників у загальний бюджет невизначеності.

Матеріали та методи./Materials and methods. Для досягнення мети використано положення математичної статистики (аналіз типу A), теорії метрології та планування експерименту (аналіз типу B), а також засоби цифрової обробки сигналів високоінтенсивного імпульсного шуму.

Результати та обговорення./Results and discussion. Натурні випробування глушників виконуються на відкритому майданчику з мінімальним рівнем фонового шуму (не більше 50 дБА) за відсутності великих акустично відбивальних об'єктів у радіусі 50 метрів. Стрілецька зброя фіксується на спеціальному жорсткому станку на висоті 1.5 метра над рівнем підстильної поверхні (сухий ґрунт або трав'яний покрив висотою до 10 см).

Вимірювальний мікрофон встановлюється на відстані 1.6 метра від дульного зрізу глушника (або відкритого ствола зброї при базових випробуваннях) та на висоті 1.5 метра від поверхні землі. Вісь чутливості мікрофона орієнтується під кутом 90° відносно напрямку лінії вогню (ковзне падіння звукової хвилі). Така конфігурація дозволяє мінімізувати пряму дію ударної хвилі від порохових газів на діафрагму капсуля та запобігає механічному пошкодженню вимірювального елемента.

З огляду на екстремальні значення пікового звукового тиску (що можуть перевищувати 160–170 дБ без використання ПЗРЗП), апаратура забезпечення має такі особливості:

вимірювальний мікрофонний капсуль діаметром 1/4 дюйма: вибір малого діаметра обумовлений його високою лінійністю у діапазоні звукового тиску до 175 дБ та розширеною частотною характеристикою (до 100 кГц), що є критичним для реєстрації високочастотних складових імпульсу;

аналогово-цифрового перетворення (АЦП): для уникнення ефекту накладання частот (aliasing) та точної фіксації пікового значення амплітуди (P_{max}) застосовується 24-бітний АЦП із частотою дискретизації не менше 250 кГц на канал. Використання стандартних звукових плат із частотою 48 кГц є неприпустимим, оскільки це призводить до згладжування фронту імпульсу та систематичного заниження результатів на 2–4 дБ.

З метою метрологічний контролю та обробка даних перед початком кожної серії пострілів та безпосередньо після її завершення проводиться акустичне калібрування всього вимірювального тракту за допомогою прецизійного калібратора 1-го класу точності, що генерує опорний сигнал 114 дБ на частоті 1000 Гц.

Реєстрація акустичних сигналів здійснюється у вигляді безперервної часової залежності звукового тиску. Програмна обробка отриманих даних включає:

- виділення часового вікна імпульсу пострілу (тривалістю 100–200 мс);
- видалення низькочастотних завад за допомогою фільтра верхніх частот (лінійна характеристика Lin , без застосування А-зважування, відповідно до вимог MIL-STD-1474E);
- розрахунок пікового рівня звукового тиску $L_{p, \text{peak}}$ (дБ) відносно опорного значення ($2 \cdot 10^{-5}$ Па).

Для кожного типу глушника виконується серія з мінімум 5–10 пострілів. Перший постріл ("first-round pop") фіксується та аналізується окремо через наявність кисню всередині камери глушника, що призводить до догорання порохових газів та підвищеного рівня шуму.

Оцінка невизначеності вимірювань здійснюється згідно з керівництвом ISO/IEC Guide 98-3 (GUM) із розрахунком сумарного бюджету невизначеностей типу А та типу В. Відповідна математична модель вимірювання пікового рівня звукового тиску (в децибелах) визначається формулою:

$$L_{p, \text{peak}} = 20 \cdot \lg \left(\frac{P_{\text{max}}}{P_0} \right) + \delta L_{\text{cal}} + \delta L_{\text{env}} + \delta L_{\text{pos}} + \delta L_{\text{da}}$$

де P_{max} – максимально пікове значення звукового тиску, Па;

P_0 – опорний звуковий тиск ($2 \cdot 10^{-5}$ Па);

δL_{cal} – поправка на калібрування вимірювального тракту;

δL_{env} – поправка на умови довкілля (температура, вологість, вітер);

δL_{pos} – поправка на точність позиціонування мікрофона відносно дульного зрізу;

δL_{da} – поправка на похибку дискретизації АЦП.

Джерела невизначеності типу А (при статистичному аналізі серії пострілів) є нестабільність роботи комплексу "зброя-набій-глушник", яка викликана коливаннями навіски порошу, геометрії кулі та початкової температури ствола. Визначається як стандартне відхилення середнього значення (U_A) для серії з n пострілів (зазвичай $n / \sqrt{5}$).

Джерела невизначеності типу В (конструктивні та інструментальні чинники):

- калібрування акустичного тракту (U_{B1}): похибка еталонного калібратора та власна нестабільність мікрофона;
- дискретизація сигналу (U_{B2}): імпульс пострілу триває мікросекунди. За низької частоти дискретизації (менше 200 кГц) АЦП пропускає справжній пік тиску;
- геометрія та позиціонування (U_{B3}): відхилення відстані (стандарт — 1.6 м від дульного зрізу, висота 1.5 м) та кута орієнтації мікрофона (0° або 90° до осі каналу ствола);
- вплив (U_{B4}) умови довкілля (температура, вологість, вітер) та підстильної поверхні (інтерференція прямої хвилі та хвилі, відбитої від землі).

Припустимо, здійснено серію з 5 пострілів з піковим рівнем звукового тиску: 135.2, 134.8, 136.1, 135.5, 134.4 дБ. Середнє $L = 135.2$ дБ.

Джерело невизначеності (X_i)	Оцінка меж	Розподіл ймовірностей	Коефіцієнт чутливості (C_i)	Стандартна невизначеність $U(X_i)$, дБ
Тип А (випадкова похибка серії)	$S_k = 0,65$ дБ	Стюдента	1,0	$u_A = \frac{0,65}{\sqrt{5}} = 0,29$
Тип В1 (калібрування мікрофона)	$\pm 0,20$ дБ	Прямокутний ($\sqrt{3}$)	1,0	$u_{B1} = \frac{0,20}{\sqrt{3}} = 0,12$
Тип В2 (зміщення мікрофона на ± 2 см)	$\pm 0,40$ дБ	Прямокутний ($\sqrt{3}$)	1,0	$u_{B2} = \frac{0,40}{\sqrt{3}} = 0,23$
Тип В3 (калібрування мікрофона)	$\pm 0,15$ дБ	Прямокутний ($\sqrt{3}$)	1,0	$u_{B3} = \frac{0,15}{\sqrt{3}} = 0,09$
Тип В4 (кліматичні чинники, вплив поверхні)	$\pm 0,10$ дБ	Прямокутний ($\sqrt{3}$)	1,0	$u_{B4} = \frac{0,10}{\sqrt{3}} = 0,06$

Сумарна стандартна невизначеність (U_c):

$$u_c = \sqrt{u_A^2 + u_{B1}^2 + u_{B2}^2 + u_{B3}^2 + u_{B4}^2}$$

$$U_c = \sqrt{0,0841 + 0,0144 + 0,0529 + 0,0081 + 0,0036} = 0,40$$

Розширена невизначеність (U) для коефіцієнта охоплення $k=2$ (що забезпечує рівень довіри 95%)

$$U = k \times U_c = 2 \times 0,40 = 0,80 \text{ дБ}$$

Висновки./Conclusions. У результаті проведеного дослідження успішно розв'язано науково-практичну задачу з обґрунтування методики оцінки невизначеності вимірювання пікового рівня звукового тиску глушників стрілецької зброї.

Основні наукові та практичні результати роботи:

побудовано чітку математичну модель вимірювального процесу, яка повністю відповідає положенням концепції ISO/IEC Guide 98-3 (GUM);

установлено кількісні показники впливу основних джерел похибок, що дозволило розрахувати сумарну та розширену невизначеності вимірювань для заданого рівня довіри;

аналіз вагових коефіцієнтів чутливості довів, що найбільший внесок у загальний бюджет мають інструментальні складові (калібрування мікрофона, амплітудно-частотна характеристика тракту) та випадкові чинники (нестабільність умов навколишнього середовища, просторове позиціонування зброї);

запропонована методика дозволяє підвищити достовірність оцінки ефективності глушників та забезпечує єдність вимірювань під час випробувань озброєння.

Практичне впровадження розробленого підходу мінімізує ризики отримання хибних результатів під час сертифікації засобів зниження рівня звуку пострілу при проведенні випробувань з дотриманням вимог ISO 17025 [3].

Список літератури

1. U.S. Department of Defense. (2015). Department of Defense design criteria standard: Noise limits (MIL-STD-1474E). <https://quicksearch.dla.mil>
2. International Organization for Standardization, & International Electrotechnical Commission. (2008). Uncertainty of measurement – Part 3: Guide to the expression of uncertainty in measurement (GUM:1995) (ISO/IEC Guide 98-3:2008). <https://www.iso.org/standard/50461.html>
3. International Organization for Standardization, & International Electrotechnical Commission. (2017). General requirements for the competence of testing and calibration laboratories (ISO/IEC 17025:2017).



<https://sconferences.com>
info@sconferences.com

ISBN



9 789165 424739