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**SCIENCE IN THE ENVIRONMENT
OF RAPID CHANGES**

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BUSINESS ECONOMICS

Adaptive Innovation Strategy for System Integration Companies' Performance under Conditions of Instability and Crisis

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Introduction.

In the modern era of global transformations [1], characterized by a state of permanent turbulence, traditional approaches to strategic planning in all (especially in high-tech) sectors of the economy require innovative reengineering [2]. This issue is particularly acute for companies specializing in system integration, which are the connecting link between innovative developments and their practical implementation in the real sector. The specificity of this industry is such that any external risks, shocks – a rupture of global logistics chains [3, 4], a shortage of semiconductors or a sharp change in vendor policy – instantly affect the stability of business processes. In the case when uncertainty becomes a constant [5], and risks – multi-level and multi-factor – classic linear strategies lose their predictive power, turning into a risk factor, rather than a development tool [6-8]. The concept of adaptive strategy comes to the fore, which involves not just reactive behavior in response to a crisis, but a deep internal transformation of the mechanisms of innovative activity [9]. The relevance of this study is dictated by the urgent need to overcome the contradiction between the long-term nature of innovation cycles and the short-term requirements of survival in conditions of instability. The aim of the work is to theoretically substantiate the model of adaptive strategy, which allows integrator companies not only to maintain target performance, but also to use crisis periods as a catalyst for a qualitative technological leap and strengthening market positions through flexible management of resources and

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competencies.

Main Part.

The main part of the study is based on the understanding of system integration as a specific high - tech service, where innovation activity is not only product-related, but also has a pronounced architectural and process character. In conditions of crisis and growing instability, the performance of such companies ceases to be derived from static competitive advantages and turns into a plane of implementation of the concept of dynamic capabilities. The theoretical basis of adaptive strategy in this context is based on the principle of strategic versatility - the ability of an organization to simultaneously optimize current operational processes (operation) and actively search for new technological niches (research). For the integrator, this is the need to maintain the stability of existing infrastructure projects while simultaneously accelerating the development of alternative software and hardware platforms. The mechanism for forming performance within the framework of adaptive strategy undergoes a qualitative transformation: if in stable conditions, priority is given to scalability and cost minimization, then in crisis conditions the dominant factor becomes the speed of resource reconfiguration. Adaptive strategy involves abandoning rigidly deterministic plans in favor of portfolio management of innovation initiatives, where each project is perceived as a set of real options. This allows the company to maintain flexibility, having the ability to quickly scale successful pilot implementations or roll back areas that have lost relevance due to changes in sanctions policy, vendor oversight, or changes in technological standards. System integration in this sense appears as a process of "intelligent assembly", where value is created not by owning individual technologies, but by unique competence in their seamless orchestration in conditions of shortage of time and resources. The key tool for implementing such a strategy is hybrid intelligent technologies [10], which become a reinforcement of the adaptive enterprise. Unlike highly specialized automation systems, hybrid intelligence allows for integrating the capabilities of machine learning and big data with the expert knowledge of highly qualified engineers [11]. In times of crisis, when historical data cease to be a reliable basis for predicting the future, it is the cognitive synergy of man and machine that allows for the formation of predictive behavior

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models. Such technologies provide intellectual support in the design of the complex systems, and automatically selecting the optimal configurations of equipment and software from analogues available on the market. As well as modeling scenarios of the resilience of the created IT infrastructure to various types of external threats. Thus, the technological stack of the integrator company itself becomes an object of continuous innovation, adapting to changing security and efficiency requirements. An important aspect of the main part of the study is the analysis of the impact of the environment on the structure of the adaptive strategy. In case of instability, the integrator company is forced to move from the "supplier-customer" model to the "technology partnership" model. This requires the introduction of innovations in the field of interaction with stakeholders: the creation of joint laboratories, the use of open platforms and active participation in the formation of new industry ecosystems. The effectiveness here is determined by the depth of integration into the client's business and the ability to offer solutions that do not simply patch holes in the IT budget, but create new growth points for the customer. In this context, the adaptive strategy includes elements of service transformation, so when the focus shifts from a one-time delivery of complex systems to ensuring their continuous evolution and support throughout the entire life cycle (which guarantees a stable cashflow and high customer loyalty even in periods of economic downturn).

Concluding the systemic consideration of the main part, it is necessary to emphasize that the effectiveness of the adaptive innovation strategy is inextricably linked to the organizational culture and the quality of human capital. The transition to hybrid intelligent technologies requires personnel not only deep technical knowledge, but also a high level of adaptive intelligence. Innovations in human resources management become an integral part of the overall strategy, ensuring horizontal connections between project teams and a free exchange of knowledge. Ultimately, system integration in an era of crises turns into the complexity management, where victory in competition goes to those companies, that were able to turn technological uncertainty into a manageable development resource, relying on the synergy of human talent and advanced intelligent systems.

Conclusions.

The analysis conducted allows us to assert that in

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conditions of systemic instability, the effectiveness of enterprises in system integration directly correlates with the ability of their management structures to dynamically reconfigure key assets. The main theoretical and practical result of the study was the proof that an adaptive innovation strategy in this sector should be based on the principles of modularity and technological neutrality. We concluded that in periods of crisis, the most stable are those players who were able to integrate "anti-fragility" mechanisms into their business model, which allow them to benefit from market chaos through rapid changes in technological stacks and diversification of partner networks. The study showed that innovations in system integration during a crisis cease to be exclusively product-based and shift towards process and organizational solutions aimed at optimizing the cost of ownership of I T infrastructure for the end customer. Thus, the formed concept of adaptability - transforms the strategy from a rigid plan into a living self learning algorithm, where performance is measured not only by the financial indicators of the current period but also by the speed of adaptation of the innovation portfolio (to radically changing market demands, which ultimately ensures long-term survival and leadership in the high - end).

Prospects for further research.

The further development of the presented issues is inextricably linked with the deep convergence of classical management approaches and hybrid intelligent technologies, which should become the foundation for new generation decision-making systems. In the context of system integration such technologies that combine the analytical power of neural network models and the cognitive flexibility of expert systems open up exceptional opportunities for predictive risk management, but in conditions of high uncertainty. A promising vector of the research is the creation of intelligent agents capable of both processing arrays of market data and integrating the implicit knowledge of leading engineers and architects into calculations (thereby forming a synergy of machine accuracy and human intuition). The use of hybrid models will allow integrator companies to automate the process of dynamically reassembling the solution portfolio, quickly selecting alternative technological stacks in the event of a sudden change in external conditions. In future work, special attention should be paid to the issues of interpretability of such systems so that the adaptive strategy is based not on

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the “black box” of algorithms, but on transparent and substantiated development scenarios. Ultimately, it is the transition to hybrid intelligence in strategic management that will allow transforming the reactive model of company behavior into a proactive one, where technological sovereignty and competitiveness will be ensured due to the system’s ability to self-learn and evolve at a pace that is ahead of the rate of increase in crisis phenomena. This approach transforms adaptability from an operational characteristic into a fundamental property of the enterprise’s digital ecosystem, determining the vector of industry development for decades to come.

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INTERNATIONAL ECONOMICS AND INTERNATIONAL RELATIONS

The Geopolitical Chessboard in the Middle East

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Abstract. The contemporary global order is currently defined by an intensification of both kinetic and economic conflicts, representing a significant shift in the international security landscape over the last half-century. This article examines whether these multifaceted confrontations represent genuine national defense or a broader process of territorial and systemic redistribution. Focusing on the Middle East, the study analyzes the strategic "triangle" involving Israel, the United States, and Iran, evaluating its impact on global energy markets and regional stability. Furthermore, it situates these regional tensions within the context of the broader U.S.-China rivalry, exploring how American geopolitical interests are increasingly defined by the containment of Chinese influence. By assessing the escalating conflict between the U.S.-Israel alliance and the Iranian axis, this paper explores the potential for regional destabilization and the long-term implications for global security architectures.

Keywords: *The Middle East, Security, Global actors, hegemony.*

Geopolitical situation in the Middle East

First and foremost, when speaking about the Middle East region, we must begin with the coalitions that pose a threat to one another in the struggle for global hegemony and during the redistribution of territories. In this article, I will highlight the Russia-Iran-China alliance, which poses a threat to America and Israel. Their confrontation with each other is expressed not only in trade relations and the pursuit of advantage, but also in the development and expansion of nuclear armaments and offensive weaponry in general.

The Middle East, by its very nature, has always

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represented a complex and multilayered geopolitical space, and today is no exception.[1] It encompasses religion, history, and energy. Accordingly, the processes unfolding here are directly connected to and impact global security, order, and the economy.

In this article, I will not examine the historical dimension, which begins long before the 21st century. I want to focus specifically on the processes currently underway and the geopolitical games in this region, and accordingly, their impact on the world's well-being.

Ever since Russia invaded Ukraine and launched a full-scale military aggression, the world has begun to think about the explosive threats of the future. Particular attention is being paid to weapons such as nuclear arms, which fall under the category of weapons of mass destruction. Accordingly, nuclear states have expressed a desire to increase their arsenals, while non-nuclear states with the capacity have begun to consider either creating them or having a nuclear state deploy nuclear weapons on their territory within the framework of a partnership. One of the states that has acquired nuclear potential is Iran. Within the framework of its partnership with Russia and China, it managed to almost fully create a weapon, and partial uranium enrichment also took place, which is perceived as a direct threat by Israel and America. Likewise, China's involvement in the Middle East and its trade relations with countries in the region are perceived as a threat by the US, since it is losing its dominance in the region, being replaced by China. I believe the processes unfolding there are entirely connected to the fears of the US and Israel regarding Iran's growing strength, Russia's and China's ties with Iran, and the historical confrontation of states in the region with Israel – all of which create a full basis for the geopolitical instability of the region. One of the key issues is the threats that may stem from China.[2] The region is rich in energy resources, which makes it attractive. China is the world's largest importing country by energy purchasing capacity. It also represents a desirable partner for states in the region, as it improves their economic situation. Moreover, China pursues a soft policy and, unlike the US, is more attractive because it does not interfere in the internal affairs of states in the region. Middle Eastern states also import green energy from China, various construction materials, electric vehicles, and – most importantly – China provides the

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construction of infrastructure projects for transit within the framework of its "Belt and Road Initiative" (BRI).

As for Russia and Iran, they are in a sense strengthening each other, especially after Russia invades Ukraine and its receipt of drones from Iran, which has deepened their partnership further. Accordingly, China-Iran-Russia formed a fairly powerful force in the region's geopolitical game. However, after Israel and America jointly launched an offensive against Iran to halt and destroy its nuclear weapons program, perceptions of power at first glance are changing, since Iran has not received open assistance, although it is likely that Russia and China are helping Iran, just not openly.[3] Their support has been expressed through humanitarian aid, which in all likelihood covertly included the assistance Iran needed. Even though the leaders of the Iranian government have been liquidated, a change of regime has still not been achieved, and the notion that America's war in Iran resembles Vietnam is already spreading widely. Meanwhile, Trump is already considering withdrawing from the current processes.

As for the relationship between Europe and the US regarding the US invasion of Iran, it has caused a rift in their relations, as Europe refused to assist America. Despite Iran having carried out minor strikes in the neighborhood, Saudi Arabia – which is considered America's partner – is also trying to maintain a neutral stance. What does all this mean, and what outcome will it bring to the US? Whether the invasion of Iran will once again secure dominance in the region or, on the contrary, further diminish it, remains a contested question. As for the consequences triggered by the commencement of military operations against Iran, these are not only results arising during the course of the war – they will inevitably continue and will deal a heavy blow to the world, especially in the trade sphere and even more so in the area of energy resources. This is because the world has fully come to understand what an energy resource deficit means – a deficit that followed Iran's closure of the Strait of Hormuz, during which countless ships in a loaded state await when they will be able to pass.[4] Moreover, Trump's statement that everyone must individually ensure the security of their own cargo makes the situation more difficult. Additionally, Iran's expressed view regarding tariffs for vessels passing through the strait further complicates the existing situation, raising the market value of energy resources

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considerably.

Based on the processes unfolding in the Middle East, one may ask: did Trump – who seemingly tried to pursue the Monroe Doctrine from the very first day of his presidency – want the attack on Iran under the umbrella of halting nuclear weapons development, or was this pressure from Israel, which had long planned and desired to create buffer zones in the Gaza Strip, in Lebanon, and to swiftly eliminate its fears stemming from Iran's growing power? [5] There is much to debate around the current processes and various views may be expressed, yet the main question that must be left under a question mark at this stage is: after the conclusion of the war in Iran, will it not be assessed in the same way as what happened in Iraq?

The US Goal in the Middle East

After Trump's presidency began, the world order was turned upside down, and his policy initially became focused on trade competition – though he does not shy away from force-based methods to achieve his goals, expressed in dominance on a global scale. His campaign and subsequent statements – America first, and non-interference in others' domestic affairs – are expressed only when it suits him, for example in the Ukraine-Russia confrontation, whereas when the matter concerned Israel, he mobilized full combat potential and, under the pretext of protecting the world and Israel's security, engaged military forces against Iran and pro-Iranian forces in the Middle East region.[6] What consequences could follow if America gains full dominance in the region and repeats the Venezuela scenario – where it created a favorable situation to push through its political interests and the ability to extract its energy resources – and if it manages to direct the region's existing energy resources as it sees fit, it will gain full hegemony in managing global energy resources, and most importantly, will create the opportunity to cut China off from the region, dealing a heavy blow to the world's largest importer dependent on the region. In this case, naturally, what is being considered is not a supply cutoff but a price increase, which will compel producer countries and will also enable control over the flow of goods coming from China. I believe the US is targeting the collapse of China's One Belt, One Road project, which runs in three directions: the northern, the middle corridor – Ecuador, and the southern. The actions of the US are not only about helping Israel and protecting the world from Iran in the future as a nuclear-armed state, but also – and primarily – about winning

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the trade war against China, which is heavily dependent on the Middle East region.[7]

Conclusion

To conclude, the Middle East represents one of the main nodes of global politics. In the region, local ambitions and international interests collide. The region is the epicenter of confrontation between two superpowers, America and China, today. For them, it serves as a proving ground for trade warfare, and in relation to Iran, as a place for containing nuclear power. As for Israel, it is the largest and most central player. It plays a pivotal role in geopolitical matters, since America, as its partner and ally, is involved in the region's ongoing processes precisely at its urging and encouragement, so that Israel may carry out a redistribution of territories and create a safe environment. Israel's primary goal was above all the neutralization and weakening of Iran, which was subsequently joined by the US at Israel's insistent demand. As I noted in the article, the processes unfolding in the Middle East will deal a heavy blow to countries across the world, including states such as Georgia, and the consequences may be more painful than for those countries that are heavily dependent on energy resources yet nonetheless possess certain reserves.

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Innovative Models of Korean Diplomacy and their Effectiveness

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Abstract. In the context of rapid globalization and technological transformation, diplomacy has evolved beyond traditional statecraft into multidimensional and adaptive practices. The Republic of Korea (South Korea) represents a compelling case of a country that has successfully integrated innovative diplomatic models to enhance its global influence. This article examines the key innovative approaches of Korean diplomacy, including soft power strategies, digital diplomacy, economic statecraft, and science diplomacy. The study analyzes their effectiveness in strengthening Korea's international standing, fostering regional stability, and expanding global partnerships. The findings suggest that Korea's hybrid diplomatic model, combining cultural influence, technological advancement, and strategic alliances, has significantly contributed to its success as a middle power in international relations.

Keywords: *Korean diplomacy, soft power, digital diplomacy, middle power, innovation, international relations.*

Introduction. In the contemporary international system, diplomacy is no longer limited to traditional negotiations between states conducted through formal diplomatic channels. The increasing complexity of global politics, the rapid development of digital technologies, the expansion of transnational economic networks, and the growing influence of culture and public opinion have fundamentally transformed the nature of diplomatic practice. As a result, states are now expected to adopt more flexible, multidimensional, and innovative diplomatic strategies in order to protect their national interests, strengthen their international standing, and respond effectively to global challenges.

Within this changing environment, the Republic of Korea has emerged as one of the most noteworthy examples of a country that has successfully modernized its diplomatic approach. Despite its relatively small geographical size and its historically complex security environment, South Korea

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has managed to establish itself as an influential actor in regional and global affairs. This achievement has not been based solely on conventional foreign policy mechanisms, but rather on the country's ability to combine traditional diplomatic instruments with new and creative models of international engagement. In this respect, Korean diplomacy offers a valuable case for examining how innovation can become an essential component of statecraft in the twenty-first century [1-3].

The evolution of Korean diplomacy has been closely connected with the country's broader political, economic, and cultural transformation. From a war-torn and economically fragile state in the mid-twentieth century, South Korea developed into one of the world's leading economies and a globally recognized technological and cultural power. This transformation has significantly shaped its foreign policy identity. Korea no longer relies exclusively on military alliances or formal bilateral negotiations; it also actively uses cultural attraction, digital communication, scientific collaboration, and economic partnerships as important tools of diplomatic influence. Such an approach demonstrates that diplomacy in the modern era increasingly depends on the ability of states to project not only power, but also innovation, credibility, and adaptability [4].

One of the most distinctive features of Korean diplomacy is its capacity to integrate multiple dimensions of influence into a coherent foreign policy strategy. The global popularity of Korean popular culture, often described through the concept of the Korean Wave or *Hallyu*, has contributed to the country's soft power by improving its international image and creating positive emotional connections with foreign societies. At the same time, Korea's advanced technological infrastructure has enabled it to develop effective models of digital diplomacy, allowing faster communication, broader public outreach, and more dynamic diplomatic engagement. In addition, its export-oriented economy, global corporations, and active participation in international research cooperation have reinforced economic and science diplomacy as essential components of its international presence[5].

The study of Korean diplomacy is particularly relevant because it reflects broader trends in international relations. In an era when middle powers seek to enhance their visibility and effectiveness without relying exclusively on hard power, Korea demonstrates how diplomatic innovation can

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serve as a strategic advantage. Its experience illustrates that influence in world politics can be built through a combination of cultural appeal, technological advancement, economic interdependence, and active participation in multilateral initiatives. Therefore, Korean diplomacy should not be viewed merely as a national case, but also as a model that may provide useful insights for other states attempting to redefine their foreign policy tools in a rapidly changing global context. At the same time, the effectiveness of innovative diplomacy should not be assumed automatically. It is necessary to examine how such models function in practice, what concrete outcomes they produce, and to what extent they contribute to the achievement of foreign policy goals. In the Korean case, this requires a careful assessment of the relationship between innovation and effectiveness. While Korea's diplomatic strategies have clearly increased its global visibility and international attractiveness, they must also be evaluated in terms of their sustainability, their impact on regional stability, and their ability to address persistent geopolitical challenges, particularly those connected to the Korean Peninsula. Against this background, the present article aims to analyze the innovative models of Korean diplomacy and to assess their overall effectiveness. Special attention is given to four major dimensions of this diplomatic framework: cultural diplomacy, digital diplomacy, economic diplomacy, and science diplomacy. By exploring these interrelated models, the article seeks to show that Korea's diplomatic success is largely based on a hybrid and adaptive approach that combines soft power resources with strategic state interests. The article also argues that the Korean example demonstrates the growing importance of innovation as a practical and conceptual foundation of modern diplomacy [7].

2. Literature Review. The concept of innovative diplomacy has gained increasing attention in contemporary international relations, particularly in the context of globalization and evolving state behavior. Traditional diplomacy, focused on state-to-state negotiations, is now complemented by new forms of engagement involving digital platforms, cultural tools, and non-state actors. One of the key theoretical frameworks is the concept of soft power, developed by Joseph Nye. He argues that states can achieve their goals not only through force or economic means but also through attraction and cultural influence. This perspective helps explain Korea's

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use of cultural exports and public diplomacy.

The theory of middle power diplomacy, associated with Andrew F. Cooper, further clarifies Korea's approach. Middle powers tend to promote cooperation, multilateralism, and problem-solving strategies, which are evident in Korea's international activities.

In addition, digital diplomacy has become an essential tool, enabling direct communication with global audiences and increasing transparency and efficiency. Economic and science diplomacy also play a significant role, as trade, innovation, and research cooperation strengthen Korea's global position. Overall, the literature shows that innovative diplomacy is a multidimensional concept. Korea's success can be understood as the result of integrating cultural, digital, economic, and scientific approaches into a coherent diplomatic strategy. This study adopts a qualitative research approach, combining descriptive, analytical, and comparative methods to examine the innovative nature of Korean diplomacy. The analysis is based on secondary sources, including academic literature, policy reports, and official documents, which provide both theoretical and practical insights. In addition, selected case studies are used to illustrate the real-world application of Korea's diplomatic strategies, while a comparative perspective helps evaluate their effectiveness in terms of global influence, economic development, and international cooperation. The findings indicate that Korean diplomacy is built on a multidimensional and integrated model that combines several key components. Cultural diplomacy, particularly through the global spread of the "Hallyu" phenomenon, plays a crucial role in enhancing Korea's international image and strengthening soft power. Digital diplomacy, supported by advanced technological infrastructure, enables fast, transparent, and direct communication with global audiences, increasing the efficiency of diplomatic engagement[8].

At the same time, economic diplomacy remains a central pillar of Korea's strategy, driven by trade expansion, international partnerships, and the global presence of major corporations such as Samsung and Hyundai. In parallel, science and technology diplomacy contributes to international cooperation and innovation, allowing Korea to actively participate in addressing global challenges and strengthening its position as a knowledge-based economy. Overall, the study demonstrates that the effectiveness of Korean diplomacy lies in the integration of cultural, digital, economic, and

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scientific approaches into a coherent and adaptive framework, which enhances the country's global competitiveness and diplomatic impact.

Results and Discussion. The analysis shows that the effectiveness of Korean diplomacy is based on the integration of several complementary models rather than on a single strategy. This multidimensional approach has made Korea's foreign policy more flexible, visible, and adaptive in the modern international environment. Cultural diplomacy has strengthened Korea's global image and increased international trust through the worldwide popularity of Korean culture. Digital diplomacy has improved the speed, transparency, and accessibility of diplomatic communication. Economic diplomacy has supported Korea's international influence through trade, investment, and strong corporate presence, while science and technology diplomacy has reinforced its role as an innovative and reliable global partner. At the same time, these diplomatic models also face certain challenges. Digital diplomacy requires protection against misinformation and cyber risks, economic diplomacy is affected by global instability, and science diplomacy depends on sustained investment in innovation and education. Overall, the results suggest that Korea's diplomatic success lies in the effective coordination of cultural, digital, economic, and scientific tools, which together enhance its international influence and strategic position[9].

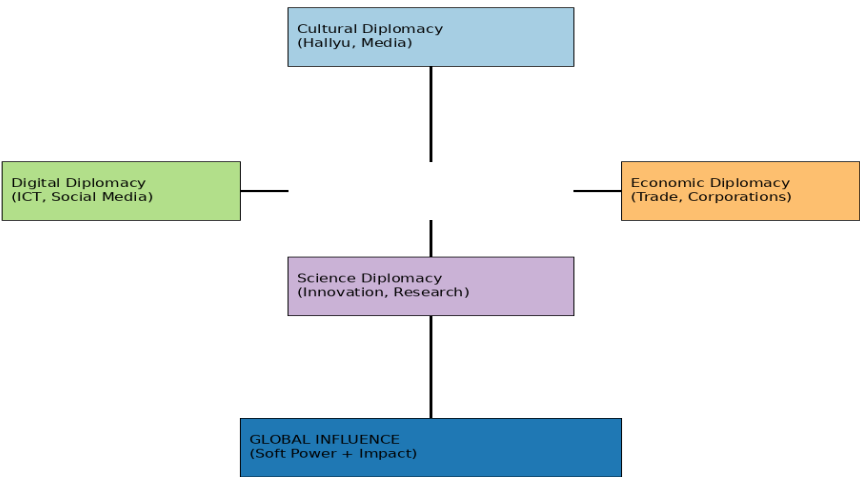


Figure 1
Integrated model of innovative diplomacy in the Republic of Korea

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Figure 1 shows that innovative diplomacy in the Republic of Korea is based on the interaction of cultural, digital, economic, and science diplomacy. Together, these interconnected components strengthen Korea's global influence and increase the overall effectiveness of its foreign policy.

Conclusion. In conclusion, the Republic of Korea has developed an effective and multidimensional model of diplomacy that combines cultural, digital, economic, and scientific tools. Its main strength lies in adaptability, as Korea continuously updates its diplomatic strategies to respond to global challenges and maintain international relevance. At the same time, the sustainability of this model depends on continued investment in culture, technology, and education, as well as careful management of geopolitical risks. Overall, Korea's experience shows that innovation has become a key element of modern diplomacy and offers a useful example for other countries seeking to enhance their global position.

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A Model for Change Management in Business Organizations

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Abstract. Business organizations search for solutions to adapt the internal and external environment to changing market relations and constant competition. Success in the market directly or indirectly depends on the conditions and factors of business development. The quality of employee performance plays a crucial role in the success of a business organization in the economic market. Any development and implementation of any change has a direct impact on the staff of the organization. Therefore, the article discusses the theoretical and practical problems of impact on staff on the application of changes in business organizations and the model of change management.

Keywords: *business, changes, management, market, personnel, effective, model, change management, enterprise reorganization, innovation.*

In the modern economy, particularly within leading enterprises and business organizations, the pace of change has increased to such an extent that it has become necessary to regularly review existing management systems.

The implementation of any changes in the activities of an enterprise or business often triggers resistance among employees. This resistance can manifest as discredit, delays, or actions aimed at hindering the change. To increase the efficiency of management changes in business organizations, a specific model for introducing changes has been developed as a methodological tool.

Business organizations must seek solutions to adapt to the changing conditions of market relations and constant competition in both internal and external environments. Success in the market is directly or indirectly related to the conditions and factors of business development.

The development and implementation of any change directly affect the organization's staff. The quality of employee performance plays a decisive role in the success of a business organization in the economic market. Therefore, the

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theoretical and practical problems of influencing personnel during the implementation of organizational changes have come to the forefront today.

The sociological aspects of these problems are of particular importance: the study of the needs, interests, motives, and incentives of the staff. How effectively changes are implemented—while maintaining or even increasing employee engagement and satisfaction—ultimately determines how efficient the company's performance will be as a whole.

Low labor productivity leads directly to losses in the wage fund, resulting in low business effectiveness indicators. Furthermore, the relevance of this topic is defined by the need to review theoretical provisions to formulate a model of the impact of changes in the management system and develop practical recommendations. This, in turn, will allow for the optimization of the enterprise's performance results.

Each change is accompanied by measures related to preventing and overcoming resistance, based on adequate causes, character, and the means available within the enterprise. The measurement of resistance levels and other characteristics is carried out through employee surveys and the processing of their results. Personnel resistance is subject to management influence throughout the entire process of implementing changes. [2]

Phase 1: Preparation for Change The first stage of the proposed model is the preparation of changes. Here, the goal of managing personnel resistance is to form a "launch pad" for the planned changes. The preparation stage begins with an analysis of the internal and external environment of the enterprise. The analysis of the internal environment is carried out to identify the gap between the actual state and the desired state of the enterprise.

In this regard, the problem of developing change management methods in scientific research becomes urgent. Its most important objects include:

•**Organizational Management:** Structure, culture, management style, etc.

•**Processes and Organizational Objects:** Marketing, finance, personnel, innovation, production, etc.

The external environment includes consumers, competitors, government organizations, suppliers, financial institutions, labor resource sources, etc. The result of the conducted research should be the formulation of the enterprise's

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problems.

Formulating Development Problems: Obstacles and contradictions exist within the organization—problems that prevent its effective operation and development. A clear understanding and formulation of these problems allow for finding adequate solutions, which in turn helps in defining change objectives.

Developing a Change Strategy: The change strategy indicates the main directions the enterprise should choose for organizational development. It is built on factual material regarding internal and external parameters and existing problems within the enterprise.

Creating a Management Team: For the successful implementation of the change strategy, a team of managers must be created who can quickly solve all problems and tasks arising during the process. It is advisable to include managers from linear and functional departments where the management changes are being implemented.

Determining Expected Results: The main results of the planned changes are shifts in the quantitative and qualitative indicators of the organization and its departments. These can be of several types: economic, material, informational, labor-related, social, psychological, etc.

Developing a Change Implementation Program: To implement the strategy, a program is developed that reflects a list of measures with specific deadlines and executors. To ensure complexity, sub-programs should be developed for all key areas of the business organization, after which a set of tools (material, financial, labor, information, technological, and other resources) is selected.

At the preparation stage, it is necessary to develop measures to prevent and overcome resistance. Possible measures include: informing the staff about the changes, training and development, involving employees in the implementation process, providing management support, as well as mandatory measures including sanctions, reprimands, and dismissal. .[4]

Phase 2: Implementation of Changes The main task here is the consistent implementation of prevention measures and the elimination of resistance to change. Implementation is carried out according to the adopted program. Prevention of resistance should be conducted before a negative reaction from the staff emerges.

Prevention is based on identifying possible causes of

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resistance within the capabilities of the change initiators. The assessment of personnel attitudes toward changes is carried out based on the proposed methodology and serves as the basis for selecting mobilization measures. The results of these measures include a decrease in resistance levels and an improvement in the psychological climate of the collective.

Achieving Results: At this stage, the indicators selected during the planning phase are evaluated. The obtained results are then compared with the expected results to identify discrepancies or deviations. [6]

Final Phase: Monitoring Results The final stage of the model consists of monitoring the results of the changes. It includes:

- Analysis of implementation errors:** It is necessary to monitor the stage of fixing results to identify errors or information about emerging dissatisfaction.

- Rewarding participants:** This is a mandatory element of the model. Payment for qualifications and additional skills, percentages from funds saved through innovation, training, conferences, and boards of honor—a combination of these methods can result in a significant effect. [5]

The implementation of changes leads to a cultural shift that must be consolidated in the minds and daily activities of employees.

- Regulation of the Change Process:** The need to regulate the process may arise from changed external conditions and internal characteristics of the business, as well as from problems identified during implementation (e.g., an ineffective strategy or lack of allocated funds). Using this developed model for implementing changes allows a business enterprise to create a permanent strategic management potential for adaptation.

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Visual Storytelling in the Modern Advertising Ecosystem: Theory, Structure, and Innovative Applications

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Abstract. This research article rigorously investigates the paradigmatic shift toward graphic narratology within modern promotional ecosystems. By leveraging semiotic frameworks alongside qualitative observational modalities, the paper decodes how chromatic, typographic, and kinetic modalities operate as advanced linguistic conduits for persuasion. Results indicate an irreversible shift from static broadcasting to multidimensional digital architectures, necessitating profound recalibrations of User Experience (UI/UX) methodologies. Concurrently, the integration of algorithmic synthesis and spatial computing mechanisms fundamentally redefines the participatory nature of brand consumption. In essence, effective commercial communication now demands a sophisticated synthesis of aesthetic mastery, neuro-cognitive insights, and cutting-edge technological deployment.

Keywords: *Graphic narratology, promotional architectures, cognitive persuasion, semiotic modalities, UI/UX frameworks, kinetic typologies, algorithmic synthesis, spatial realities, immersive consumption, digital branding.*

INTRODUCTION

The contemporary commercial arena has unequivocally evolved beyond elementary product dissemination into a complex matrix of profound emotional resonance. Central to this paradigm shift is graphic narratology, functioning as a high-velocity medium that implants multifaceted corporate identities directly into the observer's cognitive framework. Eschewing traditional text-heavy strategies, these sophisticated visual sequences utilize aesthetic encodings to establish instantaneous, resilient psychological bonds with designated demographics.

The imperative to scrutinize these graphical methodologies is deeply rooted in the biological processing

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hierarchies of the human nervous system. Empirical evidence confirms that the cerebral cortex decodes pictorial stimuli at an exponentially higher rate than linguistic strings, thereby ensuring the retention of pivotal messaging during micro-interactions. Within a saturated ecosystem characterized by acute mental fatigue, meticulously engineered narrative imagery serves as a critical stabilizing anchor, arresting fleeting consumer focus.

Architectural construction of such persuasive sequences demands rigorous harmonization of foundational design metrics, encompassing chromatic psychology, typographic tonality, and spatial equilibrium. These variables transcend mere ornamental utility, serving instead as the foundational syntactic rules governing a brand's proprietary communicative dialect. When calibrated with absolute precision, these vectors navigate the spectator through a predetermined emotional arc without necessitating explicit verbal directives.

The foundational infrastructure that hosts these constructs is rapidly migrating from stationary legacy media to highly adaptive, interactive digital topologies. This systemic migration dictates a fundamental reconfiguration of storytelling typologies to align with the fluid, user-centric demands of contemporary User Interface and Experience (UI/UX) protocols. In parallel, the infusion of predictive machine learning and simulated realities propels this evolution, transforming audiences from detached spectators into active protagonists.

Acknowledging this multidimensional metamorphosis, an exhaustive academic dissection of visual communication within promotional frameworks becomes theoretically indispensable. The present study endeavors to deliver a holistic deconstruction of perceptual doctrines, structural mechanics, and vanguard technological integrations. In conclusion, this paper illuminates how the integration of artistic intuition, psychological science, and digital innovation permanently reconstructs brand-consumer dynamics.

METHODOLOGY

The present inquiry operationalizes a qualitative, exploratory paradigm to systematically unravel the structural and psychological complexities inherent to visual storytelling within commercial media. By synthesizing canonical literature on Gestalt perceptual theories and narrative mechanics, the investigation constructs a robust

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theoretical foundation for understanding the transmutation of raw stimuli into resonant experiences.

The empirical dimension of this article necessitates the purposive curation of multifaceted promotional campaigns and digital interfaces, sourced indiscriminately from global and regional sectors. This expansive sampling strategy facilitates a rigorous comparative analysis that details the recalibration of core design variables during the systemic transition from static media to interactive ecologies.

Subsequently, accumulated artifacts undergo exhaustive semiotic deconstruction to decipher latent symbolic values embedded in spatial compositions and kinetic sequences. Concurrently, the study evaluates the disruptive impact of vanguard innovations—specifically artificial intelligence and spatial computing—to ascertain their definitive role in augmenting strategic communication efficacy.

Cognitive Perception and Narrative Mechanics

The hardwired architecture of the human visual system fundamentally governs the operational potency of visual stories in promotional contexts. Neurobiological insights affirm that the brain synthesizes graphical imagery at unprecedented speeds, facilitating the instantaneous transmission of highly complex corporate philosophies. Consequently, marketing practitioners leverage this biological efficiency to infiltrate the subconscious directly, circumventing the rational skepticism conventionally applied to text-based claims (Krishna et al., 2017).

Principles of Gestalt psychology offer a critical epistemological lens for understanding how audiences conceptualize synthesized arrangements as holistic entities before recognizing their isolated components through the strategic application of perceptual laws—namely continuity, proximity, and figure-ground segregation—creators invisibly orchestrate the spectator's ocular trajectory across a canvas. This deliberate structural choreography mitigates mental fatigue, empowering observers to internalize the intended arc without suffering cognitive overload.

Graphical narrations also operate as primary catalysts for profound emotional resonance, a factor that overwhelmingly dictates consumption behavior and purchasing outcomes. Precision in selecting chromatic temperatures and illumination techniques can instantaneously manifest specific psychological paradigms, ranging from soothing security to

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urgent vitality. Such orchestrated emotional alignment guarantees that the corporate identity is deeply experienced and permanently stored within the consumer's memory matrix (Raghubir, 2009).

Within an ecosystem characterized by extreme attention scarcity, sustaining engagement represents the paramount challenge for modern marketing strategies. Visual narratology systematically circumvents this hurdle by deploying a rhythmic succession of ocular stimuli, keeping neurological processing centers continuously engaged. As a direct corollary, these sequentially mapped stories exponentially increase dwell time on promotional materials, a metric robustly correlated with superior brand memorability.

The convergence of perceptual science and narrative architecture ensures that intended commercial messages are irrevocably inscribed into long-term mnemonic storage. When data is encoded within a highly immersive graphical journey, it transcends its role as a commercial interruption, becoming an authentic personal experience. This enduring psychological signature progressively dictates future consumer allegiances and covertly directs purchasing trajectories long after the initial exposure concludes (Arnheim, 1969).

Semantic Foundations of Design Elements

Within the architecture of promotional media, graphical constituents transcend superficial ornamentation to function as indispensable semantic units of a complex lexicon. Every calculated decision encompassing chromatic saturation, typographic weight, and spatial orientation harbors intrinsic communicative significance that delineates the overarching persona. Achieving mastery over this visual syntax is absolutely imperative for translating esoteric corporate ideologies into universally comprehensible formats.

Chromatic psychology operates as one of the most immediate and visceral communicative instruments available within this linguistic framework. Variations in electromagnetic wavelengths have been empirically shown to trigger specific autonomic responses, thereby establishing the subconscious atmospheric baseline of the entire sequence. For example, highly saturated, warm color palettes typically convey aggressive vitality, whereas desaturated, cool palettes predominantly communicate enduring stability and intellectual prestige (Elliot & Maier, 2014).

Typographic selection acts as the visual manifestation of a brand's acoustic voice, introducing an indispensable layer

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of semantic complexity. The morphological attributes of a specific font—such as terminal serifs, geometric kerning, and stroke contrast—subliminally broadcast whether a design possesses traditional authority or modern minimalism. When typographic forms are flawlessly integrated with accompanying imagery, they reinforce the core message and eliminate potential communicative dissonance.

Mathematical distribution of spatial elements and proportional geometry strictly dictates the internal cadence and hierarchical legibility of the graphical message. Strategic implementation of negative space establishes an optical hierarchy, deliberately isolating and elevating crucial components while simultaneously mitigating visual congestion. This calculated distribution of visual weight guarantees that the observer's ocular focus is systematically shepherded toward the intended commercial resolution (Arnheim, 1974).

The integration of kinetic graphics infuses the critical dimension of temporal evolution into formerly static design paradigms. The illusion of motion permits the sequential revelation of critical data, mirroring classical dramatic structures of exposition, rising tension, and climactic resolution. This dynamic methodology actively ensnares peripheral vision and translates highly complex, abstract data into easily digestible formats for lay consumers (O'Connor, 2015).

UX Design and Digital Storytelling

Systemic migration from tangible physical media toward interconnected interfaces has radically redefined the structural potentialities of visual narratology. Within contemporary cybernetic environments, a story transcends the limitations of a static image, evolving into a highly responsive, multidimensional ecosystem. This paradigm shift necessitates the seamless amalgamation of classical techniques with advanced User Interface and Experience (UI/UX) engineering doctrines.

Within these interactive digital domains, the concept of the "user journey" functions as the modern analog to a traditional literary plotline. Every distinct interactive mechanism—ranging from hierarchical navigation menus to localized scroll triggers—functions as a transformative plot point within the overarching saga. Interface architects must painstakingly chart these nodes to ensure the trajectory remains logically cohesive as the consumer traverses the

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platform (Lu et al., 2021).

Information architecture serves as the underlying skeleton that sustains the structural integrity of these complex digital storytelling frameworks. By systematically categorizing content into logical hierarchies, UI designers actively insulate the consumer from the paralyzing effects of severe data overload. A meticulously organized interface acts as an unseen narrator, shepherding the visitor through the progression with zero friction and optimal clarity.

The mechanism of "scrollytelling" has rapidly ascended as a dominant structural methodology for presenting long-form graphical content across web platforms. This interaction model utilizes parallax scrolling to trigger sequential animations and gradually reveal textual elements, weaponizing the user's scroll action into an active catalyst. Consequently, this technique fosters a highly individualized pacing mechanism, granting the audience a perceived sense of autonomy over the rate of data consumption (Wolf & Godulla, 2016).

Micro-interactions serve as nuanced, nonverbal emotional cues that establish a continuous, silent dialogue between the human operator and the machine. Imperceptible visual confirmations, such as fluid button-state transitions or subtle loading animations, provide immediate psychological validation that the system acknowledges user agency. These granular aesthetic details profoundly humanize the digital encounter, ensuring uninterrupted immersion at every micro-transaction.

Ensuring absolute visual consistency across a fragmented hardware landscape represents a formidable technical imperative in modern digital storytelling architecture. A coherent narrative must completely preserve its psychological impact and visual clarity regardless of whether it is rendered on a panoramic desktop monitor or a constrained mobile display. The implementation of responsive design frameworks guarantees that the fundamental visual hierarchy and core semantic tonality survive intact across all conceivable endpoints (Kosara, 2016).

The communicative efficacy of these digital narratives is currently subject to extreme quantification through sophisticated behavioral tracking and heat-mapping analytics. By rigorously monitoring audience engagement with specific interactive components, UI architects iteratively calibrate the flow to align precisely with empirical user preferences.

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This aggressively data-driven methodology facilitates the perpetual refinement and progressive enhancement of a brand's visual communication strategy (Sultanum et al., 2021).

The paramount objective of embedding narratology into UX architecture is to cultivate profound digital empathy between the corporate entity and the consumer. When an interactive platform intuitively anticipates user requirements and delivers solutions via an aesthetically compelling storyline, satisfaction metrics improve exponentially. This flawless synthesis of utilitarian functionality and narrative artistry successfully elevates a transient digital visitor into a fiercely loyal brand advocate.

Technological Frontiers: AI and AR/VR

The contemporary advertising industry is undergoing an unprecedented structural disruption catalyzed by the rapid proliferation of Artificial Intelligence and spatial computing technologies. Algorithmic intelligence is completely restructuring the creative supply chain, empowering the instantaneous generation and rapid iteration of hyper-realistic graphical assets derived from complex linguistic prompts. This monumental technological advancement allows corporate entities to exponentially scale production while rigorously maintaining elite artistic and conceptual standards.

Exceeding mere operational efficiency, AI systems enable hyper-personalization of visual narratology in real time by leveraging vast repositories of harvested behavioral data. Sophisticated neural networks dynamically synthesize bespoke chromatic palettes, imagery, and typographic styles perfectly calibrated to the unique psychological architecture of individual users. This granular level of customization guarantees that the delivered sequence achieves maximum psychological resonance and persuasive efficacy for every isolated viewer (Harrington, 2025).

Augmented Reality (AR) thoroughly dismantles the traditional two-dimensional screen barrier, seamlessly superimposing digital storytelling elements directly onto the consumer's physical topography. This innovation constructs a tangible bridge between simulated data and objective reality, facilitating a highly visceral, spatial interaction with virtual corporate assets. In practice, AR transforms a remote, observable story into a deeply integrated, participatory phenomenon situated directly within the consumer's daily existence.

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Virtual Reality (VR) represents the zenith of narrative immersion, physically teleporting the consumer into a meticulously engineered, fully simulated brand universe. Within these enclosed VR ecosystems, all competing external stimuli are obliterated, granting the corporate entity absolute, monopolistic control over the user's sensory attention. This unparalleled state of total sensory envelopment produces a profound emotional and neurological impact that is physically impossible to replicate on legacy broadcast screens.

Collectively, these vanguard technological instruments denote an irreversible paradigm shift in the fundamental mechanics of visual communication and consumer persuasion. The future trajectory of promotional strategy will be unequivocally defined by multidimensional, data-responsive environments where audiences actively co-author the experience. By mastering these digital frontiers, future designers will conceptualize visual journeys that are both aesthetically transcendent and technologically revolutionary (Anantrasirichai & Bull, 2022).

CONCLUSION

This treatise establishes that visual stories have entirely eclipsed their origins as mere aesthetic ornamentation. By weaponizing the neurological mechanics of human perception, modern brands successfully circumvent rational cognitive barriers. Such meticulously engineered graphic narratives now serve as the primary architects of deep emotional allegiance and sustained consumer loyalty.

The analysis confirms a definitive systemic migration toward interactive, user-centric digital ecosystems. Calculated deployment of semantic graphics is absolutely foundational to functional UI/UX architecture. Consequently, contemporary commercial success demands a frictionless digital journey that immerses the user within a cohesive visual saga.

The aggressive integration of AI and spatial computing marks a new epoch in communicative strategy. These vanguard technologies facilitate unprecedented algorithmic personalization and total sensory immersion. The future of effective advertising inextricably relies on the flawless synthesis of artistic intuition, behavioral psychology, and digital innovation.

Recommendations

Based on the results of the research conducted, the

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following recommendations can be proposed:

1. **Enforcement of Narrative Continuity:** Guarantee uncompromised aesthetic and thematic uniformity across all divergent digital and physical promotional interfaces.

2. **Execution of Analytics-Driven Aesthetics:** Leverage empirical behavioral metrics to refine chromatic, typographic, and kinetic design parameters systematically.

3. **Deployment of Algorithmic Personalization:** Utilize sophisticated neural networks to dynamically construct highly individualized narrative sequences tailored for distinct consumer architectures.

4. **Integration of Spatial Computing Platforms:** Allocate strategic resources toward Augmented and Virtual Reality development to engineer immersive, participatory brand ecosystems.

5. **Establishment of Ethical Data Protocols:** Institute rigorous privacy frameworks to safeguard consumer autonomy against aggressive algorithmic psychological profiling.

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Digital Manat Concepts Azerbaijan Impact on the Economy: Opportunities and Risks Analysis

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Abstract. Articles, the main purpose of digital manat economic mechanism of influence theoretically analyze it in the Azerbaijani economy, which can create opportunities and possible risks, identify. For these purposes, in accordance with digital currencies, the economic essence, their financial system, and the impact on the functions of various countries in this area have been studied. The conducted analyses show that the introduction of digital manat payment systems, improving the efficiency of non-cash payments, expanding the financial modernities and increasing the transparency of economic relations in terms of raising important potential. However, in the banking sector, financial intermediation, weakening probability, cybersecurity, problems and regulatory issues like certain risks also exist. Research, scientific novelty of the digital manat on the economy of Azerbaijan is a systematic mechanism that explains the conceptual models associated with the preparation. The results of the study show that the digital manat implementation of the country's financial system modernization and digital economy, the contribution to development can give. But this process is successful for the implementation of the appropriate legal and technological infrastructure, which is important. Research, one of the main goals of the Central Bank for regulatory framework, technological architecture, cybersecurity, measures and phased application of strategies related to policy recommendations - present..

Keywords: Azerbaijan, economy, digital manat, central bank of digital currency, CBDC, digital economy, financial system.

Enterance

In recent years, in the global economy, the acceleration of the financial system process and important changes have caused. Information and communication technologies, the development of payment relations, new forms of financial transactions, faster and more efficient implementation have created conditions. As a result of these changes, many countries of the money turnover in accordance with the modern requirements of new forms of creation began to conduct research.

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At the current stage of states' financial policy, the focus of which is one of the main issues the central bank has allowed digital currencies to be created. This money is in the form of traditional cash and non-cash money in circulation, complementing the new financial instrument as considered. In many countries of the world, research is being conducted in this direction, and some states have already started implementing such monetary systems.

Global economic relations are changing rapidly in the digital money environment the introduction of countries' systems of financial stability, strengthening, payment systems and economic development, transparency in terms of increasing are essential. At the same time, this process in the financial sector of new management adjoining formation and monetary policy in the implementation of new opportunities leads to the emergence.

Azerbaijan is taking important steps in the direction of the changes taking place in the global economy, taking into account the financial system. Within this framework, the Central Bank of Azerbaijan is working on the "digital manat project" development and implementation of the study of opportunities in this direction. Introduction of the country's financial system to modernize the payment infrastructure and develop the digital economy in terms of expansion is important.

This article, the main purpose of digital manat application to the economy of Azerbaijan, can explore the impact of its financial system, monetary policy, and for the banking sector, which can create opportunities and challenges analysis is to. As a result of the investigation of the digital money implementation system from the point of view of economic development, the importance and in this process must be taken into account the main issues identified.

General information about digital manat

At the present stage in the global economy, the financial system process taking place in the digital process has new approaches to shaping the economy. Information and communication technologies, as a result of the rapid development of the payment system, more quickly and efficiently began to operate, money in the circulation of new forms for the emergence of new ones. From this point of view, central banks allowed in the digital monetary units of the financial system in the development of important areas is considered one of.

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Digital manat is a state-approved and central bank-backed digital money that is available as a form of payment. This is the central bank's monetary unit, reflected in the balance sheet, and the state's obligations, based on digital financial instruments. Digital money, only in an electronic environment becomes available and financial transactions in digital platforms help create an opportunity for implementation. These features of digital manat cash and non-cash money circulation are new money as a form of payment. International financial organizations research noted that the central bank side of the issued digital money, payment systems, speed, increase the transparency of financial transactions, strengthen and financial services reachable in terms of expansion, is important [1, p. 5].

In recent years, most of the world's central bank digital money systems have been conducting research on the creation of such systems. According to the Bank's international calculations, in 2024, central banks, most of this area of research and testing, continued to work. A number of countries have already received money, projects, and tests in the past, and in the coming years they have begun to use the opportunities to evaluate them. According to research, in some central bank countries, digital monetary systems are considered possible to be phased in until 2030[2, p. 10-12]. This process of global payment systems as a new stage in development is being evaluated.

Azerbaijan in the global financial system, these changes are taking place, given that digital money research projects are active. In 2022, the Central Bank of Azerbaijan in the country "digital manat concept " over research is being conducted in this direction of initial conceptual work, which was noted. [4] At the same time, on July 31, 2024, the central bank has the opportunity to guide the country's current digital currencies if desired, and there is no specific plan for withdrawing them, but international experience, carefully noted studies and research topics are under review. And this shows that Azerbaijan for the digital manat project is still in its early research and evaluation stage[5].

At the same time, in the country of payment systems, the development of digital money, projects in the future for the use of certain technical capabilities, the formation of infrastructure. The Central Bank of Azerbaijan, created in real time, operating payment systems of instant payment platforms for financial transactions faster and more

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securely, creates conditions for implementation. This infrastructure of the digital financial system, contributing to the development, along with giving, in the future, the digital manat, for the application of the technical base can play a role[3].

From this point of view, the digital manat in the modern financial system is a new form of money in circulation, as well as its application to the country's finances, the development of payment system infrastructure, and the improvement of the digital economy in terms of expansion can be important.

Global experience

In recent years, central banks' digital money systems aimed at creating research, the number has increased significantly. International financial organizations, surveys conducted show that around the world, many countries, central banks of digital money are working on projects and in this direction at different stages, they are acting. International Settlements Bank 2024–2025 by research, mainly doxsandan many countries – the central bank of digital money in projects related to research or in the trial stage is involved. These projects' goals, from country to country, fərqlənsə and, in general, payment systems, accelerating access to financial services, expanding the national monetary protection system and the economy of digital are the main goals as shown [6. sec. 18].

In the global practice of digital money, projects, most of them are still at the testing stage. In this area, the widest range of applications is one such example-in the People's Republic of China, implemented in the digital yuan project. This project has been implemented in various cities of the country in order to test its use in everyday payment transactions to a certain extent. Many other countries, as well as in digital money systems, have the technical structure, legal regulation and application mechanisms working. International practice shows that digital monetary systems can be formed in two main directions: for the population, the envisaged system and finance between the structures used in the system. These two models, purpose, apply mechanisms and risks differ from each other[7. sec. 9].

In European countries, there is more money invested in projects, and it is being implemented in stages and systematically. The European Central Bank has developed a digital euro into a project in this area that attracts

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attention and initiatives is one of. The project implementation consists of several stages: preliminary research phase, preparatory phase, technical testing phase and legislative decisions, adoption phase. Until 2025, by the end of the European Central Bank project, the preparatory stage of completion and technical preparation, the transition stage to consider what is reported. At this stage, the main goal-the legal framework for the formation of a unified training system rules and financial services structure, suitable for technical standards, is to determine [8. sec. 14].

European approach one of the main features of monetary policy, stability and protection of the payment system, operating independent financial structures for coordination is to provide. However, the user's personal data protection from financial transactions qanunauyğunluğuna control the balance between the creation and the important issue as dealt with. In European countries, both technical compliance issues and for the legal framework for the formation of digital money, project implementation is considered one of the main priorities [9. sec. 22].

In the United States of America, a central bank digital money application issue is not yet a final decision of the stage has not been preserved. In the United States, the Federal Reserve System conducts research in this regard and submits various policy documents to prepare the issue for public and legislative discussion. In the US, a more cautious approach is considered, and here the national currency's international reserve money status, protection of commercial banks in the financial system and role in maintaining and protecting citizens ' personal data and ensuring top priorities are both perceived. For this reason, in the United States, digital money, in connection with the draft final decision making for a broad economic and legal assessment of conducting continues [10. t. 7]. Ultimately, global experience shows that the central bank's issued digital money projects in different countries, in contrast to the development of levels. Some states have already completed a trial phase, while others are still undergoing legal and technical training. This experience shows that digital money systems implementation is widespread in economic, technological and legal training that require a long-term process.

Azerbaijani economists and experts digital manats on

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their positions

In Azerbaijan, in recent years, economists and the financial sector, specialists in digital monetary systems, possibly related to the application of various scientific and analytical ideas have put forward. In general, these positions are digital money, the economy of projects created for the opportunity is positive along with the assessment of possible risks and attention, and also emphasizes the importance. The Azerbaijani economist and expert opinion shows that the digital manat project introduces both economic development and financial system stability in terms of thoroughly investigated.

Azerbaijan MP and economist expert Vugar Bayramov assesses non-cash payments, expanding the country's economy, and increasing transparency as an important factor. In his opinion, the growth of the share of non-cash payments of economic activity is even more clearly realized and the shadow economy helps to reduce. The expert notes that by using digital financial development tools, the client bank makes operations faster and safer, and creates conditions for implementation. This approach of digital manats as a new financial means of economic justification (feasibility study), which positively affects important factors, is considered one of [11. sec. 10].

Center for Economic Research, economist expert Rovshan Hasanov, and in digital payment systems, the expansion of modern economic development, which is important, emphasizes. In his opinion, states in the digital economy are developing strategies for financial stability, protection as the main priority should be taken into account. The expert notes that the central bank from the side of issued digital money systems in the banking sector, the level of liquidity and the population deposit behavior can affect. For this reason, such systems during application to the banking sector that affect risks in advance, modeling and developing regulatory preparation mechanisms is considered mandatory [12. sec. 18].

Samir Aliyev, an expert of the Center for Digital Payment Systems, Economic Development, and Economic Growth, has a positive impact on the economy. In his opinion, non-cash payments, the expansion of the tax collection increase efficiency and economic relations than transparent, create conditions for implementation. The expert also notes that in electronic financial services and alternative payment methods, the development of competition in the banking sector,

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the strengthening and quality of financial services contributes to growth [13. sec. 9-11].

The digital economy and technologies operating in the field of expert Elvina Qeribli digital manat project pays more attention to the technological parties. In his opinion, digital money systems offer modern technological solutions based on building operations that increase security and reliability. The expert notes that public services digital, electronic public services and online trading platforms, integration with the digital monetary system, increasing efficiency is one of the main factors [14. sec. 6].

Azerbaijani economist among scientists, Professor Elshad Mammadov monetary policy, new financial instruments, the application of emphasizing the importance of specialists, is one of them. In his opinion, the economy of the state, economic management, expands opportunities and money, and the implementation of policies is more flexible. The professor notes that the central bank's allowed-in digital monetary system monetary policy impact on the economy by strengthening mechanisms can play an important role. However, such systems during the application of monetary stability protection, one of the main conditions should be considered as [15. sec. 27].

The Central Bank of Azerbaijan, in official documents and digital monetary systems, the study of the issue is given attention. Central Bank, financial stability, reporting and digital payment strategiyalarında notes that the central bank side of the issued digital money systems, the possibility of applying international experience taking into account are being studied. These documents highlight digital money, projects, possible models, payment systems, impact, and financial stability issues that affect risk assessments. At the same time, cybersecurity, the protection of personal data and the banking system, and ensuring the stability of the main priority areas, as shown [16. sec. 32].

Thus, the general analysis of Azerbaijanis, economists and experts ' opinions shows that the digital manat project is generally positive for its application under certain economic and technological risks, which is considered mandatory. Based on the experts ' opinion, it can be noted that the introduction of digital money systems for non-cash payments, the expansion of the shadow economy, the reduction of state financial control, and the strengthening of financial services in terms of development can give positive results. However, in the banking sector deposits, risk reduction, money

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management, policies affecting the new factors on the emergence of personal data, security issues and technical infrastructure, development issues such as carefully must be taken into account. For this reason, digital manat project phased implementation and economic impact assessment in advance is essential.

Main purpose of the study

The purpose of this study is the digital manat concept in the economy of Azerbaijan, it is possible to study its impact on economic opportunities and potential risks.

Research to achieve the goal below shown implementation of implementation provides:

- digital money of the central bank digital currency concepts theoretical basis of study;
- in the world of digital currencies on the application of available experience, analyze;
- In Azerbaijan, digital payment systems and non-cash economy are available to assess the state;
- digital manat applications for Azerbaijan's economy that may create opportunities to identify;
- digital manat in connection with the application of potential economic and technological risks, analyze;
- the results obtained are based on digital manats in connection with the application of a general assessment.

Research Methodology

In this study, the digital manat contribution to the Azerbaijani economy has potential implications for the study, mainly theoretical and comparative research methods were used. It should be noted that in Azerbaijan, the digital manat has not yet been applied to the legal framework of non-forming and the official stage in this area of application has not yet begun. For this reason, on the topic of empirical data and statistical indicators, the lack of empirical analyses restricts maintenance. Therefore, research within the framework focuses on theoretical approaches to studying international experience and analytical approaches.

Research forms the methodological basis of scientific literature, system analysis, comparative analysis and conceptual modeling. In the first phase, central banks digital currency (CBDC) in connection with international research articles, analytical reports and international financial institutions materials were analyzed. This approach of digital currencies in the economic system, the impact on the

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mechanisms and their application, the resulting opportunities and risks, made it possible to determine.

Methodologies for the next stage of various countries' digital currency initiatives on OT are comparatively studied. In this context, digital currencies on the application of implemented pilot projects and conceptual approaches, their economic and institutional results are analyzed and evaluated. A comparative approach through these practices for the Azerbaijani economy's potential application opportunities have been identified.

Research within the framework, at the same time a conceptual model approach was used. This model of digital manat in the economic system, the mechanism of influence to explain the purpose of the project. Digital manat models the economic impact of payment infrastructure, banking sector, behavior, monetary policy, transmission mechanism and financial technology ecosystem as intermediary factors through an emerging multi-level process is considered as.

Thus, the research methodology is mainly theoretical analysis, comparative analysis and conceptual modeling, methods-based. This approach of empirical data, limited in the context of digital manat economic impact on a scientific basis to assess, and for Azerbaijan possible development scenarios can be determined.

Azerbaijan's digital manat situation

In Azerbaijan, digital manat-related processes are currently mostly research-based and under preparation. The Central Bank of Azerbaijan's financial system reqəmsallaşdırılması aimed at various strategic documents were adopted. In these documents, payment systems, information modernization, strengthening of security and financial technologies, and development were identified as priorities.

The Central Bank of Azerbaijan, according to official data, has significantly developed the country's payment infrastructure in recent years. The number of bank cards, electronic payment services, usage and online trading operations is steadily growing. And this is the digital payment environment, the expansion and future of digital money, projects that create favorable conditions for.

According to official statistics, in 2024, bank cards through transactions carried out, the total turnover of 126 billion rubles. This figure has also increased by about 27 percent compared to last year. 27 faiz artmışdır The majority

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of non-cash payments are accounted for, and this figure in the country of digital financial services has increased interest in the show. At the same time, the electronic volume of trading operations has increased rapidly in recent years [17].

At the same time, there has not yet been a large-scale pilot program or official application of digital money in Azerbaijan in connection with the project. At this stage, the main focus is on technological capabilities, research, study of international experience and the national payment system is aimed at improvement.

On the other hand, the country's ongoing digital transformation and initiatives in this direction play an important role. "Digital Azerbaijan" concept of smart city and smart village projects, as well as e-government, expansion of services in the country's digital economy, development accelerates. These initiatives of financial services and digital give a boost and further central bank that can be digital money for the institutional and technological base form.

Thus, at this stage in Azerbaijan, the digital manat concept is characterized by basic processes, analytical research, implementation of payment infrastructure and financial technology development, as well as the study of international experience.

Digital Manat applications and economic effects by generalized reviews

In the modern era of digital technologies, the rapid development of the financial and banking sector in new innovative approaches, the introduction of necessary technologies. In the world of digital transformation, the processes of expanding the monetary system to a new stage, the transition to which. In this context, many countries are conducting research on the creation and implementation of national digital currencies. In Azerbaijan, certain initiatives put forward by the digital manat in this direction have already been put on the agenda.

"Cashless economy: reliable, safe and sustainable on the theme " of the 5th International Banking Forum, it was noted that work has begun on creating a digital manat in the country. It was noted that monetary systems in the history of development of three major revolutionary changes occurred and the last change blokçeyn based on technology kriptovalyutaların emergence. Currently, the Government of

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Azerbaijan, the digital manat in connection with the application of discussions are underway and research is continuing in this direction.

Digital manat in the application of one of the main security issues and cybersecurity is their prevention. According to experts, digital currency systems of effective functioning for a strong cybersecurity infrastructure and a stable banking system, the formation is important. Cyber crime is growing rapidly in the modern era of financial systems kiberhücumların prevention, data protection and continuous monitoring the creation of mechanisms is essential. From this point of view of Azerbaijan in digital currency, the transition to a certain preparatory stage and then it may be possible [18].

Global experience shows that many countries are implementing Central Bank digital Currencies (CBDCs) aimed at creating extensive research and pilot projects. This process is the main goal of the financial system, improving the efficiency of non-cash payments, contributing to the improvement of the digital economy and supporting development. For example, the People's Bank of China digital yuan project applied started, the European Central Bank, and the digital euro in the direction of creation is conducting research. Taking into account the international experience, the Central Bank of Azerbaijan also appreciates the possibility of using the digital manat and international organizations, with technical support, carry out research in this area [22].

Digital Manat introduction One of the main conditions for making non-cash payments widely, is distribution. Currently, in Azerbaijan, the share of non-cash transactions in the total amount of money in circulation is about 10-15 percent, and cash in circulation still prevails. For this reason, an increase in the volume of non-cash payments is considered mandatory for the use of digital currency [19].

During the pandemic period, online contactless payments, as well as increased interest in Azerbaijan and non-cash payments have contributed to the expansion. According to the data of the Central Bank of Azerbaijan, \$ 14.126 billion in non-cash transactions were conducted in the country in January-August, which is 2.5 times more in previous years compared to the same period2,5 dəfə çoxdur. Of this amount, 10.621 billion manats of e-commerce, 3.485 billion manats of electronic commerce. manats, POS-terminals, 0.02 billion

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manats, and ATMs, operations were carried out through [20].

In addition, the volume of bank card transactions conducted in the country is growing. According to statistics, the operation was carried out in Azerbaijan with 38 billion rubles of bank cards, which is 11.5 billion manats (30.3 %) of non-cash payments, and this figure has increased by 79.6% compared to last year. Conducted transfers increase by 80% (60.4 million transactions), the volume, and 73% (163.1 billion manats) digital banking is carried out through the internet [23].

There are a lot of bank cards in Azerbaijan, most of them are debit cards. There are 88.87% of active bank cards in the country, or 18,181,786 numerical exactly debit cards. Credit card count of 2,278,124 is equal to that in total card count of 11.13 % - this means that. Of the population using multiple debit cards, 18.63%-ni or 3,387,683 from the social card (pensions, benefits, etc.), 15.99%-nii or 2,906,633 from a salary card is. The remaining 11,884,470 debit cards, as well as additional use for banks, receiving debit cards. These cards are 65.38 % equal in total debit cards. This year, during January-March, the volume of non-cash transactions carried out in the country amounted to 20.6 billion rubles. in the same period last year, compared to 27.2%, or 4.4 billion manats more [24].

Digital manat application of economic impact and as for research show that, digital payment systems, expansion increases the transparency of the economy, tax evasion cases, reduces and state budget revenues, growth, positively affect. The impact of the cashless economy on the development of the sağlamlaşmasına banking sector, electronic banking operations and the volume of e-commerce contribute to the expansion. At the same time, digital financial services of citizens, financial transactions are more quickly and conveniently implemented by them. At the same time, digital financial systems are accompanied by the development of certain risks. In particular, cyber fraud cases and financial data security issues in this area are considered one of the main problems. According to experts of financial literacy, and users without attention, such behavior increases risks. From this population perspective, improving financial literacy and secure digital payment skills formation is essential [21].

In general, international practice shows that central banks of digital currencies do not need to apply a powerful technological infrastructure, a perfect legal framework and

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a broad cashless payment system in the ecosystem. In Azerbaijan, the digital manat application is considered a promising direction, despite the fact that further development is necessary for the implementation of the financial system, modernization of the national payment infrastructure and digital banking services.

Digital Manat applications for Azerbaijan's economy that can create opportunities

Currently, Azerbaijan's information and communication technologies market, electronic transactions market, as well as the digital services market (digital radio broadcasting, digital television and other services) is at the stage of formation. This market, the institutional structure is still fully not developed digital economy, the potential is not fully real. At the same time, in the country, the existence of a shadow economy, as a result of generating some tangible and intangible products, official statistics, in particular, gross domestic product (GDP) in the structure fully reflects the desired. This makes it difficult to assess the real dynamics of economic growth. On the other hand, the regions of digital services and digital products in the market are generally unequal [31].

In recent years, the global financial system has been undergoing digital transformation, and the process of central banks of digital currencies to create a new trend is being shaped. Central Bank digital currency monetary policy, improving the efficiency of payment systems, modernization and finance modernities in terms of expansion of important potential. Currently, in many countries of the world, research is being conducted in this direction, and some states have already implemented pilot projects.

Azerbaijan's global digital financial transformation process does not stand aside and the digital manat concept for the preparation of research and institutional preparatory work is underway. Digital manat applications for the country's economy can create a number of important opportunities.

First of all, digital manat payment operations, acceleration and efficiency improvement can serve. Digital payment infrastructure development of operational costs, reduced payment processes, simplified and electronic means of payment integration with more efficient implementation can allow [30].

Other important financial preferences modernities with the extension is related. A digital wallet, based on the

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principle of operating through the bank account system of a smaller group of people in digital financial services, to use the opportunity can get. And this, in the financial system of even wider masses of the population, the attraction and development of the digital economy can have a positive impact on [27. s, 45].

Digital manats, as well as the region within payment systems, improving competitiveness in terms of can also play an important role. Rapid and down expense digital payment mechanisms of the country, the creation of regional trade links and the development of the financial technology sector, expansion can create conditions.

A central bank digital currency is an important feature of a programmable, money-capable mechanism. This function of state payments, social transfers, subsidies and tax operations, a more transparent and automated method of implementation allows you to create a new one. As a result of public funding in governance, transparency and efficiency, the level may rise [28. s, 72].

Digital manat in connection with the application of the main risks and difficulties

Digital manat due to the application of potential opportunities, along with certain risks and institutional difficulties are also available. First of all, it should be noted that the central bank of digital currency in the economy of Azerbaijan has not yet fully evaluated the possible consequences from a scientific point of view. Its monetary policy, banking sector, payment systems, financial modernity and macroeconomic stability effects related to systemic research are limited in number [26. sec. 85].

The main one of the risks in the banking sector is financial intermediation, a weakening assumption. If the population is in turn the head of the League of protection of commercial banks, out of digital manat directs of these banks, liquidity, reduced level and ability to issue a loan limitation may be the reason. As a result, the banking sector may face certain risks in financial stability [25].

Other important information security risks are related. Digital currencies infrastructure and large-scale technological systems can become a potential target. From this point of view, the sustainability of the backup system, the creation of mechanisms and emergency situations, the restoration of training plans is of particular importance [29. s, 28].

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Privacy of information the issue of digital currency systems in the application is one of the key. Digital payment transactions, remains the possibility of financial transparency of increasing also, the user's personal data related to the protection of legal and institutional mechanisms of formation is necessary [27. s, 45].

In addition, the digital manat application requires certain technical and financial costs. Creating an infrastructure, banking system with integrated and other financial institutions to coordinate complex and long-term processes is considered [30].

Risk management overall assessment

The risk	Explaining
the Bank's disintermediation capabilities is reduced.	The population deposits CBDC in, if, banks, issuing a loan
Cyber attacks	CBDC centralized system, where the strategic goal may be.
Confidentiality of information	In digital transactions, tracking the regulatory framework requires.
Operational risks	of the System, problems in the payment system can create large-scale shutdowns.

In opinion, digital manat to use and important economic opportunities, but also creates certain risks. For this reason, its application is phased to carry out the economic, legal and technological aspects of integrated research should be carried out.

Azerbaijan for special moments

Digital manat when applying should be considered, being one of the main issues of its use in the model is set correctly, is. Central bank digital currency has two main forms that can be applied: retail models and wholesale models. The retail model is mainly widely used in everyday payment transactions for the use provided, the wholesale model, and mainly in interbank settlements and financial institutions, between the implementation of payments pursues the goal. These two approaches have risks and benefits in terms of the distinctive features a country has and the selected model's financial system impact on scale determines [32].

Another important issue of digital currency technical structure is related. From this point of view, two main approaches exist: the capital account model and the capital

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tokens model. The capital account of the centralized system user authentication model is performed using the registration system via the internet operation. Token-based model A, in a certain sense, resembles cash and digital transfer units based on the act principle. Both models have a high level of technological requirements and from the point of view of security, it has distinctive features [33].

Digital manat during the application of the deposit market in order to maintain certain restrictions on the application is considered mandatory. For example, for users, daily or monthly balance setting limits, interest rate policies, regulation or digital currency for special accounting, implementation mechanisms in the banking sector and possible liquidity risks can help prevent [34].

Recommendations

Digital manat application in the process of a number of strategic approaches to implementation is considered appropriate.

First of all, it is recommended to implement the process in stages. To this end, initially a pilot program implementation, then a limited user-between-group test phase implementation and, consequently, a system wide application is considered appropriate .

However, improving the legal and technical infrastructure is essential. In particular, information privacy, dirty money laundering, anti-user warfare, authentication and cyber security in the area of regulatory frameworks, strengthening is not required.

Digital manat systems for the efficient operation of commercial banks and other financial institutions in close cooperation with is also important. This cooperation of liquidity mechanisms regulating the deposit base and the protection of financial stability from the point of view of collateral can play an important role.

At the same time, the use of digital financial instruments to raise awareness of the implementation of measures is also necessary for the population. In particular, those living in the regions, the population and the older generation, for the digital wallet of electronic payment systems associated with the use of special programs, the implementation of the financial inclusive extension can contribute to [35].

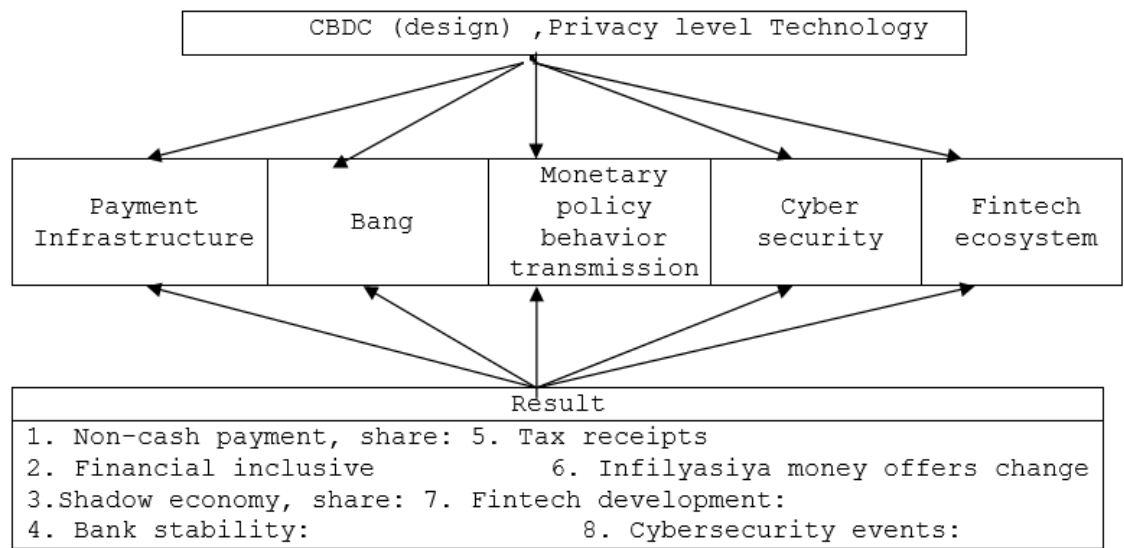
Digital manat as a result of application in the country, non-cash payments level is expected to increase. In a short time, this process of commercial banks, deposits in the

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database determine the pressure to create, then in the long term, the financial stability of the system can lead to strengthening. At the same time, digital manat monetary policy, a transmission mechanism that enhances the effectiveness of monetary policy in a more flexible way, can create opportunities.

In addition, in digital payments, expanding the volume of the shadow economy and reducing tax revenues, growth can have a positive effect. Digital manat financial inclusive can enhance the digital economy, expand and develop the financial technology sector and provide an additional incentive.

In this context, the digital manat is the application of national economic indicators, direct and indirect, that can affect the integrated economic mechanism acts as. It affects payment infrastructure, banking sector modernization, behavior, monetary policy, transfer mechanism, financial technology ecosystem, tax transparency and cyber security as intermediary factors are being formed.**Photo: 1** Digital concept models



Digital Manat Economic Impact mechanism conceptual model and research hypothesis
The author model was developed

Digital manat contribution to the Azerbaijani economy possible consequences of system analysis for research purposes, within the framework of a conceptual model formed. The central bank Digital currency (CBDC) model has an impact on the economic system that explains the main mechanisms and

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results of dəyişənlərini to determine the direction.

Conceptual models, mainly in the digital manat economic system, do not directly involve a number of intermediaries, institutions and technological mechanisms, through influence. These mechanisms between the payment infrastructure, banking sector, behavior, monetary policy, transmission mechanism, financial technology ecosystem and cybersecurity environment are becoming particularly important. These factors in digital currency on the economic integration system that provides the main channels as favored.

The digital manat framework model applies the following main economic consequences and is intended to affect:

- non-cash payments of share growth;
- financial inclusive extensions;
- shadow economy, reduction of volumes;
- tax revenues, growth;
- banking sector stability impact;
- monetary policy and the reinforcement mechanism;
- financial technologies for the development of the sector;
- cybersecurity risks of formation.

This approach is mainly in the digital manat economic system of the new financial infrastructure as an element of the new payment mechanisms of modernization and the digital economy, the expansion can affect. At the same time, the banking sector, behavior and monetary policy mechanisms applied may be subject to certain changes.

A conceptual model, according to the research under the following main hipotezler was put forward:

H1. Digital manat introduction of non-cash payments in Azerbaijan may have a positive effect on increasing the share.

H2. Digital manat financial inclusive expansion and public access to financial services opportunities can lead to growth.

H3. Digital manat application transparency of the economy by increasing the shadow economy, reducing the volume may affect.

H4. Digital manat of monetary policy, the mechanism of data transfer and monetary policy, efficiency can increase.

H5. Digital manat widespread application in the banking sector of deposit behavior affect and financial agent can create certain risks.

H6. Digital manat The application of financial

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technologies (fintech) can stimulate the development of the sector.

In opinion, presented a conceptual model of the digital manat economic mechanism of influence sistemləşdirərək research, analytical framework, forms the potential opportunities and risks for the Azerbaijani economy of this new financial instrument, assess the theoretical basis.

In the global financial system, the acceleration of central banks ' digital currencies (CBDCs), the creation and implementation of the financial system in the development of important areas have turned. The conducted research shows that the digital manat is the application of payment systems in the Azerbaijani economy, the modernization of financial services to enhance and stimulate the development of the digital economy in terms of critical potential.

Research in accordance with the objectives of the digital manat economic impact on the mechanisms analyzed and its application in possible economic outcomes were evaluated. The conducted research shows that the digital manat application of non-cash payments, the expansion of financial inclusive growth and economic relations, and increased transparency can have a positive effect. And this, in turn, can create conditions for the shadow economy to reduce tax revenues to the state budget and increase them.

As a result of the investigation, it becomes clear that the digital manat of state payments and social transfers can allow for more efficient and transparent implementation. Programmable transfer of money through the mechanisms of financial transactions, more effective management, it becomes possible that the state, finance, management, quality improvement has a positive impact on.

At the same time, the analysis shows that the growth of the manat is accompanied by certain risks. Risks in the banking sector of financial intermediation, weakening probability, deposits of commercial banks on digital currency orientation, problems of cybersecurity and personal data protection includes issues related to For this reason, the digital manat application in the process of financial stability, protection and reliable technological infrastructure creation is of particular importance.

Research, scientific novelty of the digital manat in the economy of Azerbaijan impact systematically, which explains the conceptual models associated with the preparation. The proposed models of digital manat economic impact on the

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payment infrastructure, banking sector, monetary policy, transmission mechanism and financial technology ecosystem, through the formation of the economy.

In general, studies have been conducted, as a result, it can be concluded that the digital manat application of Azerbaijan's financial system, modernization and digital economy, can create new opportunities for development. At the same time, this is a process that is considered mandatory for the successful implementation of improving the legal framework, a strong technological infrastructure, the formation of the banking sector to coordinate and ensure financial literacy of the population. In this direction, measures will be implemented to increase the manat's economic efficiency by increasing the stability of the country's financial system, which can make an important contribution.

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The Importance of Vocabulary in Language Learning

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Introduction

Language is the primary tool for communication, and vocabulary plays a central role in mastering any language. Without sufficient vocabulary, learners cannot express their ideas, understand others, or participate effectively in communication. In the context of foreign language learning, vocabulary is often considered the foundation upon which other language skills are built.

In recent years, linguists and educators have increasingly recognized the importance of vocabulary acquisition in language learning. While grammar provides the structure of a language, vocabulary provides the content. Therefore, both are essential, but vocabulary is often seen as the key to communication.

This paper aims to examine the importance of vocabulary in language learning, explore its role in developing language skills, analyze challenges learners face, and discuss effective strategies for vocabulary teaching and learning.

1. Definition and Nature of Vocabulary

Vocabulary refers to the set of words that a person knows and uses in a language. It includes not only individual words but also phrases, expressions, and idioms. Vocabulary can be divided into two main types:

- **Receptive vocabulary:** words that learners understand when they hear or read them
- **Productive vocabulary:** words that learners can use in speaking and writing

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Vocabulary knowledge involves more than just knowing the meaning of words. It includes pronunciation, spelling, grammatical usage, and contextual meaning.

2. The Role of Vocabulary in Language Learning

Vocabulary plays a crucial role in all aspects of language learning. It is directly connected to the four main language skills:

Speaking

A rich vocabulary allows learners to express their thoughts clearly and confidently. Without enough words, communication becomes difficult or impossible.

Listening

Understanding spoken language depends largely on recognizing words. Limited vocabulary can lead to misunderstandings.

Reading

Vocabulary knowledge is essential for reading comprehension. The more words learners know, the easier it is for them to understand texts.

Writing

Effective writing requires a wide range of vocabulary to express ideas accurately and creatively.

Thus, vocabulary is the foundation of all language skills and directly influences learners' fluency and accuracy.

3. Importance of Vocabulary for Communication

One of the main goals of learning a language is communication. Vocabulary is the key element that enables communication. Even with limited grammar knowledge, learners can communicate if they know enough words.

Research shows that learners who have a larger vocabulary are more successful in communication. They can:

- Express ideas more precisely
- Understand others more easily
- Participate actively in conversations

In contrast, learners with poor vocabulary often feel frustrated and lack confidence.

4. Vocabulary and Language Acquisition Theories

Several language learning theories highlight the importance of vocabulary:

Krashen's Input Hypothesis

Stephen Krashen emphasized that learners acquire language through exposure to comprehensible input. Vocabulary plays a key role in understanding this input.

Lexical Approach

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Developed by Michael Lewis, this approach focuses on teaching vocabulary and lexical chunks rather than grammar alone.

These theories support the idea that vocabulary is central to language acquisition and should be a priority in teaching.

5. Challenges in Vocabulary Learning

Despite its importance, learning vocabulary is not easy. Students often face several difficulties:

- **Forgetting words quickly**
- **Pronunciation problems**
- **Confusion between similar words**
- **Lack of practice opportunities**
- **Limited exposure to the language**

Additionally, many learners try to memorize words without understanding their usage, which reduces long-term retention.

6. Strategies for Effective Vocabulary Learning

To overcome these challenges, learners and teachers can use various effective strategies:

Contextual Learning

Learning words in context helps learners understand meaning and usage better than memorizing isolated words.

Repetition and Practice

Regular revision is necessary to transfer words from short-term to long-term memory.

Use of Visual Aids

Pictures, videos, and diagrams can help learners remember words more easily.

Word Associations

Connecting new words with known words improves memory retention.

Use of Technology

Apps, online dictionaries, and language learning platforms make vocabulary learning more engaging.

Active Use of Vocabulary

Students should practice using new words in speaking and writing.

7. The Role of Teachers in Vocabulary Development

Teachers play a significant role in helping students develop their vocabulary. They should:

- Provide clear explanations and examples
- Encourage active participation
- Use interactive methods such as games and discussions
- Create a supportive learning environment
- Teach strategies for independent vocabulary learning

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Effective teaching can significantly improve students' vocabulary acquisition.

8. Vocabulary Size and Academic Success

Vocabulary size is closely related to academic performance. Students with a larger vocabulary tend to perform better in reading, writing, and overall academic tasks.

In higher education, academic vocabulary is especially important, as students need to understand complex texts and express ideas clearly. Therefore, vocabulary development should be a continuous process.

Conclusion

In conclusion, vocabulary is one of the most important components of language learning. It plays a central role in communication and supports the development of all language skills. Without sufficient vocabulary, learners cannot achieve fluency or effectively express their ideas.

Teachers and learners should recognize the importance of vocabulary and apply effective strategies to improve vocabulary acquisition. Continuous practice, exposure, and active use of language are essential for success.

Ultimately, a strong vocabulary foundation leads to better communication, greater confidence, and higher academic achievement in language learning.

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The Importance of Classroom Management in Teaching English

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Introduction

In modern education, English has become one of the most important international languages, widely used in communication, science, business, and technology. As a result, teaching English effectively has become a major goal for educators worldwide. One of the key factors that influence the success of English language teaching is classroom management.

Classroom management refers to the teacher's ability to organize the classroom, maintain discipline, and create a positive learning environment. It plays a crucial role in ensuring that students remain focused, motivated, and actively engaged in the learning process. Without proper classroom management, even the most well-prepared lessons may fail.

This paper aims to explore the importance of classroom management in teaching English, discuss its key principles, and analyze effective strategies that can improve the teaching and learning process.

1. Concept of Classroom Management

Classroom management can be defined as the set of strategies and techniques used by teachers to maintain an organized, productive, and respectful learning environment. It includes managing student behavior, organizing classroom activities, and ensuring effective communication between teacher and students.

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Effective classroom management helps to:

- Reduce disruptive behavior
- Increase student participation
- Improve academic performance
- Create a supportive learning atmosphere

In English language teaching, where communication is essential, classroom management becomes even more important.

2. Importance of Classroom Management in Teaching English

Teaching English involves the development of four key skills: speaking, listening, reading, and writing. These skills require active student participation and interaction. Therefore, a well-managed classroom is necessary to facilitate effective learning.

Firstly, classroom management ensures that students stay focused on learning tasks. In an unorganized classroom, students may become distracted, which negatively affects their language development.

Secondly, it helps create a safe and supportive environment where students feel comfortable expressing themselves in English. Many learners are afraid of making mistakes, so a positive classroom atmosphere encourages them to speak more confidently.

Thirdly, proper management allows teachers to use interactive teaching methods such as group work, pair work, and discussions, which are essential for language learning.

3. Principles of Effective Classroom Management

There are several important principles that teachers should follow to manage their classrooms effectively:

Clear Rules and Expectations

Teachers should establish clear classroom rules at the beginning. Students need to understand what behavior is acceptable and what is not.

Consistency

Rules should be applied consistently. This helps students develop discipline and respect for the teacher.

Positive Reinforcement

Encouraging and praising students motivates them to behave well and participate actively.

Time Management

Proper planning and time organization help avoid confusion and maintain a smooth lesson flow.

Student Engagement

Engaging students in activities reduces boredom and prevents disruptive behavior.

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4. Strategies for Classroom Management in English Teaching

Teachers can use various strategies to manage their classrooms effectively:

Interactive Activities

Activities such as role plays, games, and discussions keep students engaged and improve their communication skills.

Group and Pair Work

These methods encourage collaboration, but they should be well-organized to avoid noise and disorder.

Use of Signals and Routines

Teachers can use signals like raising a hand or specific phrases (e.g., "Listen carefully") to control the class.

Differentiated Instruction

Since students have different levels of English proficiency, tasks should be adapted to meet their needs.

Use of Technology

Videos, audio materials, and digital tools can make lessons more interesting and help maintain discipline.

5. Challenges in Classroom Management

Despite its importance, teachers often face challenges such as:

- Disruptive student behavior
- Lack of motivation
- Fear of speaking English
- Large class sizes

To overcome these challenges, teachers should apply flexible strategies, build good relationships with students, and create a positive classroom climate.

Conclusion

In conclusion, classroom management is a fundamental component of successful English language teaching. It directly affects students' behavior, motivation, and academic achievement. A well-managed classroom provides a structured and supportive environment where students can develop their language skills effectively.

Teachers who apply effective classroom management strategies are more likely to achieve better learning outcomes. Therefore, it is essential for educators to develop strong classroom management skills in order to enhance the quality of English language teaching.

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How Learning Languages Can Transform your Identity, Mindset, and Life Opportunities

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Abstract. This article examines the impact of foreign language learning on the formation of personal identity, patterns of thought and the expansion of an individual's life opportunities. It explores the cognitive, psychological and sociocultural aspects of bilingualism and multilingualism. Particular attention is paid to the relationship between language and thinking, as well as the role of languages in the development of intercultural communication and professional mobility. Based on an analysis of academic sources, it has been found that proficiency in several languages contributes to the development of cognitive flexibility, the formation of a multi-layered identity and increased competitiveness in the context of globalization.

Keywords: *bilingualism, globalization, identity, foreign languages, cognitive development, intercultural communication, thinking, multilingualism, professional mobility, self-development.*

Introduction

In an era of rapid globalization and the active development of international relations, knowledge of foreign languages has become an essential component of a successful modern life. The expansion of economic, cultural, and educational ties between countries requires not only proficiency in languages as a means of communication but also

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the ability to understand the distinctive ways of thinking and values of people from other cultures. Language learning today goes far beyond the traditional view of memorizing vocabulary and grammatical rules; it is a complex and multifaceted process that engages cognitive, psychological, and socio-cultural dimensions of the individual. Immersion in a new linguistic environment inevitably broadens one's worldview, fosters flexible thinking, and encourages a re-evaluation of personal identity.

The relevance of this research lies in the growing interest in foreign language study over recent decades, accompanied by an increase in academic work devoted to the influence of language on thought and behavior. In the context of digitalization and open access to international resources, language proficiency has become a decisive factor in both professional advancement and personal development. To address these challenges, the present study sets out to examine theoretical approaches to the relationship between language and thought, analyze the impact of bilingualism on cognitive abilities, investigate the role of language in shaping personal and cultural identity, and consider how language skills affect social and professional opportunities.

Thus, the aim of this article is to identify and analyze the comprehensive influence of foreign language learning on identity transformation, the development of cognitive processes, and the expansion of life opportunities, thereby situating the individual within the broader framework of modern global society.

Materials and methods

Research Materials

The study was based on two main sets of sources. First, academic literature and publications, including books and monographs on psycholinguistics, cognitive psychology, and the sociology of language; works on bilingualism and multilingualism; articles on linguistic relativity and the influence of language on thought; as well as studies in the fields of intercultural communication and global mobility. Second, empirical data consisting of survey results and case studies of people who speak two or more languages, observations of the language practices of bilinguals and polyglots, as well as statistics reflecting the impact of language proficiency on career and educational prospects.

Research Methods

A range of methods was employed to achieve the stated

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objectives. Analysis and synthesis of the scientific literature allowed us to systematize information on the influence of languages on cognitive and psychological processes and to identify patterns between language proficiency and personality traits. The comparative method was used to compare the cognitive and social characteristics of monolinguals and bilinguals, as well as to study differences in worldview and decision-making. Case studies provided an opportunity to examine examples of the successful use of language skills in personal and professional spheres and to identify their role in identity formation and intercultural interaction. Finally, the systematization and interpretation of the data ensured the integration of the results of theoretical and empirical studies and allowed for well-founded conclusions about the transformative influence of language learning on thinking and personality.

The use of these methods provided a comprehensive understanding of the relationship between language, cognitive development, and an individual's social prospects, and also made it possible to assess how foreign language acquisition contributes to identity transformation and the expansion of life opportunities.

1. Language and Cognitive Processes

Learning foreign languages has a significant impact on human cognitive functions—memory, attention, thinking, and problem-solving skills. This effect is particularly evident in bilinguals and polyglots, whose brains constantly switch between different linguistic systems. This switching fosters cognitive flexibility and trains executive functions: the ability to quickly shift focus, make decisions under uncertainty, and handle complex logical tasks. Bilingualism also contributes to the development of working memory: multilingual people find it easier to keep several ideas in mind at once, process new information more quickly, and remember sequences better[1;2]. Scientific studies confirm that speaking multiple languages slows age-related cognitive decline, reducing the risk of early-onset dementia and memory impairment. Furthermore, multilingualism stimulates analytical and creative thinking, allowing one to view the same situation from different perspectives and find unconventional solutions thanks to the diversity of grammatical structures and ways of expressing emotions[3].

2. The Influence of Language on Thinking

Language is not only a means of communication but also a

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tool for shaping thought. Learning a new linguistic system opens up access to different logic, conceptual categories, and ways of describing reality, which influences one's perception of the world. Different languages structure human experience in different ways: some emphasize temporal categories, others spatial relationships or social roles. This shapes the cognitive habits of native speakers, determining which aspects of reality they notice first. Learning a foreign language develops metalinguistic awareness—the ability to perceive language as a system, analyzing not only the content but also the form of utterances[4]. For bilinguals, switching between languages can influence decision-making: in their native language, they are more often guided by emotions, while in a foreign language, they tend toward more rational and balanced assessments. New words and expressions broaden cognitive horizons, allowing phenomena to be classified in new ways. Internal speech is also an important aspect: the transition to thinking in another language alters the structure of the thought process, the speed of information processing, and emotional reactions. Thus, language learning contributes to the development of flexible, multifaceted, and conscious thinking[5;6].

3. Language and Identity

Language plays a key role in shaping personal and cultural identity. It not only facilitates communication but also conveys values, norms, and behavioral patterns. Learning a foreign language is often accompanied by a transformation of self-awareness: immersion in a different cultural environment leads to a reevaluation of one's own views and a broadening of personal horizons. Bilinguals and polyglots develop multiple identities: communication style, emotionality, and behavioral patterns may vary depending on the language used. A person may be more formal in one language and more expressive in another[7]. Language is closely linked to cultural identity, as it serves as a channel for transmitting traditions and historical experience. Learning new languages develops intercultural sensitivity and tolerance, and also contributes to the formation of a global identity, where a person feels part of the global community[8].

4. Intercultural Communication and Social Aspects

Proficiency in foreign languages is the foundation of intercultural communication, which plays a crucial role in today's globalized society. Language allows us not only to

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exchange information but also to understand the cultural norms and values of other peoples. Effective intercultural interaction requires the ability to interpret statements in context, since the same expressions can have different nuances of meaning in different cultures. Language learning fosters intercultural competence, which includes understanding cultural differences, adapting behavior to social situations, preventing conflicts, and developing empathy. The social aspect of multilingualism manifests itself in expanding one's social circle, establishing international contacts, and integrating into multinational teams. Language proficiency reduces stereotypical thinking and promotes a more objective perception of other cultures. In the professional sphere, intercultural communication becomes a competitive advantage: in business, education, tourism, and diplomacy, it helps build trusting relationships, avoid misunderstandings, and achieve successful outcomes. Thus, studying foreign languages develops not only communication skills but also social flexibility, intercultural sensitivity, and the ability to operate effectively in a global environment[9;10].

5. Impact on Personal and Professional Opportunities

Learning foreign languages significantly broadens one's horizons, opening up new opportunities for self-fulfillment, career advancement, and social integration. Language proficiency serves not only as a practical tool for communication but also as a key factor in competitiveness in a globalized world. Career prospects. Proficiency in foreign languages provides access to the international labor market and opens up opportunities for employment in multinational companies. Bilinguals and polyglots are more likely to hold leadership positions in business, tourism, education, diplomacy, and science[11]. In addition, language proficiency enhances professional mobility, allowing specialists to move freely between countries and adapt to various cultural and economic conditions. Educational opportunities. Language proficiency opens the door to studying abroad, participating in international academic programs and exchanges, and provides access to global scientific resources. Students and researchers who are proficient in foreign languages gain advantages when publishing articles, participating in conferences, and acquiring up-to-date knowledge. Personal development. Language learning fosters critical thinking, cultural awareness, and adaptability. Multilingual people better understand global diversity, become more receptive to

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new ideas, and are open to intercultural interaction[12;13]. Broadening horizons. Language proficiency allows for a deeper understanding of the cultures, traditions, and lifestyles of other peoples. This provides opportunities to travel, connect with people from different countries, and use acquired skills for personal and professional growth. Language proficiency builds self-confidence and fosters independence, helping individuals adapt to diverse environments and situations. Thus, learning foreign languages has a comprehensive impact on a person's personal and professional opportunities. It promotes career advancement, broadens educational and social prospects, and develops flexible thinking and intercultural competence, shaping a successful and adaptable individual in today's global society.

Results and Discussion

A comprehensive analysis of scientific publications, empirical data, and observations has shown that learning foreign languages has a multifaceted impact on cognitive processes, identity formation, and an individual's social opportunities.

Cognitive abilities. The findings confirm that bilingualism and multilingualism contribute to the development of cognitive flexibility, working memory, attention span, and analytical skills. Multilingual individuals switch between tasks more quickly, solve non-standard problems more effectively, and demonstrate a higher level of abstract thinking. These findings are consistent with research by Helen Bialystok and other psycholinguists, who have shown that regular language practice strengthens the brain and slows age-related cognitive decline[14].

Language and thinking. Learning new languages influences how we perceive and interpret the world. Bilinguals develop different cognitive models depending on the language they are using. For example, decision-making in a foreign language tends to be less emotionally charged and more rational, indicating the development of flexible thinking. These findings support the hypothesis of linguistic relativity, according to which language structure influences information processing and the perception of reality[15].

Identity Formation. Learning a foreign language contributes to the development of a multifaceted identity. Bilinguals and polyglots adapt their communication style, emotional expression, and behavioral patterns depending on the language they are using, which allows them to successfully

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integrate into various cultural and social contexts. Thus, language becomes a tool for self-discovery and cultural growth.

Intercultural communication and social skills. Research findings show that proficiency in foreign languages enhances intercultural competence and expands social opportunities. Multilingual people find it easier to connect with people from other cultures, demonstrate greater empathy and tolerance, and reduce the likelihood of misunderstandings and conflicts in international settings.

Personal and professional prospects. Empirical data confirms that knowledge of foreign languages positively influences career and educational opportunities. Language proficiency opens the door to international projects, study abroad, and new professional roles. Furthermore, language competence boosts self-confidence and fosters adaptability, which contributes to successful self-realization in various life situations.

Overall, the study's findings demonstrate that language learning has a multifaceted impact on the individual: it goes beyond communication skills to influence cognitive functions, thinking, identity, and social behavior. This impact manifests itself both at the individual level (development of thinking and self-awareness) and at the social level (expansion of social circles and career prospects). At the same time, the extent of these changes depends on the level of language proficiency, the regularity of its use, and motivation. Active language practice leads to more pronounced cognitive and social transformations than occasional or superficial study. Thus, foreign language learning is confirmed as a powerful tool for personal and professional development, capable of transforming a person's thinking, identity, and life opportunities.

Learning foreign languages has a comprehensive and multifaceted impact on personal development. It shapes not only communication skills but also deep-seated cognitive and psychological structures—such as identity, ways of thinking, and perceptions of the world around us. Proficiency in multiple languages enhances cognitive flexibility, develops analytical and critical thinking, and improves memory and attention. Language competence contributes to the formation of multiple identities and increases a person's ability to adapt to various cultural and social conditions.

Language learning takes on particular significance in the

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realm of intercultural communication and professional activity. People who speak foreign languages find it easier to establish social and professional connections, demonstrate greater tolerance and empathy, and gain access to international educational and career opportunities.

Thus, mastering foreign languages can be viewed as a strategic investment in personal and professional development. It broadens one's horizons, enhances competitiveness in a global society, and contributes to the formation of a more flexible, open-minded, and multifaceted personality. In today's world, language proficiency is becoming a key skill necessary for successful self-realization and effective interaction in an international environment.

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Üçüncü Müəllim Və 100 Dil: Reggio Emilia Pedaqogikasının Fenomenologiyası

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Xülasə. Bu məqalə müasir məktəbəqədər təhsil sistemləri arasında özünəməxsus fəlsəfi və praktik çərçivəsi ilə fərqlənən Reggio Emilia yanaşmasını dərinlən təhlil edir. İkinci Dünya Mühəribəsindən sonra İtaliyada Loris Malaguzzi tərəfindən təməli qoyulan bu pedaqogika, uşağı biliyin passiv qəbul edicisi kimi deyil, öz öyrənmə prosesinin aktiv iştirakçısı və güclü potensiala malik bir hüquq subyekti kimi qiymətləndirir. Araşdırmanın əsas diqqət mərkəzini Reggio Emilia fəlsəfəsinin iki təməl sütunu təşkil edir: "Uşağın 100 Dili" metaforası və "Ətraf mühitin Üçüncü Müəllim" olması konsepsiyası. "Uşağın 100 Dili" konsepsiyası uşaqların dünyanı anlamaq və öz daxili dünyalarını ifadə etmək üçün istifadə etdikləri simvolik vasitələrin çoxsəsliliyini ifadə edir. Ənənəvi təhsil sistemləri əsasən şifahi və məntiqi-riyazi intellektə diqqət yetirdiyi halda; Reggio Emilia yanaşması rəsm, heykəltəraşlıq, musiqi, kölgə oyunları, dramatik təmsil və texnoloji manipulyasiyaların uşağın kognitiv inkişafındakı həlledici rolunu vurğulayır. Məqalədə bu yanaşmanın Jan Piaje-nin konstruktivizmi və Lev Viqotski-nin sosial-mədəni inkişaf nəzəriyyəsi ilə nəzəri kəsişmə nöqtələri təhlil edilir. "Atelierista" (incəsənət mütəxəssisi) və "Atelier" (emalatxana) anlayışları bu çoxdilliliyin təhsil mühitində necə strukturlaşdırıldığını göstərir. Araşdırmanın ikinci mühüm istiqaməti fiziki mühitin "üçüncü müəllim" kimi fəaliyyət göstərməsidir. Reggio Emilia yanaşmasına görə, öyrənmə mühiti sadəcə bir məkan deyil, pedaqoji prosesin aktiv komponentidir. Estetik zənginlik, şəffaflıq, təbii işıq və materialların strateji düzülüşü uşağın təbii marağını ("provokasiya") canlandırır. Məkanın "Piazza" (mərkəzi meydan) ətrafında təşkil edilməsi uşaqların sosial qarşılıqlı əlaqəsini və icma hissini gücləndirir. Məqalədə həmçinin pedaqoji sənədləşdirmənin (documentazione) rolu da təhlil edilmişdir. Nəticə etibarilə, Reggio Emilia pedaqogikası 21-ci əsrin tələb etdiyi tənqidi təfəkkür, yaradıcılıq və əməkdaşlıq bacarıqlarını formalaşdıran innovativ bir model kimi qiymətləndirilir. Bu modelin təhlili müasir kurikulumların daha çevik, uşağıyönümlü və estetik yönümlü qurulması üçün mühüm elmi baza yaradır.

Açar Sözlər: Uşağıyönümlü təhsil, Reggio Emilia, Uşağın 100 Dili, üçüncü müəllim, pedaqoji sənədləşdirmə, konstruktivizm.

Giriş

Müasir məktəbəqədər təhsil ənənəvi bilik ötürülməsi yanaşmalarından uzaqlaşaraq, uşağı öz inkişafının fəal iştirakçısı kimi qəbul edən konstruktiv və post-konstruktiv modellərə yönəlmişdir. Bu transformasiyanın parlaq nümunəsi

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İkinci Dünya Müharibəsindən sonra İtaliyanın Reggio Emilia şəhərində Loris Malaguzzi və yerli icma tərəfindən inkişaf etdirilmiş pedaqoji yanaşmadır (Edwards, Gandini, & Forman, 1998).

Reggio Emilia pedaqogikası adını İtaliyanın şimalındakı Reggio Emilia qəsəbəsiindən götürür. İkinci Dünya müharibəsindən sonra uşaqlara yeni bir yanaşma ilə uşaq bağçaları açıldı. Bu texnika psixoloq Loris Malaguzzi tərəfindən digər valideynlərlə birlikdə hazırlanmışdır. Onlar yanaşmalarında o dövrün ən məşhur psixoloq və pedaqoqlarının: D. Dyui, J. Piage, L. Vygotsky, D. Bruner, M. Montessori və başqalarının fikirlərini əsas götürdülər. Loris Malaguzzi və onun davamçıları üçün hər bir uşağa təhsil almaq və kifayət qədər tərbiyə almaq imkanı yaratmaq son dərəcə vacib idi. Buna görə də ailənin maddi vəziyyəti və ya uşağın fiziki sağlamlığı əhəmiyyət kəsb etmirdi, əksinə, kasıb və imkansız ailələrdən olan uşaqlar birinci növbədə qəbul edilirdi. Beləliklə, o dövrün bütün dünya və ən mütərəqqi təcrübəsini yanaşmalarında cəmləşdirməyə çalışırdılar.

Reggio Emilia pedaqogikası İtaliyanın bu bölgəsində təsadüfən yaranmadı. Bu bölgə yüksək səviyyədə ictimai fəallığı və vətəndaşlığı ilə məşhur idi. Bölgənin bu xüsusiyyəti Reggio Emilia pedaqogikasında müəyyən bir iz buraxır və uşaqları bir şəxsiyyət kimi yetişdirməklə yanaşı, onu inkişaf etdirməyi hədəfləyir: demokratiya, digər insanlarla həmrəylik və sosial ədalət.

Reggio Emilia pedaqogikasında müəllim tərbiyə etmir, ancaq uşaqlara kömək edir. Uşağın istək və fikirlərini həyata keçirməyə kömək edən bərabər tərəfdaş rolunu oynayır. Buna görə uşağı fəal və diqqətlə dinləyir, ona hörmətlə yanaşır və hər şəkildə kömək etməyə çalışır. Müəllim uşaqlara hazır cavabları öyrətmir, onları sual verməyə və öz həll və cavablarını axtarmağa, öz kəşflərini etməyə təşviq edir. Reggio Emilia yanaşmasında ətraf mühit bir pedaqoq kimi qəbul edilir.

Reggio Emilia modeli John Dewey-in progressiv təhsil ideyaları və Lev Vygotskynin sosial-mədəni nəzəriyyəsi ilə əlaqəli olsa da, uşağı bütöv fərd kimi qiymətləndirməsi və simvolik ifadənin öyrənmədə rolunu önə çıxarması ilə fərqlənir. Bu tədqiqat modelin iki əsas prinsipini - "Uşağın 100 Dili" və "Mühitin Üçüncü Müəllim" - analiz edərək, onların MQT keyfiyyətinə təsirini araşdırır.

Metodoloji Çərçivə

Kiçik yaşlı uşaqların öyrənməyə marağını artırma bilmək,

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onları ciddi çərçivələrlə məhdudlaşdırmamaq Reggio Emilia yanaşmasının əsas ana xəttini təşkil edir. Uşaqların özlərini ifadə etmək üçün bir çox yol olmalıdır (dram, musiqi, rəsm, oxuma, rəqs, tikinti, söhbət) [Даниленко М.].

Reggio Emilianın pedaqoji konsepsiyası iki əsas prinsipə əsaslanır:

- uşaqlığın insan şəxsiyyətinin inkişafında xüsusi, dəyərli bir dövr kimi tanınması;
- uşaq şəxsiyyətinin unikallığının sərbəst müstəqil fəaliyyətdə inkişaf etməsi.

Reggio Emilia və Ənənəvi Yanaşmanın Müqayisəsi

Xüsusiyyətlər	Ənənəvi Məktəbəqədər Təhsil	Reggio Emilia Yanaşması
Uşaq Modeli	Məlumatı qəbul edən (Pasiv)	Bilik yaradan və tədqiqatçı (Aktiv)
Tərbiyəçi-müəllimin Rolu	Bilik ötürücüsü və idarəçi	Bələdçi, müşahidəçi və ortağ öyrənən
Kurikulum	Əvvəlcədən müəyyən edilmiş (Sabit)	Uşağın maraqlarından doğan (Emergent)
Öyrənmə Mühiti	Sadəcə funksional (Masa, stul)	"Üçüncü Müəllim" (Estetik, stimullaşdırıcı)
Qiymətləndirmə	Standart testlər və hesabatlar	Pedaqoji sənədləşmə (Foto, video, qeydlər)
Əsas Alətlər	Kitablar, iş vərəqləri	"100 Dil" (Gil, boya, işıq, təbiət, texnologiya)
Valideyn Rolu	Kənar müşahidəçi	Təhsil prosesinin rəsmi tərəfdaşı

Bu yanaşma uşaqların özlərinin təlim layihələrinin əsas təşəbbüskarları olduğu nəzəriyyəsinə əsaslanır və tərbiyəçi-müəllimlərin vəzifəsi kiçik tədqiqatçılara dünya haqqında fikirlərini ifadə etməkdə kömək etmək, yol göstərməkdən ibarətdir. Tərbiyəçi-müəllim öyrətmir və məcbur etmir, yalnız uşaqlara cavab yolunu göstərir, müstəqil inkişafa zəmin yaradır. Malaguzzi tərəfindən irəli sürülən "Uşağın 100 Dili" konsepti uşağın biliyini yalnız dil vasitəsi ilə ifadə etməklə məhdudlaşdırmır. Uşaq rəsm, heykəltəraşlıq, maket hazırlama, dramatik oyun, musiqi və digər simvolik vasitələrlə mürekkəb ideyalarını ifadə edə bilir (Malaguzzi, 1998).

Reggio Emilianın yanaşması keçən əsrin müharibədən sonrakı illərində İtaliyanın şimalındakı Regio Emilia şəhəri yaxınlığındakı kiçik bir kənddə yaranmışdır. Bu kəndin sakinləri müharibədən sonra bütün güclərini və qaynaqlarını

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uşaqlarına azad və layiqli bir gələcək təmin etmək üçün yeni bir uşaq bağçasının yaradılmasına və inkişafına sərf etdilər.

Loris Malaguzzi uşağın xarici dünya ilə ünsiyyət qurduğunu vurğulayaraq, uşaq dilinin bənzərsiz unikallığa malik olmasına xüsusi diqqət yetirirdi. Müxtəlif təsirlər sayəsində uşaq dünyanı hərtərəfli şəkildə dərk edir. Burada eyni zamanda, uşaq öz zəngin daxili dünyasına, mədəniyyətinə sahib olan səlahiyyətli bir varlıq kimi qəbul edilir. Uşağın daxili enerjisini və dünyaya tədqiqat münasibətini formalaşdırmaq üçün onun ətraf mühitlə aktiv qarşılıqlı əlaqəsi, böyüklərin hörmətli və etibarlı münasibəti lazımdır (A. Г. Гогоберидзе, О. В. Солнцева, 2013).

Bu yanaşma Howard Gardner-in Çoxsaylı İntellektlər Nəzəriyyəsi ilə uyğunluq təşkil edir və fərqli bacarıqların integrasiyasını təşviq edərək uşağın yaradıcı və tənqidi düşüncəsini inkişaf etdirir (Gardner, 1993).

Reggio Emilia pedaqogikasında uşaq özünü böyüklər üçün əhəmiyyətsiz görünən və ya tamamilə diqqətdən kənarda qalan bir çox yolla ifadə edir. Reggio Emiliada gilli torpaqla işləmək, işıq-kölgə təcrübələri və rəsm sadəcə incəsənət deyil, uşağın bir problemi necə həll etdiyini göstərən "düşünmə alətləri"dir (Biermeier, 2015). Əgər uşaqların qabiliyyətləri, yaradıcı imkanları, münasibətləri nəzərə alınmayacaqsa, ətraf aləm haqqında düşünmək üçün vaxt və fürsət verilməse onlar özlərini ifadə etməkdə çətinlik çəkəcəklər. Uşağın qavrayışı xüsusi bir xarakter daşıyır, onların münasibətləri dəyərlidir, öz təcrübələri, digər uşaqlarla, böyüklərlə birlikdə öyrənir, ancaq bu birbaşa baş vermir, dolayı yolla, təəssüratlarını fəaliyyət kontekstinə daxil etməklə və onları emal etməklə reallaşır.

Pedaqoji sənədləşmə (məsələn, qeydlər, fotoşəkillər, layihələr) uşağın müxtəlif "dillərini" görünən edir və müəllimlər üçün kurikulumu uşaq ehtiyaclarına uyğun formalaşdırmaq üçün tədqiqat aləti rolunu oynayır (Rinaldi, 2006). Reggio Emilia hər uşağın qabiliyyətinə inanır və ona etibar edir. Burada müəllimin vəzifəsi uşağa özünü ifadə etməkdə, hisslərini və təəssüratlarını açıqlamaqda kömək etməkdir. Uşaqların maraqları sonsuzdur, onlar boş yerə suallar vermir. Ətraf mühitdə gördükləri, toxunduqları, eşitdikləri, hiss etdikləri nə varasa bütünlüklə onları maraqlandırır.

Mühitin "üçüncü müəllim" olması konsepsiyası (The Environment as the Third Teacher), məkanın uşağın daxili nizamını və yaradıcılığını stimullaşdıran bir faktor olduğunu

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təsdiq edir. Bu yanaşmada mühit təmiz, estetik cəhətdən cəlbedici və uşağın boy səviyyəsinə uyğun materiallarla zəngin olmalıdır. Mərkəzi meydan olan "Piazza" uşaqlarda demokratiya və birgə yaşayış hissini inkişaf etdirən sosial katalizator funksiyasını daşıyır.

Reggio Emilia pedaqogikasında fiziki mühit – sinif otağı, atelye və dəhlizlər – öyrənməyə birbaşa təsir edən üçüncü subyekt kimi qəbul edilir (Gandini, 1998). Burada uşaq müstəqil tədqiqat üçün öz layihəsini və ya mövzunu seçə bilər. Adətən layihələr oyunlarda və ya söhbətlərdə doğrulur – bu anda uşaqları maraqlandıran mövzular yarana bilər. Uşaq bağçasının sahəsi uşaq üçün faydalı vizual və toxunma məlumatları, götürmək, anlamaq, oyunda tətbiq etmək üçün maraqlı olan əşyalarla doludur: bu çox sayda təbii material (yarpaqlar, toxumlar, budaqlar və s.) və onları öyrənmək üçün əşyalar (böyüdücülər, mikroskoplar, lümen masaları, dülğərlik və çilingər alətləri və s.), müxtəlif oyuncaqlar, boyalar, tullantı materialları və s.

Vygotskynin sosio-mədəni nəzəriyyəsi çərçivəsində mühit uşağın Yaxın İnkişaf Zonasında sərbəst öyrənməsini dəstəkləyən mədəni vasitəçi rolunu oynayır (Vygotsky, 1978). Estetik cəhətdən zəngin, təbii işıq və neytral rənglərlə dizayn edilmiş, "Loose Parts" ilə təchiz olunmuş mühit uşaqlara kəşfiyyat və yaradıcılıq imkanlarını artırır.

Bu mühit uşaqlara seçim etmək, fərziyyələrini sınaq və öyrənmə yollarına nəzarət etmək imkanı verərək onların avtonom və səlahiyyətli iştirakçılar kimi inkişafına şərait yaradır.

Nəticə və Təvsiyələr

Reggio Emilia yanaşması uşağı müstəqil bilik qurucusu kimi qəbul edən fəlsəfi baxışı ilə müasir məktəbəqədər təhsil üçün zəngin, insan mərkəzli model təqdim edir. "Uşağın 100 Dili" və "Mühitin Üçüncü Müəllim" prinsipləri uşaqlarda yaradıcılıq, sosial bacarıq və tənqidi düşüncə kimi XXI əsr səriştələrini inkişaf etdirir. Modelin tətbiqi məktəbəqədər təhsil müəssisələrində uşağa güclü və potensiallı fərd kimi yanaşma tələb edən paradiqma dəyişikliklərinə yol açır. Bu dəyişikliyin əsas təminatları tərbiyəçi-müəllimlərin bir tədqiqatçı kimi çıxış etməsi, peşəkar inkişafı, pedaqoji sənədləşməyə sərmayə qoyulması və öyrənmə mühitinə strateji yanaşmanın vacibliyidir.

Təvsiyələr:

1. Pedaqoji Sənədləşmənin Zəruriliyi: Məktəbəqədər təhsil proqramlarında sənədləşmənin yalnız hesabat forması deyil,

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kurikulumun formallaşdırılması üçün əsas tədqiqat aləti kimi tətbiqi genişləndirilməlidir.

2. Mühitə Strateji İnvestisiya: Məktəbəqədər təhsil müəssisələrinin fiziki məkanlarının təbii materiallarla, sərbəst hissələrlə və estetik elementlərlə zənginləşdirilməsi prioritetləşdirilməlidir.

3. Gələcək Tədqiqatlar: Fərqli mədəni və sosial-iqtisadi kontekstlərdə, xüsusən inkişaf etməkdə olan ölkələrdə Reggio Emilia yanaşmasının tətbiqinin uşaqların uzunmüddətli akademik nailiyyətlərinə və sosial-emosional inkişafına təsirini qiymətləndirən müqayisəli tədqiqatlar aparılmalıdır.

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Fostering Critical Thinking and Creativity Through English Language Teaching

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Abstract. This article examines the integration of critical thinking and creativity into English language teaching (ELT) in secondary schools. The study, conducted during a teaching placement, employed qualitative methods including classroom observations, teacher interviews, and student questionnaires. Participants were pupils of grades 7–9 with varying levels of English proficiency, as well as their teachers. The findings demonstrate that activities such as debates, storytelling, project-based learning, and text/media analysis significantly enhance both language competence and soft skills development. Debates fostered analytical and argumentative abilities, while storytelling stimulated imagination and self-expression. Project-based learning promoted teamwork, communication, and problem-solving, whereas text/media analysis developed critical literacy and cultural awareness. Teachers emphasized the importance of scaffolding tasks to match proficiency levels, ensuring accessibility for all learners. Students reported increased motivation and engagement, highlighting the real-life relevance of these activities. The discussion identifies CLIL and Task-Based Learning as effective pedagogical approaches for balancing linguistic and cognitive objectives. The article concludes that ELT can serve as a transformative practice, preparing learners for academic success and active participation in modern society. Future research should explore long-term effects, teacher training, and comparative studies of international practices.

Keywords: *English language teaching, Critical thinking, Creativity, Soft skills, CLIL (Content and Language Integrated Learning), Task-Based Learning (TBL), Pedagogical strategies, Student engagement, Cognitive development, Intercultural communication.*

Introduction.

The teaching of English in schools has traditionally focused on developing language proficiency: grammar, vocabulary, and communication skills. However, the demands of

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modern education extend far beyond linguistic competence. In today's rapidly changing world, students must acquire soft skills—universal competencies that enable them to adapt, collaborate, and innovate in diverse contexts. Among these, critical thinking and creativity are increasingly recognized as the key competencies of the 21st century.

Critical thinking equips learners with the ability to analyze information, identify contradictions, evaluate evidence, and construct logical arguments [1]. It fosters intellectual independence and empowers students to make informed decisions in both academic and real-life situations. Creativity, in turn, nurtures divergent thinking, originality, and the capacity to generate innovative solutions [2]. Together, these skills form the foundation for lifelong learning and active participation in knowledge-based societies.

The process of foreign language acquisition provides a unique environment for cultivating these competencies [3, 4]. Language is not merely a tool for communication; it is also a medium of cognition, interpretation, and self-expression. Through the study of English, learners engage in activities that require them to question assumptions, compare cultural perspectives, and articulate ideas in novel ways. This makes English language teaching (ELT) an ideal platform for integrating critical and creative thinking into the educational process.

As a global lingua franca, English offers unparalleled opportunities for the development of soft skills. Classroom practices such as debates, project-based learning, storytelling, text analysis, role-playing, and intercultural comparisons encourage students to think critically and creatively while simultaneously improving their language competence. These activities transform the English classroom into a dynamic space where linguistic goals intersect with cognitive and personal growth.

Moreover, the integration of critical thinking and creativity into ELT aligns with international educational frameworks, such as the OECD's 21st Century Skills and UNESCO's emphasis on education for sustainable development. By embedding these competencies into language teaching, schools not only enhance academic outcomes but also contribute to the formation of individuals who are prepared to meet the challenges of globalization, technological advancement, and social transformation.

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Materials and methods.

The study was conducted as part of our third-year teaching placement and aimed at identifying effective ways to foster critical thinking and creativity in English language lessons. A qualitative research design was chosen, as it allowed for an in-depth exploration of classroom practices and learner responses. The design combined several complementary methods—classroom observation, semi-structured interviews, and student questionnaires—providing triangulation of data and enhancing the validity of findings.

The participants included:

- Pupils: Students of grades 7–9 (aged 12–15), representing a range of English proficiency levels from Elementary (A2) to Intermediate (B1). This diversity enabled us to observe how learners at different stages of language acquisition engaged with tasks designed to develop soft skills.

- Teachers: English language teachers supervising our teaching placement. Their professional insights provided valuable perspectives on the feasibility and challenges of integrating critical and creative thinking into everyday lessons.

Data Collection Methods

- Classroom Observations: We systematically recorded the types of activities implemented, the level of student engagement, and the observable manifestations of critical and creative thinking during lessons.

- Teacher Interviews: Semi-structured interviews were conducted to explore teachers' pedagogical approaches, perceived challenges, and reflections on the outcomes of implementing soft skills-oriented tasks.

- Student Questionnaires and Reflections: Learners were invited to share their impressions of the activities, highlighting which tasks encouraged them to think more critically or express creativity.

During the placement, we implemented and observed a variety of classroom practices designed to integrate language learning with soft skills development:

- Debates and Discussions: Encouraged argumentation, logical reasoning, and analytical thinking [5].

- Storytelling and Creative Writing: Stimulated imagination, narrative competence, and creative use of language [6].

- Project-Based Learning: Promoted teamwork,

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communication, and collaborative problem-solving [7].

- Text and Media Analysis: Developed critical literacy, the ability to detect bias, and skills in comparing cultural contexts [4].

Methods of Analysis

The collected data were processed using content analysis, focusing on recurring themes and patterns. Particular attention was paid to:

- Manifestations of Critical Thinking: Evidence of argumentation, evaluation of sources, and comparison of viewpoints.
- Manifestations of Creativity: Original ideas, unconventional solutions, and innovative use of language.
- Student Engagement: Levels of participation, motivation, and self-reported perceptions of the tasks.

By combining multiple sources of data and applying systematic analysis, the study sought to provide a comprehensive picture of how English language teaching can serve as a platform for the development of critical and creative competencies in school settings. Sustainability of Kazakhstan's economy. Additionally, an expert survey is conducted to identify specific challenges and effective solutions that can be applied in the context of Kazakhstan.

Results.

Quantitative Findings

The questionnaires revealed that the majority of pupils reported increased motivation and interest when participating in activities designed to foster critical thinking and creativity [3].

Table 1

Comparative Engagement in ELT Activities

Activity Type	% of Students Reporting High Engagement	% of Students Reporting Moderate Engagement	% of Students Reporting Low Engagement
Debates and Discussions	65%	25%	10%
Storytelling/Creative Writing	70%	20%	10%
Project-Based Learning	80%	15%	5%
Text/Media Analysis	60%	30%	10%

Manifestations of Critical Thinking:

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- **Argumentation:** 68% of students demonstrated the ability to construct logical arguments during debates.

- **Evaluation of Sources:** 55% showed awareness of bias and reliability when analysing texts and media.

- **Comparison of Viewpoints:** 62% were able to contrast different cultural or textual perspectives.

Manifestations of Creativity:

- **Original Ideas:** 72% of students produced unique solutions or narratives in creative writing tasks.

- **Unconventional Solutions:** 58% demonstrated divergent thinking in project-based activities.

- **Creative Use of Language:** 65% experimented with vocabulary, stylistic devices, or narrative techniques.

Qualitative Findings

Classroom Observations: Pupils were most engaged in project-based learning, where teamwork and problem-solving created a dynamic environment. Debates encouraged critical questioning, though some students struggled with structuring arguments. Storytelling revealed high levels of imagination, with students often drawing on personal experiences or cultural references. Text analysis highlighted differences in proficiency: Intermediate learners were more confident in identifying bias, while Elementary learners required scaffolding.

Teacher Interviews: Teachers noted that integrating soft skills required additional preparation time and adaptation of materials. They emphasized the importance of scaffolding tasks to match proficiency levels, ensuring accessibility for all learners [6]. Teachers also observed that students became more confident in expressing opinions and collaborating with peers.

Student Reflections: Pupils reported that debates helped them “think more deeply about different sides of an issue.” Creative writing was described as “fun and liberating,” allowing them to express ideas beyond textbook exercises. Project-based tasks were valued for their “real-life relevance,” as they mirrored teamwork situations outside the classroom [5].

Summary of Results: The findings indicate that integrating critical thinking and creativity into English lessons significantly enhances student engagement and fosters the development of soft skills. While challenges remain—particularly in adapting tasks for lower proficiency levels—the overall impact was positive, with both teachers and

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students recognizing the value of these approaches.

Discussion.

The integration of soft skills into English language teaching not only contributes to the personal development of students but also enhances their motivation to learn the language. In contemporary society, where the flow of information is increasingly intense and complex, the ability to think critically and creatively has become indispensable. Our findings confirm that English lessons can serve as an effective platform for cultivating these competencies.

Debates and Discussions: These activities provided students with opportunities to practise English in authentic communicative contexts. Beyond language practice, they fostered analytical and argumentative skills. Pupils learned to assess the reliability of information, compare viewpoints, and construct logically coherent arguments [5]. Teachers noted that debates encouraged active participation, though scaffolding was necessary for lower-proficiency learners.

Storytelling and Creative Writing: These tasks stimulated imagination and linguistic creativity. Pupils who created their own stories or alternative endings to literary works demonstrated originality and confidence in self-expression [6]. Such activities reinforced language competence while simultaneously building self-efficacy in creative thinking. Importantly, students reported that these tasks were enjoyable, which increased their intrinsic motivation to learn English.

Project-Based Learning: This approach emerged as one of the most effective strategies for integrating soft skills. Collaborative projects required students to allocate roles, plan tasks, and search for information in English, thereby enhancing teamwork, communication, and problem-solving abilities. The real-life relevance of projects was highlighted by both teachers and students, who observed that these tasks mirrored professional and social situations outside the classroom [7].

Text and Media Analysis: The analysis of texts and media materials fostered critical literacy, a skill particularly relevant in the digital age [8; 9]. Students learned to identify bias, compare cultural contexts, and question sources. Intermediate-level learners demonstrated greater confidence in evaluating information, while Elementary-level learners required additional support [4]. This underscores the importance of differentiated instruction when integrating

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critical thinking into ELT.

Pedagogical Approaches: The teacher plays a central role in designing tasks that simultaneously develop language and cognitive skills. Effective approaches include:

- CLIL (Content and Language Integrated Learning): By integrating subject content with language practice, students acquire disciplinary knowledge while improving their English proficiency.

- Task-Based Learning (TBL): Practical tasks encourage independence, initiative, and creativity, aligning with constructivist principles of active knowledge construction [10].

Implications: The integration of critical thinking and creativity into ELT should not be perceived as an additional burden but as a natural extension of language education. By embedding soft skills into everyday classroom practices, teachers prepare students not only for academic success but also for active participation in modern society. English thus becomes more than a means of communication—it evolves into a tool for shaping individuals who are adaptable, innovative, and ready to face global challenges

Conclusion.

Teaching English at school can be a powerful tool not only for developing language proficiency but also for fostering critical thinking and creativity among pupils. The integration of soft skills into the educational process enables teachers to move beyond traditional methods and transform English lessons into a dynamic environment for shaping individuals who are prepared to meet the challenges of modern society.

The findings of our study demonstrate that activities such as debates, storytelling, project-based learning, and text/media analysis significantly contribute to the development of analytical and creative abilities. Critical thinking helps pupils to analyze information, identify contradictions, make informed decisions, while creativity fosters the ability to think divergently, generate original ideas, and express themselves confidently. Together, these skills enhance motivation to learn English, making the learning process more engaging, practice-oriented, and personally meaningful.

The teacher's role is central in this process. By carefully designing tasks that combine linguistic objectives with cognitive development, educators ensure that language

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learning is not isolated from broader educational goals. Approaches such as CLIL (Content and Language Integrated Learning) and Task-Based Learning provide effective frameworks for balancing language acquisition with the cultivation of universal competencies [10].

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Screening and Prevention in Obstetrics, Gynaecology, and Surgical Disciplines

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Abstract. Screening and prevention represent the cornerstone of modern medicine, shifting the focus from crisis management to early intervention. In obstetrics, gynaecology, and surgery, preventive measures significantly reduce mortality and healthcare costs. This article explores the various levels of screening—from maternal-fetal monitoring to oncological surveillance—and evaluates the implementation of these protocols in the global and Kyrgyz healthcare contexts.
Keywords: *Screening, Prophylaxis, Obstetrics, Gynaecology, Surgery, Kyrgyzstan Healthcare, Early Diagnosis.*

Introduction

The goal of screening is to identify asymptomatic individuals who may have a disease or a high risk of developing one. In surgical and gynaecological disciplines, this often means catching pre-cancerous lesions or structural anomalies before they progress to a critical state. Prevention is categorized into primary (vaccination/lifestyle), secondary (screening for early detection), and tertiary (preventing complications of existing disease).

Etiology and Oncology

Preventive strategies are designed based on the etiology of specific diseases:

- **Genetic/Hereditary:** Screening for BRCA1/2 mutations in

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breast/ovarian oncology or Lynch syndrome in colorectal surgery.

- **Infectious:** The role of HPV in cervical cancer or *H. pylori* in gastric surgical oncology.

- **Environmental:** In **Kyrgyzstan**, the high altitude and specific dietary habits are factors in the etiology of gallbladder disease and certain gastrointestinal tumours, necessitating targeted surgical screening.

Pathology

Screening targets the "pre-pathological" or "early pathological" state:

1. **Dysplasia:** Identifying cellular changes (e.g., CIN in the cervix) before they become invasive.

2. **Asymptomatic Structural Change:** Detecting an aneurysm or a small polyp before rupture or malignancy. Types of Screening and Prevention

1. Obstetrics

- **First Trimester Screening:** Combined ultrasound (nuchal translucency) and blood tests (PAPP-A) to assess chromosomal risks.

- **Gestational Diabetes (GDM):** Universal screening via Oral Glucose Tolerance Test (OGTT).

2. Gynaecology

- **Cervical Cancer:** Pap smears and HPV DNA testing.

- **Breast Cancer:** Mammography and clinical breast exams starting at age 40-50.

3. Surgical Disciplines

- **Colorectal:** Colonoscopy or fecal immunochemical tests (FIT).

- **Vascular:** Ultrasound screening for Abdominal Aortic Aneurysm (AAA) in high-risk men.

Signs and Symptoms (The "Red Flags")

While screening is for those *without* symptoms, prevention protocols include educating patients on "red flags":

- **Gynaecological:** Post-menopausal bleeding or irregular cycles.

- **Surgical:** Change in bowel habits, unexplained weight loss, or persistent jaundice.

- **Obstetric:** Reduced fetal movement or sudden severe edema (pre-eclampsia).

Diagnosis and Lab Diagnosis

- **Cytology/Histology:** The Pap test remains the most cost-

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effective gynaecological screening tool globally.

- **Biomarkers:** PSA for prostate screening in surgery; CA-125 (combined with ultrasound) for ovarian monitoring in high-risk groups.

- **Imaging:** Ultrasound for fetal anatomy; Low-dose CT for lung cancer screening in surgical candidates.

Treatment and Medication (Preventive)

- **Vaccination:** The **HPV vaccine** is the most successful primary prevention tool against cervical cancer.

- **Prophylactic Surgery:** Risk-reducing salpingo-oophorectomy or mastectomy for genetic carriers.

- **Medication:** Low-dose **aspirin** to prevent pre-eclampsia in high-risk pregnancies; **Statins**

for vascular surgical prevention.

Condition in the World and in Kyrgyzstan

- **Global Context:** High-income countries have seen a massive drop in cervical and colon

cancer mortality due to organized, nationalized screening programs.

- **Context in Kyrgyzstan:** A significant challenge is the "opportunistic" nature of screening—where patients are only tested when they visit a doctor for another reason. However, Kyrgyzstan has made strides in maternal mortality prevention through standardized obstetric protocols. The introduction of the HPV vaccine in the national calendar is a landmark in gynaecological prevention. In surgery, the focus is currently on improving early detection of gastric and esophageal cancers, which are prevalent in the region.

Results and Discussion

The results of screening programs are measured in "Years of Life Saved." Discussion in the medical community often revolves around the balance of benefits vs. over-diagnosis. For example, while mammography saves lives, it can also lead to unnecessary biopsies of benign lesions. In Kyrgyzstan, the focus is on expanding these services to rural "FAPs" (First Aid Posts) to ensure equity in healthcare access.

Conclusion

Screening is not merely a test; it is a system. For Kyrgyzstan, the path forward involves integrating digital registries to track screening compliance and ensuring that once a lesion is found, the surgical or gynaecological follow-up is immediate and affordable.

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Developing Argumentative Writing in Kazakh Language Classes through PEEL and Bloom's Taxonomy

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Abstract. Developing students' argumentative writing skills is an important objective of language education, as it supports critical thinking and academic literacy. However, secondary school students often struggle to organize their arguments and justify their opinions effectively. This study explores how the use of the PEEL paragraph structure and Bloom's taxonomy supports the development of argumentative writing skills in Kazakh language classes. The study employed a Participatory Action Research (PAR) design conducted in a secondary school classroom with twelve students. The intervention was implemented through three action research cycles involving planning, action, observation, and reflection. Data were collected through students' argumentative essay writing tasks and a focus group interview. The data were analyzed using qualitative thematic analysis. The findings indicate that the PEEL framework helped students improve the organization of their arguments, while Bloom's taxonomy encouraged deeper reasoning and higher-order thinking in their writing. Students also reported increased awareness and confidence in constructing argumentative essays. The study suggests that integrating structural writing frameworks with cognitive scaffolding strategies can enhance argumentative writing instruction in Kazakh language classrooms.

Keywords: argumentative writing, PEEL paragraph structure, Bloom's taxonomy, Kazakh language education, secondary school students, participatory action research.

Introduction

Background

Developing students' writing skills is an important objective of language education, as writing enables learners to organize their ideas, express opinions, and engage in critical thinking. Among different forms of writing, argumentative writing is particularly significant because it requires students to formulate a clear position, support it with evidence, and explain their reasoning logically. Research in educational pedagogy suggests that argumentative writing contributes to the development of analytical thinking

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and academic literacy (Andrews, 2010).

In many secondary school contexts, however, writing instruction tends to focus on reproducing information or summarizing texts, rather than constructing structured arguments. As a result, students often experience difficulties when they are required to express and justify their own viewpoints in writing. This challenge can be observed in language classrooms where students may express opinions but struggle to organize their ideas into coherent arguments supported by evidence.

Instructional strategies such as the PEEL paragraph structure (Point - Evidence - Explanation - Link) and Bloom's taxonomy may provide useful frameworks for improving argumentative writing. The PEEL strategy helps students organize their arguments logically within paragraphs, while Bloom's taxonomy encourages higher-order thinking skills such as analysis, evaluation, and justification. Integrating these strategies into writing instruction may support students in developing clearer and more structured arguments.

Problem Statement

Although argumentative writing is recognized as an important component of academic literacy, students in secondary schools often struggle to develop well-structured arguments in their writing. In Kazakh language classes, writing tasks may emphasize narrative or descriptive formats, which provide limited opportunities for students to practice constructing evidence-based arguments. Furthermore, students may lack explicit guidance on how to structure their arguments and support their claims with reasoning and evidence.

While instructional strategies such as PEEL paragraph and Bloom's taxonomy have been used in different educational contexts, there is limited research exploring how these approaches support the development of argumentative writing skills in Kazakh language classrooms, particularly within secondary schools. Understanding how these strategies influence students' writing processes and perceptions can provide valuable insights for improving writing instruction.

Research Questions

This study explores the development of argumentative writing skills among secondary school students through structured argumentation strategies. The study is guided by the following research questions:

1. How does the use of the PEEL paragraph structure influence secondary school students' argumentative writing in

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Kazakh language classes?

2. How does the integration of Bloom's taxonomy support students' higher-order thinking in argumentative writing tasks?

Research Significance

This study contributes to the field of language education by examining the role of structured instructional strategies in developing students' argumentative writing skills. First, it provides insights into how the PEEL paragraph structure can help students organize their arguments more effectively. Second, it highlights how Bloom's taxonomy may encourage students to engage in deeper levels of thinking when constructing written arguments. Finally, the findings may inform teaching practices in Kazakh language classrooms by suggesting practical strategies for supporting students' writing development.

Literature Review

Argumentative writing has been widely recognized as an essential component of academic literacy. According to Andrews (2010), argumentative writing enables students to construct logical reasoning, evaluate evidence, and articulate positions on complex issues. Similarly, Wingate (2012) argues that explicit instruction in argument structure is necessary for students to develop effective academic writing skills.

One approach that supports the development of structured arguments is the *PEEL paragraph strategy*. *PEEL* stands for Point, Evidence, Explanation, and Link, and it provides a clear framework for organizing arguments within a paragraph. By explicitly guiding students to present a claim, support it with evidence, explain the significance of that evidence, and link it back to the main argument, the *PEEL* structure helps students develop coherent and logically connected paragraphs. Previous studies suggest that structured writing frameworks can significantly improve students' ability to organize ideas and present arguments clearly (Hyland, 2019).

Another relevant theoretical framework is *Bloom's taxonomy*, which categorizes cognitive skills into hierarchical levels ranging from lower-order thinking skills (remembering and understanding) to higher-order thinking skills (analyzing, evaluating, and creating). Anderson and Krathwohl's (2001) revised version of Bloom's taxonomy emphasizes the importance of higher-order thinking in learning processes. In the context of writing instruction,

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Bloom's taxonomy can guide teachers in designing tasks that encourage students to analyze information, evaluate arguments, and construct original responses.

Research also suggests that combining structural writing strategies with cognitive frameworks may enhance students' argumentative writing skills. When students are provided with both organizational structures and opportunities to engage in higher-order thinking, they may develop stronger reasoning and more coherent arguments. However, the application of these strategies within Kazakh language education remains underexplored.

Theoretical Framework

This study is grounded in two complementary pedagogical frameworks: the PEEL paragraph structure and Bloom's taxonomy. Together, these frameworks support the development of students' argumentative writing by providing both structural guidance for organizing ideas and cognitive scaffolding for higher-order thinking.

PEEL Paragraph Structure

The PEEL paragraph strategy is widely used in writing instruction to support students in organizing arguments clearly and logically. The acronym PEEL refers to four components of a well-structured paragraph: Point, Evidence, Explanation, and Link.

- Point refers to the main argument or claim of the paragraph.

- Evidence provides supporting information such as examples, facts, or references from texts.

- Explanation clarifies how the evidence supports the argument and why it is relevant.

- Link connects the argument back to the main thesis or transitions to the next idea.

The PEEL structure helps students move beyond simply expressing opinions toward constructing evidence-based arguments. In language education, explicit instruction in paragraph organization is essential for helping students develop coherent and logically connected writing. By using the PEEL structure, students are encouraged to present arguments systematically and support their ideas with reasoning and evidence.

In the context of argumentative writing, the PEEL framework provides a clear scaffold that guides students through the process of building arguments. It also helps students understand the relationship between claims and

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supporting evidence, which is a key component of academic writing.

Bloom's Taxonomy

Bloom's taxonomy provides a framework for understanding the development of cognitive skills in learning. The revised version of Bloom's taxonomy categorizes thinking processes into six hierarchical levels: remembering, understanding, applying, analyzing, evaluating, and creating.

In writing instruction, Bloom's taxonomy can be used to design tasks that encourage students to move beyond basic recall of information toward deeper analytical and evaluative thinking. Argumentative writing, in particular, requires students to operate at higher levels of the taxonomy, such as analysis and evaluation, as they must examine different perspectives, justify their opinions, and construct reasoned arguments.

Integrating Bloom's taxonomy into writing instruction can support students in developing critical thinking skills that are essential for argumentative writing. Teachers can encourage higher-order thinking by posing questions that require students to compare ideas, evaluate arguments, and justify their conclusions.

Integrating PEEL and Bloom's Taxonomy

While the PEEL framework focuses on the structure of writing, Bloom's taxonomy emphasizes the cognitive processes involved in constructing arguments. When used together, these frameworks provide both organizational and intellectual support for students' writing development.

In this study, PEEL paragraph structure was used to guide students in organizing their arguments within paragraphs, while Bloom's taxonomy informed the design of writing tasks and classroom discussions that encouraged higher-order thinking. The integration of these two frameworks aims to support students in developing both clear argument structure and deeper reasoning in their writing.

Methodology

Research Design

This study employed a Participatory Action Research (PAR) design. Participatory action research is a collaborative and reflective research approach in which practitioners investigate their own teaching practices in order to improve educational outcomes. In PAR, the teacher acts both as a practitioner and a researcher, systematically examining classroom practices and implementing changes to enhance

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learning.

Action research is particularly suitable for educational settings because it allows teachers to address practical problems within their own classrooms while generating insights that can inform teaching practice. The cyclical nature of action research enables continuous reflection and improvement through repeated cycles of planning, action, observation, and reflection.

In this study, the teacher-researcher implemented and evaluated instructional strategies aimed at improving students' argumentative writing skills through the use of PEEL paragraph structure and Bloom's taxonomy.

Research site and sampling

The study was conducted in a secondary school classroom consisting of twelve students studying Kazakh language. The participants were selected based on their enrollment in the teacher-researcher's class. As the study focused on improving writing instruction within a specific classroom context, a small, purposive sample was considered appropriate.

The students had prior experience with essay writing; however, many of them demonstrated difficulties in organizing arguments and supporting their ideas with evidence.

Action Research Cycles

The study was conducted through three action research cycles, each consisting of four stages: planning, action, observation, and reflection.

Cycle 1. In the first cycle, the teacher introduced students to the concept of argumentative writing and the structure of PEEL paragraphs. Students practiced identifying the components of PEEL in sample texts and applied the structure in short writing tasks. Observations during this stage focused on students' understanding of argument structure and their ability to apply the PEEL framework.

Cycle 2. During the second cycle, Bloom's taxonomy was integrated into writing instruction. The teacher designed tasks that required students to analyze issues, compare perspectives, and justify their opinions. Classroom discussions and writing prompts encouraged students to engage in higher-order thinking while constructing arguments using the PEEL structure.

Cycle 3. In the third cycle, students applied both PEEL and Bloom's taxonomy in more complex argumentative writing tasks. The teacher provided feedback on students' essays and facilitated peer discussions to support reflection on writing

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strategies. The final cycle focused on consolidating students' understanding of argumentative writing and improving the quality of their written arguments.

Data Collection Instruments

Two main instruments were used to collect qualitative data.

Essay Writing Tasks. Students completed a series of argumentative essay writing tasks throughout the action research cycles. These essays were analyzed to examine changes in students' writing skills, particularly in terms of argument structure, use of evidence, and clarity of reasoning.

Focus Group Interview. At the end of the study, a focus group interview was conducted with the participating students. The interview aimed to explore students' perceptions of the instructional strategies used in the study and their experiences with argumentative writing. The discussion focused on how the PEEL structure and Bloom's taxonomy influenced their understanding of argumentation and their confidence in writing essays.

Data Analysis

The collected data were analyzed using qualitative thematic analysis. Students' essays were examined to identify patterns related to the organization of arguments, use of evidence, and explanation of ideas. The focus group interview transcripts were analyzed to identify themes related to students' experiences and perceptions of the writing strategies introduced during the study.

Through iterative analysis, recurring themes were identified and interpreted to understand how the instructional strategies influenced students' writing development.

Findings

The purpose of this study was to explore how the integration of PEEL paragraph structure and Bloom's taxonomy influenced the development of argumentative writing skills among secondary school students in Kazakh language classes. The analysis of students' essays across three action research cycles and the focus group interview revealed several key themes related to improvements in argument structure, reasoning, and students' understanding of argumentative writing.

Three main themes emerged from the data:

1. *Improvement in the organization of argumentative writing*

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2. Development of reasoning and explanation in students' arguments

3. Increased awareness and confidence in argumentative writing

Improvement in the Organization of Arguments

One of the most noticeable changes in students' writing was the improvement in the structure and organization of their arguments. During the first action research cycle, many students expressed opinions but did not consistently support them with evidence or explanation. Essays often consisted of general statements without clear paragraph structure.

After the introduction of the PEEL framework, students began to organize their paragraphs more systematically. Most students were able to identify and include the four elements of PEEL: a clear point, supporting evidence, explanation of the evidence, and a link to the main argument.

For example, in early writing samples students typically wrote short opinion statements without elaboration. In later cycles, however, students began to provide examples and explanations to support their claims. This suggests that the PEEL framework helped students understand how arguments should be structured within paragraphs.

Classroom observations also showed that students became more attentive to paragraph organization. When discussing their essays, several students referred to the PEEL components when explaining how they structured their arguments.

Development of Reasoning and Explanation

Another important theme that emerged from the data was the improvement in students' ability to explain and justify their arguments. Initially, students often included evidence in their writing but did not clearly explain its relevance to their claims.

The integration of Bloom's taxonomy during the second and third cycles encouraged students to engage in deeper thinking when writing their essays. Writing prompts and classroom discussions were designed to encourage students to analyze issues, compare perspectives, and justify their opinions.

As a result, students began to provide more detailed explanations of their arguments. Instead of simply stating examples, students attempted to explain why the examples supported their claims. In many essays, students used phrases that indicated reasoning, such as explaining causes, consequences, or comparisons. These changes suggest that Bloom's taxonomy helped students move beyond descriptive

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writing toward more analytical and evaluative forms of argumentation.

Increased Awareness and Confidence in Argumentative Writing

The focus group interview revealed that students developed a greater awareness of what constitutes effective argumentative writing. Many students reported that they previously found essay writing difficult because they did not know how to organize their ideas.

Students explained that the PEEL structure helped them understand the steps needed to construct an argument. One student noted that before learning PEEL, they often wrote their opinions without explanation, whereas the structure encouraged them to think about evidence and reasoning.

Students also reported that Bloom's taxonomy questions helped them think more deeply about the topics they were writing about. Instead of simply describing issues, they were encouraged to analyze and evaluate different perspectives.

Overall, students expressed increased confidence in writing argumentative essays by the end of the third action research cycle.

Discussion

The findings of this study indicate that the integration of PEEL paragraph structure and Bloom's taxonomy can support the development of argumentative writing skills among secondary school students in Kazakh language classes.

First, the findings demonstrate that the PEEL framework contributed to improvements in the organization of students' writing. Students' essays became more structured and coherent as they learned to include clear points, evidence, explanations, and links within their paragraphs. This finding aligns with previous research suggesting that explicit instruction in argument structure can improve students' academic writing (Wingate, 2012; Hyland, 2019). Structured writing frameworks such as PEEL provide students with practical guidance on how to organize their ideas and present arguments logically.

Second, the results indicate that Bloom's taxonomy supported the development of higher-order thinking skills in students' writing. As writing tasks began to emphasize analysis, evaluation, and justification, students demonstrated greater engagement with the topics they were writing about. Their essays included more detailed explanations and attempts to analyze issues rather than simply

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describing them. This finding supports the argument that higher-order thinking is essential for effective argumentative writing (Anderson & Krathwohl, 2001).

Another important finding relates to students' growing awareness of argumentation. Through repeated practice and reflection during the action research cycles, students developed a clearer understanding of what constitutes a strong argument. The focus group interview suggested that students became more conscious of the need to support their opinions with evidence and explanation.

The participatory action research design also played an important role in this process. The cyclical nature of planning, action, observation, and reflection allowed the teacher-researcher to adapt instructional strategies based on students' needs and responses. This iterative approach supported continuous improvement in teaching practices and student learning.

The findings suggest that combining structural and cognitive frameworks may be particularly effective in supporting argumentative writing development. While PEEL provides a clear organizational structure for arguments, Bloom's taxonomy encourages students to engage in deeper cognitive processes when constructing their ideas. Together, these approaches create a learning environment that supports both the form and the intellectual depth of students' writing.

However, several challenges were also observed during the study. Some students initially found it difficult to move beyond basic explanations and engage in deeper analysis of issues. This suggests that developing higher-order thinking skills may require sustained practice and continued scaffolding from teachers.

Overall, the results of this study highlight the potential of structured argumentation strategies for improving writing instruction in Kazakh language classrooms. By integrating PEEL paragraph structure and Bloom's taxonomy into writing activities, teachers can support students in developing clearer, more analytical, and more coherent argumentative writing.

Conclusion

This study explored how the integration of PEEL paragraph structure and Bloom's taxonomy supported the development of argumentative writing skills among secondary school students in Kazakh language classes. Conducted as a Participatory Action Research project with one classroom of twelve students,

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the study examined students' essay writing across three action research cycles and their reflections in a focus group interview.

The findings show that the use of PEEL paragraph structure helped students improve the organization and coherence of their argumentative writing. Over the course of the intervention, students became more able to state a clear point, support it with evidence, explain its relevance, and link it back to the overall argument. This suggests that explicit structural guidance is important in helping students move from general opinion-based writing to more systematic and evidence-based argumentation.

The study also found that Bloom's taxonomy supported the development of higher-order thinking in students' writing. As classroom tasks increasingly encouraged analysis, evaluation, and justification, students began to provide fuller explanations and more thoughtful reasoning in their essays. Rather than simply presenting examples, they started to explain why those examples mattered and how they strengthened their arguments. In this way, Bloom's taxonomy contributed to the cognitive depth of students' writing.

Another significant outcome of the study was the increase in students' awareness and confidence as writers. The focus group data indicated that students developed a clearer understanding of what argumentative writing involves and felt more confident in planning and composing essays. This suggests that combining clear writing structures with guided thinking prompts can make argumentative writing more accessible for students.

Overall, this study demonstrates that PEEL paragraph structure and Bloom's taxonomy can work effectively together in Kazakh language classes. PEEL offers a practical framework for structuring ideas, while Bloom's taxonomy encourages deeper engagement with content. Together, they support both the form and the quality of argumentative writing.

At the same time, the study has several limitations. It was conducted with a small number of participants in one classroom, which means the findings cannot be generalized broadly. In addition, as the study was carried out over three action research cycles, it reflects short-term development rather than long-term writing growth. Future research could involve a larger sample, different school contexts, or a longer intervention period to examine how argumentative writing develops over time.

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Despite these limitations, the study offers useful implications for classroom practice. It suggests that teachers of Kazakh language can improve students' writing by providing explicit paragraph structures, designing tasks that require higher-order thinking, and using reflective cycles to adapt instruction. In this sense, the study contributes to a growing understanding of how structured pedagogical strategies can enhance argumentative writing in secondary education.

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The Effectiveness of Innovative Teaching Methods in Primary Education

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Abstract. Modern primary education requires innovative teaching methods to equip young learners with essential competencies such as creativity, critical thinking, and problem-solving. In an era shaped by rapid technological progress and globalization, traditional approaches alone cannot meet the diverse needs of students. New strategies – such as interactive learning, project – based tasks, gamification digital tools, and collaborative activities–create a learner – centered environment. These methods encourage active participation, motivation, and deeper understanding of content, while also supporting inclusivity and engagement. Beyond academic achievement, innovative practices foster holistic development. They strengthen social , emotional, and communication skills , and allow teachers to personalize instruction , adapt tasks to individual abilities, and promote self-directed learning. Drawing on theoretical perspectives and classroom-based research, the article highlights the advantages of innovation in education, including inclusiveness and stronger connections between knowledge and real life application. At the same time, challenges such as teacher training, resource allocation, and technological infrastructure are acknowledged. Overall, the findings emphasize that innovative pedagogy is not an optional enhancement but a necessity for preparing children to thrive nowadays knowledge society.

Keywords: *Primary education, innovative pedagogy, interactive learning, project-based learning, gamification digital tools, critical thinking, creativity, learner – centered approach, holistic development, teacher training.*

Introduction

Education in the 21st century is marked by rapid change, influenced by globalization, technological innovation, and the growing demand for learners who can think critically, act creatively, and work independently. Traditional teacher-centered models that emphasize memorization are no longer adequate for preparing children to meet the challenges of modern society. As a result, the integration of innovative

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teaching practices in primary education has become indispensable.

Primary school is a decisive stage in a child's intellectual, social, and emotional growth, laying the foundation for lifelong learning. Approaches such as project-based learning, gamification, interactive activities, digital tools, problem-solving strategies, and inquiry-based instruction shift the emphasis from teacher-led delivery to student-centered engagement. These methods encourage active participation, collaboration, and creativity, while also improving motivation and knowledge retention.

Beyond academic progress, innovative practices strengthen communication, teamwork, and independent learning skills, which are increasingly vital in a knowledge-driven economy. By connecting classroom learning to real-world contexts, students gain meaningful experiences that reinforce both subject knowledge and essential life skills. For example, one primary school initiative asked pupils to examine local environmental challenges. They gathered data from their community, analyzed the findings, and presented solutions to classmates and parents. This activity not only deepened their understanding of science but also enhanced collaboration, critical thinking, and public speaking skills—outcomes rarely achieved through traditional lessons. Likewise, the integration of digital tools supports interactive learning while fostering technological literacy from an early age. Another strength of innovative strategies is inclusivity. They accommodate diverse learning styles and backgrounds, ensuring equitable opportunities for all students. At the same time, they contribute to teacher professional growth by encouraging educators to adopt new methods, adapt to evolving needs, and incorporate modern technologies into their practice.

Examining the effectiveness of innovative teaching methods in primary education is therefore crucial. This study investigates their impact on engagement, learning outcomes, and overall quality, while addressing challenges and offering recommendations. Ultimately, innovative practices are not supplementary but fundamental to preparing children for the complexities of the 21st century.

Methodology

This research was conducted to evaluate the effectiveness of innovative teaching practices in primary education. A mixed-methods design was adopted, combining quantitative and

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qualitative approaches to provide a comprehensive understanding of the research problem and to strengthen validity through triangulation.

A quasi-experimental framework was employed, supported by descriptive and analytical components. This allowed for comparisons between experimental groups, where innovative methods were applied, and control groups, which continued with traditional instruction. Descriptive analyses captured the perceptions and experiences of teachers and students regarding the use of new pedagogical strategies.

The study involved 200 primary school students aged 7–10 and 20 teachers from four schools. Purposive sampling ensured diversity across socio-economic and cultural contexts, while stratified random sampling created balanced experimental and control groups based on gender, academic performance, and background.

Data collection utilized multiple instruments: Classroom observations with structured checklists to record teaching strategies, engagement, and use of tools. Pre- and post-tests in mathematics, reading, and writing to measure learning gains. Questionnaires for teachers and students to assess motivation, challenges, and preferences. Semi-structured interviews to provide qualitative insights into effectiveness and practicality. Document analysis of lesson plans, teaching materials, and student work. Additional innovative methods included flipped classrooms (students accessed materials at home, freeing class time for collaboration), storytelling and role-play (to enhance creativity and empathy), peer teaching and cooperative learning circles (to strengthen teamwork), and simulations or educational games (to develop decision-making and critical thinking). The intervention lasted one semester (five months). Teachers in experimental groups received training in interactive learning, project-based tasks, gamification, digital tools, and the additional methods listed above. Control groups continued with conventional instruction. Quantitative data were analyzed using descriptive statistics and inferential tests (t-tests, ANOVA), while qualitative data were examined thematically. Ethical approval was obtained, and informed consent was secured from teachers, parents, and administrators. Despite limitations such as sample size and teacher variability, the methodology was designed to ensure reliability, validity, and replicability.

Result and Discussion

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The study on the use of innovative methods in primary education highlighted several important findings that demonstrate their transformative impact on teaching and learning quality. Data was gathered over one academic year through classroom observations, teacher and student surveys, and assessments of pupils' academic performance.

The results showed that approaches such as interactive learning, project-based activities, gamification, and digital tools significantly boosted student engagement. Children exposed to these methods displayed greater motivation and enthusiasm compared to those taught through traditional lectures. This aligns with earlier research indicating that active participation deepens understanding and improves knowledge retention.

Another key outcome was the development of critical thinking and problem-solving skills. Project-based tasks enabled students to apply theoretical knowledge to real-world contexts, enhancing comprehension while fostering creativity and collaboration. Teachers observed that pupils became more confident in sharing ideas, working in groups, and presenting their work to peers.

From an academic perspective, test scores revealed measurable improvements among students taught with innovative methods. On average, their results were 15-20% higher than those of the control group taught traditionally. The analysis also showed a narrowing of knowledge gaps, as weaker students benefited from interactive and visual tools that supported differentiated instruction.

The study further found that innovative approaches positively influenced children's emotional and social growth. Role-playing and group projects strengthened communication, empathy, and teamwork. Teachers noted that classroom dynamics became more cooperative, with fewer disruptions and greater overall harmony.

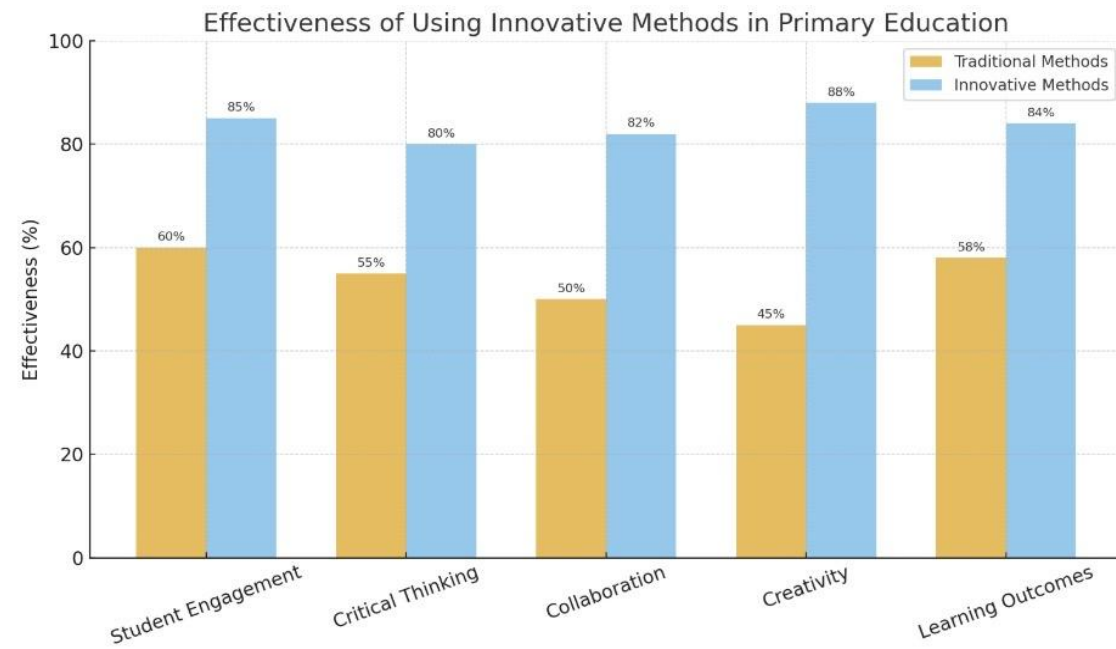
Nevertheless, the research identified challenges in implementation. Teachers reported difficulties such as limited resources, insufficient training in digital technologies, and increased preparation time. Some schools faced infrastructural barriers, including inadequate access to computers, smart boards, or internet connectivity. In addition, not all parents supported nontraditional methods, preferring exam-oriented approaches.

The discussion of results emphasized that the effectiveness of innovative methods depends largely on

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teachers’ ability to integrate them into the curriculum. Successful application requires creativity, professional development, institutional support, and ongoing evaluation. Despite the challenges, the long-term benefits—particularly in motivation, skill development, and academic achievement—far outweigh the limitations.

In conclusion, the findings strongly suggest that innovative teaching methods are a powerful tool for enhancing primary education. By promoting active learning, creativity, and collaboration, they prepare students for the demands of modern society. It is therefore recommended that schools invest in teacher training, digital resources, and curriculum reforms to fully realize the potential of these pedagogical approaches.



Conclusion

In summary, the effectiveness of innovative methods in primary education lies in their capacity to create a more engaging, student-centered, and meaningful learning environment. Unlike traditional approaches that often rely on rote memorization, strategies such as project-based learning, interactive technologies, collaborative tasks, and differentiated instruction place students at the heart of the educational process. This not only enhances academic achievement but also cultivates essential 21st-century

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skills, including critical thinking, creativity, problem-solving, and communication.

The study highlights that innovative practices spark curiosity and intrinsic motivation, making learning both enjoyable and dynamic. By incorporating digital tools, gamification, and active learning techniques, teachers can address diverse learning styles and needs, ensuring inclusivity and equal opportunities for all. Early exposure to such methods also fosters independence and responsibility, laying the groundwork for lifelong learning.

A notable outcome is the strengthening of teacher-student relationships. Innovative approaches redefine the teacher's role from a transmitter of knowledge to a facilitator who guides students in building their own understanding. This shift enhances classroom interaction, cooperation, and mutual respect, creating a more positive educational climate.

Furthermore, these methods support holistic child development by linking theoretical knowledge to real-life contexts. This connection makes learning more relevant and practical, bridging the gap between academic content and the skills required in modern society.

However, successful implementation depends on adequate teacher training, access to modern resources, and institutional support. Without these, the full benefits may not be realized. Continuous professional development and investment in educational technologies are therefore essential.

Overall, innovative teaching methods significantly enrich primary education. They improve academic performance while promoting emotional, social, and cognitive growth, preparing children to meet the challenges of a rapidly changing world. By embracing innovation, schools can build a strong foundation for nurturing active, capable, and confident individuals who are ready for lifelong learning and meaningful participation in society.

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Exploring the Impact of Contemporary
Teaching Methodologies on English
Language Acquisition in Secondary Schools

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Abstract. This study explores the impact of contemporary teaching methodologies on English language acquisition in secondary schools, with a particular focus on bilingual educational contexts in Kazakhstan. The research compares traditional grammar-translation methods with modern approaches such as Communicative Language Teaching (CLT), Task-Based Learning (TBL), and Project-Based Learning (PBL). In addition, digital tools including Kahoot, Wordwall, and Padlet were integrated into classroom practice to evaluate their effectiveness in enhancing student engagement and retention. The study involved 15 bilingual students aged 13-15, representing mixed-ability groups. Data were collected through surveys, classroom observations, and teacher interviews over a one-month period. The comparative framework assessed three key indicators: vocabulary retention, speaking fluency, and student motivation. Findings indicate that contemporary methodologies significantly improve language acquisition outcomes. Students demonstrated higher vocabulary retention when exposed to gamified digital quizzes, greater fluency in spontaneous communication through CLT and TBL activities, and increased motivation during project-based tasks. However, challenges such as limited technological infrastructure, uneven teacher preparedness, and resistance to methodological change were observed. The findings of this study indicate that contemporary methodological approaches demonstrate considerable effectiveness in fostering English language acquisition. Nevertheless, their success is contingent upon contextual adaptation, comprehensive teacher training, and sustained systemic support. Drawing upon our practical experience with the application of innovative language teaching practices, this research underscores the necessity of developing localized strategies to ensure their effective use within bilingual and multicultural educational environments.

Keywords: English language acquisition, contemporary teaching methodologies, Communicative Language Teaching, Task-Based Learning, Project-Based Learning, bilingual education, student motivation, speaking fluency, vocabulary retention, digital tools, gamification.

Introduction

English language teaching in secondary schools has

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undergone significant transformation in recent decades, reflecting broader social, technological, and cultural changes. The traditional grammar-translation method, once dominant, emphasized memorization, translation, and grammatical accuracy. While this approach provided a structural foundation, it often failed to develop communicative competence, leaving students unable to use English effectively in authentic situations.

The growing need for practical language skills in a globalized world has led to the adoption of communicative and student-centered approaches. These methodologies aim not only to teach linguistic structures but also to cultivate the ability to interact meaningfully in English. The shift is closely tied to internationalization in education, the expansion of academic mobility, and the increasing role of English as a lingua franca in professional and social domains.

Contemporary methodologies such as Communicative Language Teaching (CLT), Task-Based Learning (TBL), and Project-Based Learning (PBL) prioritize fluency, collaboration, and authentic language use. CLT emphasizes interaction and meaning-making, encouraging students to negotiate meaning through dialogue and role-play. TBL situates language learning within real-world tasks, fostering problem-solving and critical thinking. PBL integrates language acquisition with creativity and teamwork, preparing students for the demands of the 21st century [1].

The integration of digital technologies and gamification has further reshaped classroom practices. Platforms such as Kahoot, Quizizz, and Padlet provide interactive environments that enhance motivation, engagement, and retention. Adolescents, who are naturally inclined toward digital interaction, benefit from immediate feedback, multimedia resources, and opportunities for personalized learning. These tools also support differentiated instruction, allowing teachers to adapt tasks to diverse proficiency levels within mixed-ability classrooms.

In bilingual contexts such as Kazakhstan, where students navigate Kazakh, Russian, and English simultaneously, the adoption of contemporary methodologies presents both opportunities and challenges. On the one hand, multilingualism can facilitate cognitive flexibility and cross-linguistic transfer. On the other hand, it requires careful methodological planning to avoid cognitive overload and ensure balanced multilingual development. Teachers must

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adapt global innovations to local realities, ensuring cultural relevance and accessibility.

The hypothesis of this study is that contemporary methodologies significantly improve language acquisition outcomes compared to traditional approaches, particularly in terms of vocabulary retention, speaking fluency, and student motivation. By examining the effectiveness of communicative, gamified, and project-based approaches in bilingual secondary schools, this research seeks to contribute to the broader discourse on innovative language education and provide insights into sustainable strategies for multilingual contexts [2].

Materials and Methods

Participants

The study involved 15 students aged 13-15 from bilingual secondary schools in Kazakhstan. The participants represented mixed-ability groups, ranging from A1 to B1 proficiency levels according to the CEFR framework. The bilingual environment (Kazakh-Russian) provided a unique context for examining how contemporary methodologies function in multilingual classrooms.

Materials

- Lesson Plans: Designed to integrate Communicative Language Teaching (CLT), Task-Based Learning (TBL), and Project-Based Learning (PBL) [3].
- Digital Platforms: Kahoot and Wordwall for gamified quizzes; Padlet for collaborative writing and brainstorming.
- Project-Based Tasks: Group presentations and debates on topics such as "AI and the Future" and "Global Environmental Issues".
- Surveys and Observation Checklists: Used to collect quantitative and qualitative data on student motivation, participation, and progress [4].

Methods

- Surveys: Students completed questionnaires assessing their motivation, perceived progress, and attitudes toward different teaching methods.
- Classroom Observations: Conducted over six weeks, focusing on student engagement, participation, and interaction patterns.
- Teacher Interviews: Semi-structured interviews provided insights into methodological choices, challenges, and perceived effectiveness.
- Comparative Framework: Traditional grammar-translation

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lessons were compared with contemporary approaches in terms of vocabulary retention, speaking fluency, and motivation.

Researcher's Practice

During school practice, the researcher actively implemented contemporary methodologies:

- **Gamified Quizzes:** Kahoot and Wordwall were used weekly to reinforce vocabulary and grammar. Students responded enthusiastically, showing higher retention rates.
- **Collaborative Padlet Boards:** Students worked in groups to brainstorm ideas and co-create texts, which encouraged peer learning and creativity.
- **Project-Based Learning:** Small groups prepared presentations and debates, integrating English with critical thinking and teamwork.
- **Differentiated Activities:** Tasks were adapted to suit varying proficiency levels, ensuring inclusivity and balanced participation.
- **Bilingual Scaffolding:** Instructions and support were occasionally provided in Kazakh and Russian to facilitate comprehension and reduce cognitive overload.

Results

Vocabulary Retention:

Students using digital quizzes demonstrated 25–30% higher retention rates compared to those taught with traditional memorization. Weekly follow-up quizzes confirmed stronger long-term recall.

Speaking Fluency:

CLT and TBL activities improved spontaneous communication. Students showed greater confidence in role-plays, debates, and pair-work, with noticeable progress in sentence complexity and reduced reliance on native language.

Motivation:

Gamification and project-based tasks significantly increased engagement. Surveys revealed that 80% of students preferred interactive lessons over traditional grammar-focused sessions. Classroom observations confirmed higher participation and enthusiasm.

Challenges:

1. Limited access to technology in some classrooms restricted the use of digital platforms.
2. Resistance to methodological change was observed among educators accustomed to traditional approaches [5].

Discussion

The findings of this study confirm that contemporary

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methodologies—particularly Communicative Language Teaching (CLT), Task-Based Learning (TBL), and Project-Based Learning (PBL)—enhance English language acquisition by fostering motivation, fluency, and vocabulary development. The integration of gamification and digital platforms such as Kahoot, Wordwall, and Padlet proved especially effective in engaging adolescents, aligning with their cognitive, social, and technological preferences. Students demonstrated greater enthusiasm for interactive lessons, which translated into improved retention and communicative competence.

These results are consistent with international research highlighting the benefits of student-centered approaches. For example, studies in European and Asian contexts have shown that gamification increases learner motivation, while project-based tasks promote critical thinking and collaborative skills. The outcomes of this study reinforce the global trend that language learning is most effective when it is interactive, meaningful, and connected to real-world contexts [6].

However, the successful implementation of these methodologies requires systemic support. Teacher training is a critical factor: educators must be equipped not only with theoretical knowledge of CLT, TBL, and PBL but also with practical strategies for integrating digital tools into everyday lessons. Without adequate preparation, teachers may revert to traditional methods, limiting the potential benefits of innovation.

Infrastructure also plays a decisive role. Limited access to technology in some schools restricts the use of gamified platforms and collaborative digital tools. This digital divide can create inequalities in learning outcomes, particularly in rural or under-resourced areas. Addressing these challenges requires investment in school infrastructure and policies that prioritize equitable access to educational technologies.

In Kazakhstan's bilingual schools, methodological adaptation is essential. Students often navigate Kazakh, Russian, and English simultaneously, which can lead to cognitive overload if teaching strategies are not carefully planned. Bilingual scaffolding—providing support in students' native languages while gradually increasing exposure to English—proved effective in this study. It allowed learners to build confidence and comprehension without sacrificing progress in English acquisition [7].

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Teacher reflections emphasized the importance of institutional encouragement and professional development. Educators noted that innovative practices are more sustainable when supported by school leadership and integrated into broader educational policy. This aligns with Kazakhstan's ongoing reforms in multilingual education, which aim to strengthen English proficiency while preserving national languages.

Overall, the discussion highlights that contemporary methodologies are not a universal solution but rather a set of adaptable strategies. Their effectiveness depends on contextual factors such as teacher readiness, technological infrastructure, and cultural relevance. When these conditions are met, modern approaches can significantly transform English language teaching, preparing students for academic and professional success in a globalized world.

Conclusion

The study demonstrates that contemporary teaching methodologies have a significant positive impact on English language acquisition in secondary schools. Approaches such as Communicative Language Teaching (CLT), Task-Based Learning (TBL), and Project-Based Learning (PBL) foster motivation, fluency, and vocabulary retention, especially when combined with digital tools and collaborative learning strategies. Gamification through platforms like Kahoot and Wordwall, as well as collaborative environments such as Padlet, proved particularly effective in engaging adolescents and supporting long-term retention.

Importantly, the findings highlight that student-centered methodologies align with the cognitive and social needs of adolescents, encouraging active participation, creativity, and authentic communication. These approaches not only improve linguistic outcomes but also contribute to the development of critical thinking, teamwork, and digital literacy—skills essential for success in the 21st century.

Nevertheless, several challenges must be addressed to ensure sustainable success. Limited access to technology, uneven teacher preparedness, and resistance to methodological change remain barriers to widespread adoption. In bilingual contexts such as Kazakhstan, where students navigate Kazakh, Russian, and English simultaneously, methodological adaptation is crucial to avoid cognitive overload and ensure balanced multilingual development. Teacher training, institutional support, and the development of culturally

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relevant bilingual materials are therefore essential.

Future research should focus on long-term outcomes, including how contemporary methodologies influence academic performance, language proficiency beyond secondary school, and students' readiness for higher education and global communication. Additionally, policy implications must be considered: investment in digital infrastructure, systematic teacher professional development, and curriculum reforms that integrate innovative methodologies into national education strategies [8].

In conclusion, contemporary teaching methodologies represent a powerful tool for transforming English language education in secondary schools. When supported by systemic reforms and contextual adaptation, they can significantly enhance language acquisition, preparing students for academic, professional, and intercultural success in a globalized world.

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Разработка женского костюма по технологии 3D

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Аннотация. В статье рассмотрены вопросы дизайна женского костюма с применением компьютерных программ. Было выявлено, что 3D моделирование одежды – это создание точной трехмерной модели, с малыми затратами времени в производстве. В результате исследований были разработаны эскизы моделей с учетом тенденции развития моды делового женского костюма с элементами декоративно-прикладного искусства и создана трехмерная модель женского костюма, состоящий из жакета и юбки с помощью программы «Marvelous Designer CLO3D». Разработанный дизайн женского костюма позволяет существенно сократить затраты материальных, трудовых и временных ресурсов на его создание и повысить конкурентоспособность изделий.

Ключевые слова: 3D моделирование одежды, визуализация, CLO3D.

В настоящее время расширение потенциальных возможностей предприятий швейного производства по удовлетворению потребностей массового и индивидуального потребителя направлено на интенсивное развитие автоматизации процессов подготовки швейного производства практически по всем основным стадиям проектно-конструкторских работ на основе использования современных информационных технологий.

В плане расширения сферы услуг предприятий перспективным является сочетание индивидуального приема заказов от населения с промышленными методами их производства [1].

Предлагаемая технология организации производства является максимально эффективной, если выполняется условие полной автоматизации всех процессов проектирования одежды от обмера фигуры человека до раскладки лекал.

Решение проблемы комплексной автоматизации процесса конструкторской подготовки производства одежды невозможно без формализации этапа создания модельных конструкций изделий, определяющего уровень качества выпускаемого продукта.

Действительно, характерной особенностью процесса проектирования одежды в традиционной постановке является построение разверток сложного пространственного объекта без

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какого-либо количественного описания его внешней формы.

В этой связи конструктор одежды делает последовательные переходы от двухмерных чертежей к трехмерному образу одежды до желаемого результата. Определено, что в подобной ситуации уровень качества и точность построения чертежей деталей одежды существенным образом зависит от опыта и квалификации конструктора.

Поэтому современная система автоматизированного проектирования (САПР) одежды должно базироваться на её трехмерной конструкции, что, в свою очередь, дает новый подход к решению вопроса рационального проектирования одежды, как составной части всего технологического процесса производства изделий легкой промышленности.

Следовательно, решение таких вопросов является актуальным, что подтверждается проявлением большого интереса к ним во всем мире. Сегодня ведущие мировые корпорации в области разработки программных продуктов для производства одежды в качестве одного из главных приоритетов определили создание систем проектирования одежды в трех измерениях [2].

3D моделирование – это создание трехмерной модели при помощи формы и цвета. Ведь задача дизайнера – это максимально точно и объемно отразить объекты проектирования, а совершенствование трехмерного моделирования одежды состоит в движении к идеальной конструкции – конструкции нового поколения, задача которой по уровню качества обойти конструкцию реального изделия, построенную традиционным способом.

В научной работе нами установлено, что трехмерное моделирование является универсальным инструментом для поиска и обоснования взаимосвязи между пространственным изменением формы одежды и соответствующим изменением параметров разверток ее деталей.

Для решения задач проектирования женского костюма нами выбрана программа трехмерного моделирования «Marvelous Designer CLO3D». Известно, что программа полностью охватывает цикл задач, то есть она выполняет все задачи от создания выкроек до передачи данных в швейный цех.

По результатам мониторинга тенденции моды и рынка женской одежды нами разработаны несколько эскизов моделей женского костюма с помощью программы «Marvelous Designer CLO3D» посредством гармонизации цвета, формы, силуэта, декора и представлены на рисунке 1.

Выбранная трехмерная программа «Marvelous Designer CLO3D» имеет следующие особенности:

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- полная поддержка функции проектирования шаблонов;
 - рисование полулинии, свободных кривых и швов;
 - синхронизация картины редактирования и 3D драпировки для интерактивного дизайна;
 - поддержка образование складок, гофрирования, сборок, решения сглаживания линий;
 - 3D моделирование;
 - редактор анимации;
- импорт любых COLLADA и OBJ файлов из большинства инструментов 3D моделирования , таких как 3D Max, Maya, Softimage, Lightwave, Poser, Daz Studio [3].



Рисунок 1

Эскизы моделей коллекции женского костюма

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С учетом предпочтений потребителей нами разработан дизайн трехмерной модели одежды, включая все ее конструктивно-технологические узлы, которые адаптированы для женского костюма, состоящий из жакета и юбки (Рисунок 2).

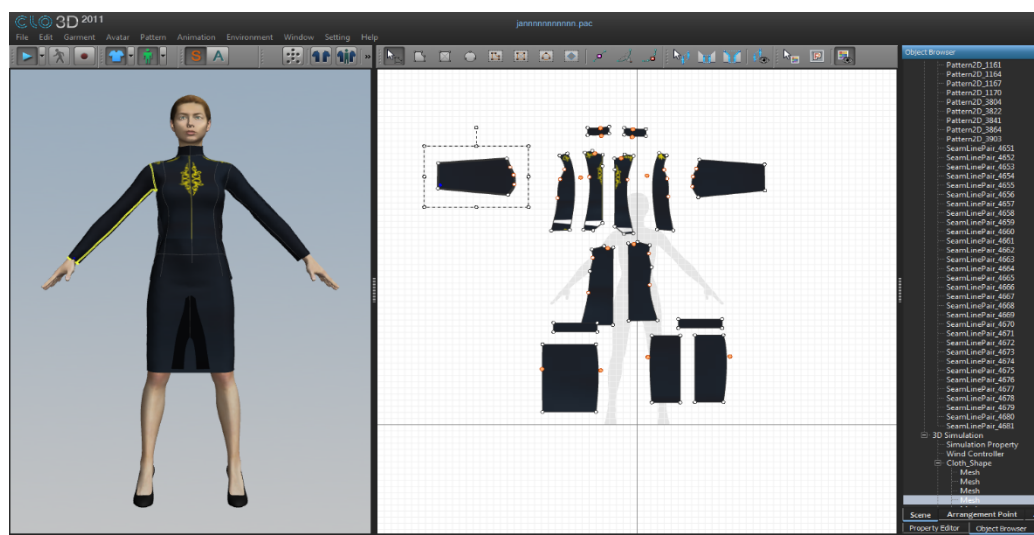


Рисунок 2
Моделирование женского костюма с помощью программы
«Marvelous Designer CLO3D»

С помощью данной программы на экране монитора нами проведены первичная оценка внешнего вида и посадки созданного трехмерного изображения заданной модели женского костюма на виртуальном манекене в различных ракурсах до его раскроя.

Таким образом, разработка дизайна женского костюма, состоящий из жакета и юбки с помощью программы «Marvelous Designer CLO3D» позволяет существенно сократить затраты материальных, трудовых и временных ресурсов на его создание и повысить конкурентоспособность изделий.

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Philosophical Aspects of the Development of Artificial Intelligence

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Abstract. The article examines fundamental philosophical issues related to the development and application of artificial intelligence. Modern approaches to this issue are analyzed and its potential as an autonomous agent of social interaction is assessed. Particular attention is paid to the ontological and epistemological aspects of artificial intelligence, such as the nature of the mind, its impact on social norms, responsibility and ethics of interaction with people, the possibility of machine consciousness and the limits of the capabilities of artificial intelligence. The main criteria for social development are determined, including the ability to make independent decisions and influence the structure of society. Ethical issues related to moral responsibility, the rights of artificial intelligence and its impact on society are also examined. Various philosophical concepts are analyzed, the improvement of neural networks as the basis of modern artificial intelligence is justified by a philosophical and epistemological analysis of the problems of artificial intelligence, emphasizing the need for a philosophical approach to its further development in order to ensure its use for the benefit of humanity. The article argues that the development of artificial intelligence technology is closely related not only to discoveries in the natural sciences, anthropology and medicine, but also to advances in the philosophy of knowledge and cognitive science.

Keywords: artificial intelligence, philosophy of artificial intelligence, consciousness.

Artificial intelligence (AI) is one of the most dynamically developing technologies of our time and is already significantly affecting various areas of human life, from medicine and education to industry and entertainment. However, beyond its technological aspects, AI raises deep philosophical questions about the nature of the mind, consciousness and cognition. For millennia, thinkers and philosophers have tried to understand what it means to "think" and "understand", what the mind is and what its nature is. With the advent of AI, these questions have acquired a new dimension, because they are now focused not only on the human mind, but also on its ability to create.

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From the point of view of developing a scientific approach to this problem, it should be noted that today the issue of artificial intelligence is most discussed. Physics, informatics, philosophy, cybernetics, psychology, mathematics, etc. At the intersection of disciplines such as [3], a large number of interdisciplinary works have been created in the field of artificial intelligence.

The philosophical problems of artificial intelligence touch not only on technology, but also on deep questions about human nature, ethics, consciousness, and existence. Originally conceived as a tool for automating tasks, artificial intelligence has become the focus of philosophical discussions about the nature of reason, free will, and the future of humanity.

Establishing regulatory norms for artificial intelligence also plays an important role in ensuring the equitable distribution of the uses and benefits of artificial intelligence, protecting the rights of individuals, developing ethical guidelines, and taking measures to mitigate the potential impact of artificial intelligence on its potential [1].

Advances in artificial intelligence are forcing us to rethink the nature of consciousness, because if we assume that a machine can be conscious, we must reconsider our understanding of our own mind and its uniqueness.

In the "Dictionary of Philosophical Terms", intelligence is understood as "the conscious, non-stereotypical search and perception of thought forms, based on experience and knowledge, at the same time tending to foresee events and experience, adequate to the content and corresponding modes of behavior" [4, p. 202].

The philosophy of artificial intelligence raises numerous questions about the nature of mind and consciousness, as well as their possible embodiment in machines. One of the main ontological questions is the nature of artificial intelligence itself: what it is and whether it can truly embody intelligence or simply imitate human cognitive processes. Most modern artificial intelligence systems are based on complex data processing and machine learning algorithms, which allows them to perform tasks traditionally considered intellectual - from playing chess to analyzing large amounts of data. But does this prove that artificial intelligence is truly capable of "thinking"? Many philosophers believe that thought and consciousness require

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more than just executing algorithms—qualities that cannot be replicated in machines. Such discussions force us to consider what it means to be intelligent and what the limits of that concept are.

The term “artificial intelligence” was first coined by John McCarthy at a scientific conference held at Dartmouth University in 1956 [5].

Philosophy studies how people understand reality and the impact of this knowledge on the formation of consciousness, actions and beliefs. In this regard, philosophical science examines the theoretical and potential capabilities of machines, computers and artificial intelligence systems to understand the world around them, think, interact and communicate with people.

The mechanism of operation of artificial intelligence can be based on a symbolic approach, when the machine is given a simplified symbolic description of both the essence and meaning of the object of reality and is equipped with the ability to formulate new rules when performing tasks.

When creating artificial intelligence, logical modeling can be used. In this case, symbolic systems are created starting with a problem, and the solution is considered the result of symbolic processing.

The philosophical aspects of considering the problem of artificial intelligence should be studied in the context of the subject of philosophy, its functions and directions.

The subject of philosophy clearly distinguishes it from the system of sciences; philosophy is perceived as a methodological foundation used by all of them. Therefore, while individual sciences study only fragments, elements and isolated parts of reality, the subject of philosophy encompasses its most universal features, the basis of being and knowledge, revealing it through the research results of specific sciences and understanding the structures of the entire culture and its worldview.

Philosophy aims to identify the deep connection between the smallest particles and parts of the world and to comprehend their unity.

Philosophy studies the uniqueness and meaning of human existence in the world, the relationship of man to the essence of the universe, his evolution, concepts and ideas about knowledge, issues of morality and beauty, consciousness, soul, philosophy of society and history, and the history of philosophy itself.

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Modern concepts of artificial intelligence are aimed at the development of artificial intelligence based on the understanding of cognitive processes developed in various sciences. This involves the perception, sorting and processing of information according to certain procedures.

When a person receives information, he does not simply assimilate it; he associates it with his own ideas about morality, good, evil, love and other value dimensions. A person forms or develops his own creativity.

This superficial view of the problem of artificial intelligence emphasizes several aspects. First, the need to adhere to operational models that reliably imitate intelligence in decision-making. Second, the creation of algorithms and programming of this technology so that it works in a way that is considered intelligent. Third, the introduction of intelligent procedures for processing knowledge, signs and symbols in these algorithms and programs.

That is, there is a well-founded opinion in the scientific community that artificial intelligence should be developed, first of all, to repeat the creation of original programs by the human mind for its creative activity.

Unlike artificial intelligence or computer science, philosophy considers these issues in a broader context. It is believed that intelligent beings perceive the world around them through practical activities aimed at changing it, act in the conditions of their existence, perceive and evaluate them, and choose acceptable decisions and actions.

Philosophy as a science provides this opportunity due to the ontological, existential and worldly features of philosophical problems, such as their existential basis, their essential importance for the individual, their fundamentality and the synthesis of the immutable and the variable. Philosophy views artificial intelligence not only as a tool or a set of procedures for understanding a certain object of reality for existing computational tasks, but also from the point of view of the study of consciousness.

As artificial intelligence (AI) is already impacting various aspects of our lives, from medicine to legal systems, it is important to consider not only its functional capabilities but also the ethical limitations of its application. After all, the ultimate goal is not only to create increasingly intelligent systems, but also to ensure that they serve the benefit of people without threatening their rights and values. In this context, the philosophy of

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AI not only analyzes current achievements, but also provides a basis for decision-making that will determine the development of technologies and their future impact on our society.

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Антропогенная трансформация лесных ландшафтов южного склона Большого Кавказа

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Аннотация. Изучение природных ландшафтов южного склона Большого Кавказа имеет большое значение для совершенствования народного хозяйства нашей страны. Правительство Азербайджана поставило перед наукой задачу обеспечения охраны окружающей среды посредством комплексного использования природных ресурсов, а также, используя природные условия страны, совершенствования территориальной организации сельско-хозяйственного производства, защиты почв от ветровой и водной эрозии, сохранения рационального использования пахотных земель и поиска путей улучшения экологического состояния этих территорий. В рамках данной статьи предпринята попытка исследовать указанные вопросы.

Ключевые слова: ландшафт, Большой Кавказ, экосистема, горно-лесной пояс, склон Чакильдага.

Сохранение и улучшение природных ландшафтов является одной из важнейших экологических проблем современности. В этой связи изучение горных ландшафтов с целью их эффективного использования имеет значительное практическое и научное значение. Учитывая, что южный склон Большого Кавказа представляет собой крупный природно-хозяйственный регион, где происходят мощные селевые процессы, изучение антропогенной трансформации его ландшафтов и разработка мер по их охране имеют большое значение (7). Лесные ландшафты южного склона Большого Кавказа изучены в значительной степени (Н.К. Керемов (1952, 1963), В.Н. Набиев (1964), Б.А. Будагов и В.Н. Набиев (1964), Х.И. Омерова и И.Т. Мамедов (1970), Р.Х. Дашдиев (1990, 1994)). Ряд работ посвящён антропогенной трансформации ландшафтов региона и изучению их экологического состояния (11).

Н.К. Керемов классифицировал ландшафты южного склона в системе типологических категорий. Тот же автор выделил южный склон Большого Кавказа как отдельный структурный тип (Шеки–

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Закатала) и разграничил в его пределах высотные зоны и пояса (5). Х.И. Омерова сравнительно изучила современные ландшафтные пояса южного и северного склонов Большого Кавказа. Автор выделила на южном склоне Габала-Исмаиллинский структурный тип и в его пределах определила высотные пояса, соответствующие ландшафтным особенностям. Существующие условия каждого пояса были подробно описаны.

В период начала развития рыночной экономики в нашей республике, в условиях приватизации совхозов на исследуемой территории и увеличения числа индивидуальных фермерских хозяйств, сохранение и улучшение природных ландшафтов южных склонов Большого Кавказа приобрело особую актуальность. В последние годы в связи с усилением антропогенной нагрузки возникла необходимость в новом и комплексном изучении природных ландшафтов исследуемой территории; поэтому мы обратились к данной теме.

Охрана и восстановление лесных ландшафтов, являющихся важной составной частью биосферы и играющих значительную роль в стабилизации и улучшении окружающей среды, имеют большое значение. В этой связи изучение характера и направлений динамических процессов, происходящих в лесных экосистемах под воздействием хозяйственной деятельности человека, является одной из наиболее актуальных научных задач. Исследования по данной проблеме имеют как теоретическое, так и практическое значение.

В предгорных и нижнегорных лесных поясах южных склонов Большого Кавказа основными лесообразующими породами являются граб и грузинский дуб. В составе лесных насаждений также встречаются полевой клён, ясень обыкновенный и каркас (7).

На южных предгорьях Большого Кавказа в зависимости от интенсивности и характера хозяйственной деятельности человека высокобонитетные буковые леса были заменены редколесьями и безлесными участками.

Во многих местах коренные буковые леса трансформировались в разреженные и низкопродуктивные вторичные грабовые леса; этот процесс происходит там, где буковые леса постепенно вырубались или полностью уничтожались. Поскольку лесные насаждения этого пояса длительное время подвергались вырубке и выпасу скота, возраст леса не превышает 20–40 лет. Высота деревьев колеблется от 4 до 10 м, а их диаметр – от 5 до 20 см. Характерной особенностью нижнего горно-лесного пояса является разреженность травяного покрова и его значительная роль в составе лесного сообщества.

В подлеске основное место занимают такие кустарники, как

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мушмула, шиповник, боярышник, кизил, крушина, сумах, тёрн, ежевика и другие.

На большей части этого пояса, особенно в районах, расположенных вблизи населённых пунктов, в результате длительных интенсивных вырубок, выпаса скота и использования земель под сельскохозяйственные культуры сформировались открытые пространства. Деревья в этих лесах сильно разрежены, и большинство из них имеет порослевое происхождение. Кустарники, произрастающие здесь, иногда по высоте не уступают древесным породам.

В настоящее время интенсивный выпас скота и рубка лесов оказывают сильное воздействие на растительный покров этих склонов.

На склонах и в долинах, удалённых от населённых пунктов, лесные насаждения относительно хорошо сохранились по своей густоте и высоте. В таких более увлажнённых местах широко распространены ясень обыкновенный, граб, лещина и боярышник.

На участках, где леса вырублены или сильно нарушены в результате рубки и выпаса, почвенный покров представлен главным образом различными злаково-разнотравными сообществами.

Вследствие интенсивного выпаса скота и подверженности склонов эрозии общее проективное покрытие составляет 20-50 %, а травяной покров очень слабый. Поэтому с точки зрения предотвращения эрозии существующий растительный покров не способен выполнять свою почвозащитную функцию.

В результате рубки лесов и интенсивного выпаса скота на рубленных участках на больших территориях уничтожаются естественная поросль и молодые деревья леса, что, в свою очередь, ускоряет процесс эрозии.

На южном склоне Большого Кавказа на высотах 900-1400 м над уровнем моря разрежение грабово-буковых лесов приводит к развитию лещиновых зарослей. Густые, труднопроходимые заросли лещины часто рассматриваются как первая стадия деградации буковых лесов.

В нижнем горно-лесном поясе южного склона на высотах 500-700 м над уровнем моря дубовые леса под воздействием антропогенных факторов заменяются лесами из дуба крупнопольничкового (*Quercus macranthera*). При сильном воздействии человека высокая порослевая способность этого вида постепенно вытесняет дуб из состава леса, формируя вторичные заросли крупнопольничкового дуба. В отдельных случаях на южных склонах Большого Кавказа этот процесс наблюдается на высотах около 1000 м над уровнем моря.

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Разрежение дубовых лесов приводит к постепенному сокращению доли дуба в составе леса и увеличению кустарников, иногда с образованием колючих зарослей. В относительно более увлажнённых условиях на северных склонах разрежение дубово-грабовых или грабовых лесов вызывает активное развитие подлеска и формирование колючих кустарниковых зарослей. На лесных полянах и плодородных влажных почвах в таких зарослях преобладают плодово-ягодные виды – черника, боярышник, кизил, лещина, ежевика, сумах.

В нижнем горно-лесном поясе южного склона Большого Кавказа состав вторичных колючих зарослей также представлен плодово-ягодными видами – яблоней, грушей, алычой, кизилом, мушмулой, боярышником, ежевикой, шиповником, лещиной и др. Иногда среди густых кустарников встречаются деревья ореха и каштана.

Гемимезофильные колючие заросли, состоящие из плодово-ягодных кустарников и деревьев, в основном формируются в районах, близких к населённым пунктам. В этом процессе важную роль играет вырубка человеком неплодоносящих деревьев и кустарников.

На южном склоне Большого Кавказа разреженные субальпийские леса занимают очень крутые склоны (30° – 60°) на высотах 2000–2200 м над уровнем моря. Эти леса характеризуются низкорослыми деревьями с высоким травяным покровом. Незаконные вырубки и выпас скота в субальпийских буковых лесах приводят к их разрежению, а на каменистых и скалистых склонах таких территорий произрастают такие виды, как клён ясенелистный и черёмуха.

В результате сильного антропогенного воздействия субальпийские леса заменяются кустарниковыми зарослями и лугами. В настоящее время площадь субальпийских дубовых лесов на южном склоне Большого Кавказа значительно сократилась. Многие из них сохранились на нижней границе своего ареала, преимущественно на высотах 1600–2000 м, и их площадь продолжает уменьшаться.

В западной части Шекинского района территории, расположенные в нижнем поясе горных склонов, в течение длительного времени подвергались вырубке и выпасу скота. В результате леса здесь практически трансформировались в низкорослые древесно-кустарниковые формы. Сомкнутость древостоев снизилась до 0,2–0,3. Интенсивный выпас привёл к образованию троп на склонах, а почвы подверглись как поверхностной, так и глубинной эрозии.

Бассейн реки Киш также сильно пострадал от антропогенного

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воздействия. На южных склонах на высоте около 1100 м над уровнем моря произошли наиболее интенсивные антропогенные изменения. Леса в этой зоне сильно деградировали, и в их составе остались лишь малоценные древесные и кустарниковые породы. В настоящее время в результате интенсивных вырубок и выпаса леса приобрели кустарниковый характер. Сомкнутость крон таких насаждений не превышает 30–35 %. Эти территории сильно подвержены эрозии: сформировались тропы, а местами обнажились коренные породы.

В нижнем горно-лесном поясе эрозия почв также усиливается из-за стаскивания срубленных деревьев с верхних частей склонов вниз.

Тропы, образующиеся при транспортировке древесины, часто приводят к формированию оврагов на склонах.

Как видно, вследствие интенсивного выпаса скота на южном склоне Большого Кавказа эрозия почв значительно усилилась на обширных территориях. По мере увеличения высоты эрозия уменьшается, и выше примерно 1000–1200 м эрозионные процессы выражены очень слабо.

В целом в горно-лесном поясе развитие эрозии в основном связано с вырубкой лесов. В среднегорном лесном поясе деградация почв в результате выпаса не наблюдается. Леса с нормальной продуктивностью здесь эффективно защищают горные склоны.

На участках, прилегающих к субальпийским лугам верхнего горно-лесного пояса, выпас осуществляется на приграничных пастбищах шириной около 100–150 м. Выпас в этом поясе ведётся на протяжении многих лет и распространяется также на верхний горно-лесной пояс. В результате естественное возобновление леса затруднено, насаждения разрезаются, под копытами скота разрушается травяной покров, образуются тропы, усиливаются эрозионные процессы.

В то же время сильные и частые осадки в верхнем горно-лесном поясе и субальпийских лугах также способствуют развитию эрозии. В этом поясе количество осадков на 30–40 % выше, чем в нижнем горно-лесном поясе.

Таким образом, по мере приближения к высокогорным лугам лесные насаждения значительно изменяются как по составу, так и по густоте.

По данным некоторых исследователей (Мельник, Давитая, 1962), леса могут произрастать на высотах, где сумма активных температур за вегетационный период достигает 200–300 °С. Однако в исследуемом районе на высотах современного распространения лесов (1900–2000 м) сумма активных температур

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превышает 700 °С. Это свидетельствует о том, что верхняя граница леса в этих условиях могла бы подниматься выше (до 2400–2500 м). Резкое понижение верхней границы леса обусловлено антропогенным воздействием.

В верхнем горно-лесном поясе сокращение лесных площадей и усиление эрозионных процессов обусловлены не только вырубкой лесов, но и интенсивным выпасом скота.

В жаркие летние месяцы отары овец в полуденное время содержатся под пологом деревьев и также выпасаются на этих участках. Под копытами овец разрушается травяной покров и верхний слой почвы, оголяются корневые системы взрослых деревьев. Этот процесс часто наблюдается в верхних частях горно-лесного пояса, особенно в бассейнах рек Кишчай, Гурмухчай, Шинчай и Дашагылчай вблизи высокогорных пастбищ.

Например, на склонах Чакильдага на высоте 2000 м над уровнем моря леса сильно изменены в результате рубок и выпаса. Сомкнутость древостоев снизилась ниже 0,2, средняя высота деревьев составляет 18 м, а диаметр – 40 см. В результате молодые деревья уничтожены, естественное возобновление очень слабое, а поверхность склонов покрыта густой сетью скотопрогонных троп шириной 25–35 см и глубиной 10–15 см.

Почвы под пологом деревьев также сильно эродированы. Из-за содержания скота на этих территориях травяной покров полностью разрушен, а корневые системы разреженных взрослых деревьев полностью оголены.

Выпас скота в лесных ландшафтах также серьезно нарушает естественное лесовозобновление. Естественные всходы и молодые деревья уничтожаются, поскольку активно поедаются и вытаптываются животными.

В целом длительная нерациональная хозяйственная деятельность человека существенно изменила лесные ландшафты как в нижнем горно-лесном поясе, так и на верхней границе леса. На больших территориях леса стали разреженными и превратились в низкорослые порослевые деревья и кустарники. В результате такие леса не могут в полной мере выполнять противоэрозионную функцию.

В верхних частях горных речных бассейнов вблизи высокогорных пастбищ формируется густая сеть скотопрогонных троп. В нижнем горно-лесном поясе лесные ландшафты заменены низкорослыми деревьями и кустарниками.

Общая площадь горно-луговых ландшафтов на южном склоне Большого Кавказа составляет 499,4 км², из которых 177,7 км² (35,5 %) подвержено различным степеням эрозии.

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Субальпийские луга нижней части высокогорного лугового пояса на высотах 2000–2200 м и до 2600 м занимают 373,8 км² (74,8 % общей площади горно-луговых ландшафтов). Эти территории подверглись сильной почвенной эрозии под воздействием антропогенных факторов.

В бассейнах рек Кишчай и Катехчай, в районах Ханьяйлаг и Баскитучук, выпас в районе заповедника Баскитучук Зангезурского заповедника был запрещён после исследований, проведённых 30–35 лет назад. Однако район Ханьяйлаг до сих пор используется бессистемно и как сенокосные угодья. Поэтому верхние границы лесных ландшафтов, особенно субальпийские луга, сильно подвержены антропогенному воздействию. В то время как заповедный режим в Баскитучук смягчил факторы эрозии почв, состояние Ханьяйлага в значительной степени зависит от хозяйственной деятельности человека. Уже сейчас большие площади горно-луговой зоны оголены в результате интенсивной эрозии.

В субальпийских и альпийских луговых ландшафтах, расположенных между лесным и нивальным поясами, усиленное антропогенное воздействие ускоряет процессы денудации и эрозии. Из-за перевыпаса скота травы становятся редкими или исчезают, почвенный слой разрушается копытами, и обнажается коренная порода. В результате каменистые участки горно-луговых ландшафтов расширяются (2).

Чрезмерный выпас в высокогорных пастбищах привёл к формированию густой сети троп. Установлено, что на сильно выпасаемых пастбищах приходится 25–29 троп на 1000 м². Эти тропы часто становятся началом формирования оврагов.

В высокогорных луговых ландшафтах многолетний бессистемный выпас серьёзно нарушил естественные кормовые угодья, значительно снизив их продуктивность.

Из-за нерегулируемого выпаса скота в летних пастбищах многие склоны и участки подверглись деградации, в результате чего пастбища ослаблены. Эрозия усиливается, почва оголяется, и эти территории занимают разреженные кустарники и дикорастущие растения, непригодные для корма.

В высокогорных пастбищах скот должен в основном поедать растения на кустарниковой стадии, поскольку выпас во время цветения или семяобразования снижает кормовую ценность растений. Большинство растений вытаптывается животными, что снижает их продуктивность.

В высокогорном луговом поясе бессистемный выпас позволяет скоту непрерывно питаться в течение всего пастбищного сезона, без контроля частоты и длительности поедания растений.

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Исследования показывают, что свободно пасущийся скот поедает лучшие травы не менее десяти раз за сезон. Кроме того, в начале пастбищного сезона, когда травы много, животные не полностью съедают растения, и легко поедаются верхушечные побеги. В результате усиливается кустарниковая растительность.

Когда скот впервые выпускается на горно-луговые пастбища, он поедает наиболее питательные и вкусные травы. В поисках таких трав животные широко перемещаются, вытаптывая и повреждая пастбище. В этом процессе несъеденные травы разрушаются, высыхают и становятся грубыми, теряя свои ценные качества, включая высокую питательность и усвояемость. Таким образом, свободный выпас на горно-луговых пастбищах приводит к снижению фактической продуктивности пастбищ и способствует засорению сорной растительностью (8).

Одним из факторов, влияющих на растительность летних пастбищ, является плотность выпаса скота, которая напрямую связана с площадью пастбищ и разделением пастбищных участков. Чем больше число участков, тем меньше их индивидуальная площадь и тем выше плотность выпаса. При очень малых площадях пастбищ и высокой плотности выпаса животные мешают друг другу при кормлении. В результате значительная часть травы вытаптывается и уничтожается, а верхний слой почвы деградирует.

В настоящее время в большинстве высокогорных луговых ландшафтов процессы эрозии почв усилились и достигли пика. Одной из главных причин является интенсивный и бессистемный выпас в горно-луговой зоне. Возникающие эрозионные процессы и их разрушительное воздействие в целом подразделяются на четыре категории:

1. нарушенные, 2) слабовыраженные, 3) умеренно активные, 4) активные.

На склонах горно-луговых территорий участки с незначительной эрозией и слабым смывом встречаются редко. Такие участки в основном приурочены к пологим водоразделам, особенно в западной части южного склона в пределах Зангезурского заповедника, где природные геосистемы защищены от антропогенного воздействия.

Слабовыраженные эрозионные процессы наблюдаются главным образом на склонах с уклоном 20° – 25° .

В горно-луговых зонах процессы эрозии и денудации в целом имеют умеренную активность.

Активные эрозионные процессы в горно-луговых зонах происходят преимущественно на склонах, подверженных

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денудации, с линейным смывом поверхностного слоя почвы.

В целом развитие эрозии на территории зависит от климатических условий, литологического состава пород и морфометрических характеристик склонов. Помимо этих природных факторов, антропогенное воздействие усиливает интенсивность эрозионных процессов. По сравнению с горно-луговыми поясами эрозия сильнее выражена в нивальных зонах и слабее – в лесных ландшафтных поясах. Таким образом, интенсивность эрозии уменьшается от высоких высот к низким (4), что связано как со стабильностью почвенного покрова, так и со снижением антропогенного давления.

Высокогорные луга на южном склоне Большого Кавказа в настоящее время находятся под сильным антропогенным воздействием. В среднем нагрузка скота на летние пастбища в 1,5–2 раза превышает норму, а в отдельных районах – в 3–4 раза, что значительно превышает допустимые уровни. Склоны густо покрыты тропами, и процессы эрозии почв усиливаются. В результате продуктивность пастбищ ежегодно снижается.

Анализ проведённых исследований по южному склону Большого Кавказа позволяет сделать следующие выводы:

В результате сильного антропогенного воздействия горно-лесные ландшафты южного склона Большого Кавказа изменены в различной степени, а в отдельных районах их структура нарушена. В нижних горных лесах, подвергшихся наибольшим изменениям, необходимо запретить вырубку и выпас скота, а также провести лесомелиоративные мероприятия для улучшения состояния лесов. Площадь существующих лесов следует расширять за счёт новых посадок (3).

Интенсивный выпас скота и рубка леса должны быть строго запрещены в грабово-дубовых лесах среднего горного пояса. Для обеспечения эффективной охраны заповедных лесов необходимо усилить заповедный режим (9; 10). Для рационального использования горно-луговых ландшафтов следует правильно устанавливать нормы выпаса и внедрять системный выпас. Необходимо проводить комплексные мероприятия по улучшению пастбищ и сенокосов (12).

Южный склон Большого Кавказа рассматривается как один из регионов страны с богатыми и перспективными ландшафтными ресурсами. Высокогорные луга являются ценным источником кормов для развития животноводства (6). В настоящее время для повышения продуктивности летних пастбищ и улучшения их долговременного использования необходимо строго внедрять агротехнические меры, а также систему ротационного выпаса (1). Одним из наиболее эффективных средств предотвращения

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поверхностной эрозии является полное прекращение вырубок в горных лесах и проведение мероприятий по их искусственному расширению.

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Retrofuturism Aesthetics in Art: a Comprehensive Exploration of Temporal Design Narratives and Future-past Visual Paradigms

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Abstract. This article provides a comprehensive, interdisciplinary examination of retrofuturism aesthetics in contemporary art and visual design. Defined as the intersection of past visions of the future and present artistic interpretations, retrofuturism serves as a profound cultural lens through which society navigates temporal displacement, technological anxiety, and collective memory. The aim of this research is to deconstruct the visual language of retrofuturism, analyzing how historical optimism and subsequent disillusionment are encoded into contemporary artistic practices. Employing a qualitative, theoretical, and comparative methodology grounded in cultural studies, semiotics, and media theory, this study investigates the semantic foundations and cognitive mechanics of retrofuturistic art. The theoretical framework integrates Svetlana Boym's typologies of nostalgia and Mark Fisher's concept of hauntology to understand the psychological and emotional engagement elicited by these aesthetics. Key conclusions reveal that retrofuturism is not merely a superficial stylistic pastiche, but a sophisticated narrative device that critiques the teleological narrative of perpetual progress inherent in late capitalism. By utilizing deliberate anachronism, retrofuturistic art allows audiences to mourn "lost futures" while simultaneously reimagining alternative trajectories for human-technological evolution. The findings demonstrate that the materiality, typography, and geometry of retrofuturism function as semiotic signifiers that bridge cognitive dissonance, offering both a refuge in historical familiarity and a critical platform for interrogating contemporary socio-technical trajectories.

Keywords: *Retrofuturism, Hauntology, Visual Semiotics, Temporality, Cultural Nostalgia, Speculative Design, Temporal Displacement, Postmodern Aesthetics.*

INTRODUCTION

The intersection of temporalities in visual culture has given rise to one of the most conceptually rich and visually arresting movements in contemporary art: retrofuturism. As an aesthetic and cultural phenomenon, retrofuturism is

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fundamentally paradoxical; it is the contemporary artistic manifestation of past generations' visions of the future. Art historian Elizabeth Guffey, a foundational scholar on the subject, delineates retrofuturism not merely as a revival of old styles, but as a complex reflection on the trajectory of technological progress and human aspiration. In the realm of art and design, retrofuturism manifests as a deliberate juxtaposition of anachronistic design paradigms with speculative technological advancements, creating a visual language that is at once deeply familiar and profoundly alien. It represents a temporal short-circuit, a space where the "future that never was" materializes within the present, compelling the observer to confront the discrepancies between historical utopian promises and the actualized realities of the contemporary era.

The historical roots of retrofuturism are inextricably linked to the rapid industrialization and technological optimism of the early to mid-20th century. During the late 19th and early 20th centuries, catalyzed by the Second Industrial Revolution, authors like H.G. Wells and Jules Verne, alongside art movements such as Italian Futurism, envisioned futures characterized by mechanization, speed, and the triumphant conquest of nature through human ingenuity. This unbridled optimism reached its zenith during the mid-century Space Age, heavily influenced by events like the 1939 New York World's Fair, which presented the "World of Tomorrow." In this era, architects, industrial designers, and illustrators propagated a vision of the future defined by sleek aerodynamics, nuclear power, and space exploration. However, the subsequent decades, marred by the Cold War, the threat of nuclear annihilation, ecological crises, and the socio-economic upheavals of late capitalism, fractured this utopian consensus. Retrofuturism emerged in the late 20th century precisely from the ashes of this fractured optimism. It evolved as an artistic response to the realization that the gleaming, chrome-plated futures promised by mid-century corporatism and state-sponsored science were largely illusory.

In contemporary visual culture, the relevance of retrofuturism cannot be overstated. We currently reside in an era characterized by rapid, often disorienting technological advancement—from artificial intelligence to ubiquitous digital surveillance—yet simultaneously plagued by a pervasive sense of cultural stagnation. In this context,

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retrofuturism functions as a critical aesthetic sanctuary. Sub-genres such as Steampunk (extrapolating Victorian-era steam technology), Cyberpunk (marrying 1980s analog-digital interfaces with hyper-capitalist dystopias), Atompunk (reviving the atomic anxiety and Google architecture of the 1950s), and Cassette Futurism (highlighting the tactile, analog technology of the late 20th century) dominate contemporary illustration, cinema, video games, and industrial design. These aesthetics resonate profoundly with modern audiences because they offer a legible, human-scaled relationship with technology, contrasting sharply with the invisible, algorithmic, and often alienating nature of contemporary digital paradigms. Retrofuturism in the 21st century is therefore a multifaceted tool; it is deployed both as a mechanism of escapist nostalgia and as a subversive critique of contemporary techno-solutionism.

Given this complex landscape, the primary objective of this article is to systematically deconstruct the aesthetic, cognitive, and semantic dimensions of retrofuturism in art and design. This research seeks to answer the following core questions: How do the visual mechanics of retrofuturism manipulate human cognitive perception and temporal understanding? In what ways do specific design elements—such as materiality, geometry, and typography—function as semiotic vehicles for historical narratives and technological anxieties? Furthermore, how does retrofuturism transcend mere aesthetic imitation to function as a vital narrative framework in contemporary storytelling? By addressing these questions, this article aims to elevate the discourse surrounding retrofuturism from a niche subcultural curiosity to a central component of postmodern visual theory.

METHODOLOGY

To rigorously investigate the multifaceted nature of retrofuturism aesthetics, this study employs a comprehensive, qualitative methodological framework anchored in theoretical and comparative visual analysis. Recognizing that retrofuturism is not an isolated stylistic choice but a complex cultural symptom, the research adopts an inherently interdisciplinary approach. It synthesizes paradigms from art theory, media studies, cultural studies, and semiotics to construct a holistic understanding of how these visual texts operate upon the viewer.

The foundational epistemology of this research is situated within hermeneutic phenomenology and social

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constructivism. Hermeneutics allows for the interpretation of visual artifacts not merely as

objects, but as texts embedded with historical and cultural meaning. Social constructivism dictates that the "future" and the "past" are not objective, fixed realities, but culturally mediated constructs. To decode these constructs, the methodology relies heavily on the semiotic traditions of Roland Barthes and Erwin Panofsky. Panofsky's method of iconological analysis—which moves from pre-iconographical description to iconographical analysis, and finally to iconological interpretation—serves as the primary structural tool for dissecting individual artworks, architectural designs, and cinematic frames. This allows the research to peel back the layers of a retrofuturistic artifact, moving from its literal visual components (e.g., a brass gear or a neon sign) to its broader cultural symbolism (e.g., Victorian industrialism or 1980s techno-capitalism).

Furthermore, the theoretical lens through which these semiotic analyses are interpreted is deeply informed by contemporary cultural theory, specifically the discourse surrounding nostalgia and temporality. Svetlana Boym's seminal work, *The Future of Nostalgia*, provides a crucial methodological distinction between "restorative nostalgia" (the desire to reconstruct a lost past) and "reflective nostalgia" (the critical, melancholic lingering on the ruins of time). This distinction is utilized to categorize and analyze different retrofuturistic artworks based on their underlying ideological motivations. Additionally, the methodology incorporates the concept of "hauntology," originally coined by Jacques Derrida and later adapted for cultural analysis by Mark Fisher. Hauntology provides a robust theoretical framework for analyzing how contemporary art is "haunted" by the ghosts of "lost futures"—the utopian visions that were promised but never materialized. Applying these theoretical frameworks ensures that the visual analysis is grounded in rigorous academic discourse.

The selection of examples and sources for comparative analysis is guided by purposive sampling, designed to encompass a diverse cross-section of visual media where retrofuturism is most prominently articulated. The dataset includes illustrative concept art (e.g., the works of Syd Mead and contemporary digital artists), cinematic production design (ranging from Fritz Lang's *Metropolis* to Ridley Scott's *Blade Runner* and Terry Gilliam's *Brazil*), architectural

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movements (such as the Googie and Raygun Gothic styles), and interactive media/video games (notably the Fallout and BioShock franchises, which represent apogees of interactive retrofuturism). These specific mediums are selected because they require comprehensive world-building, necessitating a totalizing application of retrofuturistic design principles.

The analytical procedure involves a comparative juxtaposition of these disparate sources against their original historical inspirations. For instance, the analysis of Atompunk aesthetics in the Fallout series is comparatively evaluated against genuine 1950s atomic age advertisements and industrial design archives. This comparative methodology isolates the deliberate artistic interventions—the exaggerations, the anachronisms, and the subversions—that transform historical source material into contemporary retrofuturism. By systematically triangulating semiotic analysis, cultural theory, and comparative historical referencing, this methodology ensures a deep, structured, and academically rigorous excavation of retrofuturism's visual and cognitive mechanics.

Cognitive Perception and Narrative Mechanics

The efficacy of retrofuturism in art relies fundamentally on its ability to hack human cognitive perception, specifically our subjective experience of time, memory, and spatiality. Unlike purely historical art, which attempts to accurately recreate a specific bygone era, or traditional science fiction, which extrapolates forward from the present, retrofuturism occupies a liminal, non-linear temporality. It forces the human brain to process multiple temporal markers simultaneously. When an observer encounters a piece of retrofuturistic art—for example, an illustration of an interplanetary spacecraft designed with the riveted steel and steam-powered gauges of a 19th-century locomotive—they experience cognitive dissonance. This dissonance triggers a sophisticated psychological engagement. The brain recognizes the signifiers of the past (rivets, steam, brass) and the signifiers of the future (space travel), resulting in an "uncanny valley" of time. This temporal anachronism commands attention because it disrupts the teleological, linear narrative of progress that the modern human mind is conditioned to expect.

Central to this cognitive manipulation is the potent, often overwhelming role of nostalgia. However, within the context of retrofuturism, nostalgia is rarely

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straightforward. Utilizing Svetlana Boym's framework, much of retrofuturistic art operates within the realm of reflective nostalgia. It does not seriously propose that we return to the Victorian era or the 1950s; rather, it uses the aesthetic language of those eras to reflect upon our current condition. Nostalgia, in this sense, is weaponized. By wrapping advanced, often dystopian technological concepts in the comforting, familiar aesthetics of the past, artists can bypass the viewer's initial psychological defenses. The warmth of a glowing vacuum tube or the tactile click of a mechanical typewriter keyboard evokes a sense of comfort, authenticity, and human-scaled interaction. When these comforting elements are juxtaposed with terrifying concepts—such as artificial intelligence, genetic modification, or totalitarian surveillance—the emotional impact is magnified. The viewer is drawn in by the warmth of the past, only to be confronted by the anxieties of the future.

Furthermore, the cognitive engagement of retrofuturism is deeply intertwined with cultural memory and the mourning of "imagined futures." Cultural theorist Mark Fisher's application of hauntology is vital here. Fisher argued that contemporary culture has lost the ability to imagine new futures, resulting in a persistent recycling of the past. Retrofuturism is the ultimate visual manifestation of this hauntological state. When we look at the soaring, streamlined chrome architectures of Raygun Gothic art, we are not just looking at a design style; we are looking at the ghost of a mid-century utopian promise that was broken by the realities of war, economic disparity, and ecological collapse. Retrofuturistic art induces a profound, melancholic emotional engagement by allowing viewers to grieve for these lost futures. It taps into a collective, inherited memory of a time when the future was perceived as a realm of boundless possibility and human triumph, contrasting it sharply with the often cynical, apocalyptic determinism of contemporary futurism.

This complex psychological and cognitive interplay makes retrofuturism an incredibly powerful tool for narrative storytelling in visual art and design. In narrative mediums such as cinema, video games, and sequential art, retrofuturism allows for sophisticated "environmental storytelling." The world itself becomes a text that communicates history, ideology, and tragedy without a single word of exposition. A quintessential example is the underwater city of Rapture in

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the video game BioShock. The city is designed in a pristine Art Deco style, a 1920s and 30s aesthetic that visually screams of objectivist ambition, human exceptionalism, and unbridled capitalism. However, the player encounters this environment in a state of catastrophic decay. The narrative of ideological hubris leading to societal collapse is embedded directly into the leaking, cracked, and rusted Art Deco geometry. The retrofuturistic aesthetic serves as the primary narrative device: the contrast between the intended utopian design and its ruined reality tells the entire story.

Similarly, in cinematic works like Blade Runner or Alien, the use of "cassette futurism"—where advanced space travel or artificial life is managed through clunky, analog, cathode-ray tube (CRT) monitors and physical toggle switches—serves a dual narrative purpose. First, it grounds the science fiction in a gritty, blue-collar, industrial reality, making the universe feel lived-in and corporatized rather than magical and sterile. Second, it shifts the narrative focus away from the magic of technology and onto the human condition. When technology is depicted as fallible, physical, and requiring manual maintenance, it mirrors human vulnerability. Therefore, the cognitive perception of retrofuturism in storytelling goes beyond mere world-building; it establishes the thematic stakes of the narrative. It dictates the emotional frequency of the artwork, compelling the audience to engage with complex questions about technological ethics, historical determinism, and the enduring human spirit within an increasingly mechanized, yet hauntingly familiar, universe.

Semantic Foundations

The efficacy of retrofuturism relies not only on its conceptual premise but heavily on the meticulous orchestration of its visual language. The semantic foundations of retrofuturistic design elements—colors, typography, geometry, and specifically, materiality—operate as a complex semiotic code. Artists and designers manipulate these elements to encode highly specific past visions of the future, creating a visual lexicon that communicates volumes before the viewer consciously processes the narrative context.

Materiality is arguably the most critical semantic signifier in retrofuturism. The textures and materials chosen anchor the speculative technology to specific historical epochs, dictating the sub-genre and its associated

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ideological baggage. In Steampunk, the dominant materials are brass, copper, mahogany wood, and hand-tooled leather. Semiotically, these materials represent the First Industrial Revolution and the Victorian era. They speak of a time when technology was understandable, mechanical, and crafted by human hands. The visibility of gears, cogs, and steam valves functions as a rejection of the "black box" nature of modern microelectronics. By rendering speculative marvels—like flying machines or automatons—in brass and wood, artists encode a narrative of rugged individualism, imperial exploration, and the triumph of analog mechanics.

Conversely, the material language of Atompunk and Raygun Gothic is defined by polished chrome, molded Bakelite, early plastics, and brushed aluminum. These materials are intrinsically linked to the post-WWII economic boom, the birth of consumer culture, and the Space Race. Chrome, in particular, is highly semantic; its reflective surface symbolizes hygiene, speed, and a frictionless utopian future. When an artist designs a nuclear-powered vehicle or a domestic robot using smooth chrome and pastel plastics, they are encoding the 1950s American Dream—a future of leisure, limitless atomic energy, and domestic convenience, often papering over the underlying Cold War anxieties of mutually assured destruction.

Geometry and form further reinforce these semantic foundations. Retrofuturistic design frequently employs distinct geometric paradigms. The streamlined, aerodynamic shapes (teardrops, swept-back wings, parabolic curves) prevalent in mid-century retrofuturism are symbolic of motion and escaping earthly bounds. Even static objects, such as toasters or diners in the Googie architectural style, were designed to look as if they were in flight. This "streamlining" is a semantic embodiment of progress—the physical manifestation of humanity hurtling toward a brighter tomorrow. In contrast, the geometry of Cyberpunk is heavily rooted in Brutalism and hyper-dense urbanism. The visual language here is dominated by towering, oppressive blocks of decaying concrete juxtaposed with a chaotic tangle of exposed wiring and glowing neon. The geometry is not aerodynamic; it is monolithic and claustrophobic. This encodes a future where human progress has been stalled by corporate dominance, overpopulation, and environmental degradation. The future is no longer about upward trajectory, but lateral survival within an inescapable urban sprawl.

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Color palettes and lighting (illuminants) act as immediate emotional and historical triggers. The muted, sepia-toned palettes of Steampunk evoke old photographs and industrial smog. The vibrant, highly saturated primary colors and pastel mints/pinks of Atompunk evoke mid-century advertising and Kodachrome film, signifying manufactured cheerfulness. Cyberpunk and 1980s retrofuturism (Synthwave/Outrun) rely heavily on neon aesthetics—specifically stark contrasts between deep, inky blacks (signifying the polluted, sunless environment) and hyper-vibrant magenta, cyan, and grid-like lasers. The neon light is an essential symbol: it represents the seductive, artificial glow of commercialism and synthetic realities piercing through the gloom of physical decay.

Typography also plays a subtle yet profound semantic role in retrofuturism. The use of elaborate, flourished Victorian serifs instantly situates a design in the 19th century. Bold, geometric Art Deco sans-serif fonts evoke the roaring twenties and the rise of the machine age. Perhaps most iconically, the use of glowing, green or amber monospaced pixel fonts (reminiscent of early MS-DOS or UNIX terminal interfaces) is the hallmark of late-20th-century retrofuturism. This specific typography carries immense semantic weight; it symbolizes the dawn of the information age, the archetype of the "hacker," and a time when computing was raw, command-line driven, and devoid of user-friendly graphical interfaces.

Finally, the deliberate inclusion of decay and patina is a vital semantic element across nearly all retrofuturistic art. A gleaming, perfect retro-rocket represents pure historical illustration. However, a retro-rocket that is rusted, dented, and leaking oil shifts the image into true retrofuturism. The patina is the physical manifestation of time passing. It encodes the narrative that this "future" has already happened, has been used, and has ultimately decayed. It subverts the utopian promise by showing the inevitable entropic reality of all technology. Through the masterful synthesis of these semantic elements—materiality, geometry, color, typography, and decay—artists create a dense visual poetry, encoding complex sociopolitical critiques and historical reflections into the very fabric of their designs.

CONCLUSION

The investigation into the aesthetics of retrofuturism within art and design reveals a profound, multifaceted cultural phenomenon that extends far beyond the parameters of

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stylistic pastiche or superficial nostalgia. By systematically analyzing its historical genesis, cognitive mechanics, and semantic foundations, this article establishes that retrofuturism operates as a vital critical apparatus in contemporary visual culture. It is an aesthetic strategy uniquely equipped to navigate the complex, often contradictory relationships humans maintain with time, technology, and progress.

Key findings of this research highlight that retrofuturism fundamentally disrupts linear temporality, creating an anachronistic space that forces the observer into a heightened state of cognitive and emotional engagement. It leverages the psychological potency of nostalgia not to advocate for a return to the past, but to critically illuminate the anxieties of the present and the unfulfilled promises of historical utopianism. Through the theoretical lens of hauntology, retrofuturism is understood as the visual mourning of "lost futures"—a poignant reflection on the stagnation of contemporary socio-political imagination in the face of hyper-capitalism and technological alienation. Furthermore, the semantic analysis demonstrates that every design choice in retrofuturism—from the tactile brass of Steampunk to the sleek chrome of Atompunk and the glowing phosphors of cassette futurism—functions as a highly coded semiotic signifier. These material and geometric choices encode historical ideologies, enabling environmental storytelling and complex thematic layering without the need for explicit exposition.

The theoretical and artistic significance of retrofuturism lies in its capacity to humanize the speculative. As we progress deeper into the 21st century, dominated by invisible algorithms, cloud computing, and artificial intelligence, technology has become increasingly abstract and detached from human-scale understanding. Retrofuturism counteracts this alienation by re-anchoring the future in the physical, the mechanical, and the tactile. It demands that technology be visible, fallible, and subject to the physical laws of wear and decay. In doing so, retrofuturistic art offers both a refuge and a warning. It provides the comforting aesthetics of the familiar while simultaneously critiquing the hubris of perpetual technological progress. Ultimately, retrofuturism proves that the most effective way to analyze the trajectory of our future is to examine the discarded visions of our past, using the

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remnants of yesterday's tomorrows to build a more critical, reflective visual culture today.

Recommendations

1. Based on the theoretical analysis and findings presented in this article, several practical recommendations can be formulated for contemporary artists and designers, alongside vital directions for future academic research in the field of visual culture and speculative aesthetics.

2. Practical Suggestions for Artists and Designers For artists and designers operating in digital, industrial, or narrative mediums, the conscious application of retrofuturistic principles can significantly elevate the emotional resonance and critical depth of their work.

3. Deliberate Semiotic Layering: Designers should move beyond superficial imitation of past styles and deeply consider the semiotic weight of their material and typographic choices. If designing a speculative user interface (UI) for a film or game, consider the narrative implications of using analog, tactile inputs (switches, dials, CRT curvature) versus sleek, holographic projections. The friction of analog interfaces can instantly communicate a gritty, grounded reality and humanize the interaction between character and machine.

4. Utilize the Patina of Time: Artists should embrace degradation, rust, and repair in their designs. The inclusion of a "lived-in" aesthetic through deliberate weathering adds narrative depth, communicating that technology is not a pristine savior but a tool subject to entropy, maintenance, and human failure. This subverts utopian sterility and enhances the realism of speculative worlds.

5. Contrast as a Critical Tool: Use the cognitive dissonance of retrofuturism strategically. By housing dystopian or terrifying concepts (e.g., hyper-surveillance) within comforting, nostalgic shells (e.g., mid-century aesthetic casing), designers can create a powerful "uncanny" effect that provokes critical thought in the audience rather than passive consumption.

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How Artificial Intelligence is Shaping the Future of Visual Advertising

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Abstract. This study explores the profound transformation of the visual advertising industry driven by the rapid integration of generative artificial intelligence (AI). Historically reliant on static, analog, and mass-market methodologies, advertising has evolved into a highly dynamic, algorithmically governed ecosystem. Utilizing a qualitative research design, this article analyzes how generative AI models fundamentally redefine the traditional creative workflow. By leveraging advanced neural networks, these systems enable unprecedented operational efficiency and hyper-personalization, shifting the paradigm from generalized broadcasting to tailored, user-specific visual narratives. However, the research highlights that this technological acceleration concurrently precipitates critical ethical and professional dilemmas. The unconstrained use of AI raises significant challenges regarding intellectual property infringement, latent algorithmic bias, and the erosion of consumer trust through hyper-realistic synthetic media. Ultimately, the study concludes that the future of visual advertising will not be defined by the obsolescence of human labor, but rather by human-AI synergy. To ensure a sustainable and ethically responsible future, the industry must prioritize algorithmic transparency and foster a collaborative model where computational velocity is consistently guided by human emotional intelligence, cultural empathy, and strategic oversight.

Keywords: *Artificial Intelligence (AI), Visual Advertising, Generative AI, Algorithmic Personalization, Advertising Ethics, Intellectual Property, Human-AI Synergy, Digital Transformation.*

INTRODUCTION

Since the dawn of the second decade of the 21st century, the global economic landscape and its underlying communication infrastructures have undergone a profound and irreversible transformation. At the epicenter of this paradigm shift lies the unprecedented acceleration of digitalization, synergistically coupled with the rapid advancement of artificial intelligence (AI) technologies.

The advertising industry, historically reliant on established methodologies, emerges as one of the sectors most

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acutely impacted by these structural disruptions. For decades, traditional advertising mediums—encompassing print media, television broadcasting, and radio—functioned as the quintessential channels for audience engagement and brand communication. However, the ubiquitous proliferation of the Internet, alongside the subsequent dominance of digital platforms in capturing consumer attention, has catalyzed a fundamental metamorphosis within this domain, effectively shifting the locus of power from mass broadcasting to hyper-targeted digital ecosystems.

Within this evolving context, visual advertising stands out as arguably the most dynamic and consequential component of this contemporary digital transformation. Grounded in the cognitive reality that a predominant majority of human perception and information processing is driven by visual stimuli, advertisers have persistently sought to engineer highly compelling and psychologically resonant imagery. Historically, this was a labor-intensive, human-centric endeavor.

Today, however, artificial intelligence does not merely accelerate the mechanical aspects of this creative process; it fundamentally subverts and redefines its underlying operational logic. With the advent of sophisticated generative AI models, visual content is no longer statically created in isolation. Instead, it is continuously analyzed through massive datasets, algorithmically optimized for maximum engagement, and dynamically personalized in real-time to align with the idiosyncratic preferences and behavioral patterns of individual consumers.

Consequently, the primary objective of this article is to provide a comprehensive and critical analysis of the historical evolution of visual advertising, tracing its trajectory from analog origins to its current state of algorithmic dominance. Furthermore, this research aims to meticulously examine the revolutionary disruptions introduced by generative AI models within the creative sector. Beyond analyzing the technological capabilities, the study will rigorously address the concurrent ethical and professional dilemmas that have surfaced as a direct corollary of these advancements—ranging from intellectual property disputes and algorithmic bias to the broader ontological questions concerning the future role of human creativity in an increasingly automated industry.

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METHODOLOGY

To investigate the dynamic relationship between artificial intelligence and visual advertising, this study employs a qualitative and exploratory research design. Because AI technologies in the creative sector are evolving at an unprecedented pace, a qualitative approach provides the necessary flexibility to thoroughly examine fundamental shifts in industry practices, artistic paradigms, and ethical standards.

The research relies on a systematic review of secondary data to construct a robust theoretical foundation. The core data is gathered from a diverse range of authoritative sources, including peer-reviewed academic journals, industry reports from leading technology and advertising firms, and published case studies of AI-driven marketing campaigns. This comprehensive literature review enables a clear contextual contrast between historical analog methods and modern technological advancements.

For the analytical framework, the study utilizes both comparative and thematic approaches. A comparative analysis contrasts traditional, human-centric advertising techniques with modern, algorithmically generated processes to highlight operational shifts and efficiency gains. Simultaneously, a thematic analysis is applied to evaluate the ethical and professional implications—such as intellectual property disputes, algorithmic bias, and the changing nature of creative labor—ensuring a highly objective assessment of how AI is currently redefining the industry.

The Evolution of Visual Advertising: From Analog to Algorithmic

The historical trajectory of visual advertising is fundamentally a transition from static analog formats to dynamic algorithmic ecosystems. Throughout much of the 20th century, the industry relied heavily on print media, such as newspapers and billboards. This analog era was defined by a human-centric, artisanal approach to design. Campaigns were inherently static and built for mass distribution, relying on broad visibility rather than precise targeting to build brand equity.

The advent of television broadcasting introduced the first major structural shift, adding kinetic imagery and audio-visual synergy to the marketing repertoire. While this amplified the emotional resonance of campaigns, it remained firmly entrenched in the mass broadcasting model. Advertisers

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lacked granular audience segmentation, meaning visual content was still engineered to appeal to the widest possible demographic rather than addressing individualized consumer preferences.

The proliferation of the Internet marked a critical turning point, dismantling the dominance of traditional media. Early digital advertising, characterized by static banners, initiated the transition from passive consumption to interactive engagement. More importantly, it laid the foundational infrastructure for data collection. Advertisers could now track basic user behavior and click-through rates, transforming visual advertising from a purely creative endeavor into a measurable, data-informed discipline.

As digital ecosystems matured into the Web 2.0 era—dominated by social media networks—programmatic and data-driven advertising emerged. This phase signified the definitive shift from manual media placement to automated distribution. Visual content was strategically deployed based on intricate consumer profiles constructed from behavioral data. The industry's focus pivoted to micro-targeting, compelling creative teams to generate multiple variations of assets for highly segmented audiences.

Today, this evolution has culminated in an era of algorithmic dominance powered by artificial intelligence. Visual advertising has entirely transcended its earlier constraints, becoming a fluid, hyper-personalized, and generative process. Modern AI algorithms actively participate in the conceptualization, generation, and real-time optimization of content. Consequently, the contemporary visual artifact is no longer static; it is a dynamic entity continuously adapting to predictive analytics, redefining the very ontology of modern advertising.

Generative AI Models: Redefining Content Creation and Personalization

Generative AI marks a paradigm shift in advertising, moving from manual design manipulation to algorithmic synthesis. Utilizing advanced neural networks, these systems generate high-fidelity imagery directly from text prompts, transforming human creators from mechanical executors into strategic directors. (Feuerriegel et al., 2024)

By processing massive multimodal datasets, AI models efficiently decode complex aesthetic patterns. This exponentially accelerates production, replacing costly, weeks-long traditional photoshoots with instant, algorithmic

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generation that fundamentally alters industry economics. (Baek et al., 2023)

Beyond rapid content creation, generative AI drives hyper-personalization. When integrated with predictive analytics, it analyzes individual digital footprints to generate bespoke, real-time visual advertisements tailored to the psychological triggers of micro-segmented audiences. (Milovanović & Novaković, 2025)

Ultimately, this renders the traditional "one-size-fits-all" marketing model obsolete. However, while maximizing operational efficiency, this convergence of human and machine destabilizes established norms, introducing profound ethical dilemmas regarding creative ownership, bias, and authenticity.

Technological Impact on Digital Media and Audiovisual Design

The rapid integration of generative artificial intelligence into the visual advertising ecosystem has catalyzed unprecedented operational efficiencies; however, it has simultaneously precipitated a complex spectrum of ethical and legal dilemmas. Because the technological advancement of these models significantly outpaces the development of corresponding regulatory frameworks, the industry finds itself operating within a highly ambiguous moral landscape. Consequently, advertisers are compelled to navigate profound challenges regarding intellectual property rights, algorithmic fairness, and the fundamental preservation of consumer trust in an era dominated by synthetic media.

Perhaps the most immediate and contentious legal challenge arises from the domain of intellectual property and copyright infringement. Generative AI models derive their synthesizing capabilities from being trained on colossal datasets comprised of billions of pre-existing digital images, artworks, and photographs. Often, this data is indiscriminately scraped from the internet without the explicit consent, attribution, or financial compensation of the original human creators. This foundational process severely destabilizes traditional concepts of creative ownership, raising critical questions not only about the legality of the training mechanisms but also about the rightful ownership of the final machine-generated outputs. (Appel et al., 2023)

Beyond legal ownership, the reliance on massive, unfiltered historical datasets inherently introduces the

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pervasive risk of algorithmic bias. Generative models do not possess an innate moral compass; they operate by identifying and replicating statistical patterns embedded within their source material. Consequently, if the training data contains historical prejudices, systemic inequalities, or demographic underrepresentations, the AI will inevitably inherit, replicate, and often amplify these societal stereotypes. If left unchecked, this technological flaw can result in discriminatory, offensive, or culturally skewed visual representations in global advertising campaigns, necessitating the implementation of rigorous algorithmic auditing protocols. (Kordzadeh & Ghasemaghaei, 2022)

Furthermore, the proliferation of hyper-realistic, AI-generated imagery fundamentally threatens the core tenet of effective marketing: authenticity. As generative models become increasingly sophisticated, the ontological distinction between actual photography and synthetic generation completely blurs. This hyper-realism allows for the creation of entirely fabricated scenarios, products, or human endorsements, exposing consumers to an increasingly deceptive media landscape. The potential misuse of manipulated visuals necessitates a critical re-evaluation of brand transparency, raising the argument that AI-generated advertisements should require explicit disclosure to protect consumer integrity and maintain trust. (Campbell et al., 2022)

Ultimately, these escalating ethical dilemmas underscore the urgent and critical need for a balanced approach to AI adoption within the creative sector. While the transformative technological capabilities of generative AI are undeniably revolutionary, their unconstrained application poses significant risks to the industry's reputation. Therefore, the advertising ecosystem, in collaboration with policymakers, must establish stringent ethical guidelines, robust regulatory frameworks, and standardized transparency practices. Proactively navigating these moral hazards is essential not only for legal compliance but for setting the precedent for a sustainable, responsible, and trustworthy future in digital marketing. (Floridi & Cowls, 2019)

The Future of Creative Labor: Human-AI Synergy in the Advertising Industry

The rapid proliferation of generative AI has inevitably sparked widespread anxiety regarding the obsolescence of human creative labor within the advertising industry. However, framing AI as a direct substitute for human

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professionals represents a fundamental misunderstanding of its current capabilities. Rather than initiating mass displacement, artificial intelligence is functioning as a powerful augmentative mechanism. By automating repetitive, labor-intensive tasks—such as formatting, resizing, and basic drafting—AI liberates human practitioners to focus exclusively on higher-order strategic thinking, conceptual innovation, and complex problem-solving. (De Cremer & Kasparov, 2021)

Consequently, the future of creative labor is defined not by competition, but by a synergistic model of human-AI co-creation. In this collaborative paradigm, each entity contributes its distinct, complementary strengths. Artificial intelligence provides unparalleled computational velocity, the ability to synthesize vast datasets, and infinite visual iteration. Conversely, human professionals supply the irreplaceable elements of emotional intelligence, deep cultural nuance, and empathetic storytelling. This synergy ensures that advertising campaigns remain not only technologically efficient but also profoundly resonant with the human condition.

This symbiotic relationship is catalyzing a radical reskilling of the advertising workforce, leading to the emergence of entirely novel professional roles. The traditional skillset of designers and copywriters is expanding to encompass algorithmic literacy and AI curation. Roles such as "prompt engineers" and "AI strategists" are becoming central to the creative workflow. Modern art directors are increasingly transitioning into editorial curators, responsible for evaluating, refining, and ethically vetting machine-generated outputs to ensure they align perfectly with brand identity and broader societal values.

Ultimately, the integration of AI will not spell the end of human creativity, but rather its profound elevation. In a saturated digital market where access to generative algorithms is universally democratized, the technology itself will eventually cease to be a competitive differentiator. Instead, the true competitive advantage will rely exclusively on human ingenuity—the unique ability to ask the right questions, direct the algorithmic process, and inject authentic emotional depth into the final artifact. Thus, the future of advertising belongs unequivocally to those who successfully master this human-machine synthesis.

CONCLUSION

In conclusion, the integration of artificial intelligence

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into visual advertising marks a fundamental paradigm shift. The industry has irreversibly evolved from static, analog mass-marketing to dynamic, hyper-personalized digital ecosystems, with generative AI completely redefining the speed and scale of content creation.

However, this rapid technological acceleration presents profound ethical complexities. As AI adoption outpaces regulatory frameworks, the advertising sector faces urgent challenges regarding intellectual property rights, algorithmic bias, and the preservation of consumer trust. Addressing these moral hazards through stringent ethical guidelines is imperative for a sustainable future.

Ultimately, the future of advertising lies not in the obsolescence of human creativity, but in human-AI synergy. While algorithms provide unprecedented efficiency and iteration, emotional intelligence and strategic storytelling remain uniquely human. The industry's next era will belong to professionals who seamlessly blend computational power with authentic human insight.

Recommendations

Based on the results of the research conducted, the following recommendations can be proposed:

1. **Promotion of AI Literacy:** Incorporate prompt engineering and algorithmic understanding into the training of creative professionals.

2. **Establishment of Ethical Guidelines:** Develop clear industry standards for the responsible and transparent use of AI-generated visual content.

3. **Protection of Intellectual Property:** Implement robust legal frameworks to manage the copyright of synthetic assets and respect original human creators.

4. **Implementation of Algorithmic Auditing:** Regularly monitor AI models and datasets to identify and eliminate demographic or cultural biases in advertisements.

5. **Enhancement of Brand Transparency:** Ensure clear disclosure to consumers when hyper-realistic, AI-generated imagery is used in marketing campaigns.

6. **Encouragement of Human-AI Synergy:** Foster collaborative workflows where AI accelerates production while human designers provide strategic and emotional direction.

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BIOLOGY AND BIOTECHNOLOGY

Effect of Ultrasound on the Cell Membrane

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The cell membrane is a fundamental structure that maintains the integrity and functionality of all living cells (2). The cell membrane plays an important role in the regulation of substance transport, signal transduction, and energy conversion, which makes it essential for maintaining homeostasis and responding to environmental factors. The main approaches to ultrasound-membrane interaction include cavitation, sonoporation, and mechanotransduction, which are used in drug delivery and diagnostics. Ultrasound causes functional changes in cell membranes through three main approaches: cavitation, sonoporation, and mechanotransduction. Cavitation creates mechanical forces through the formation and collapse of microbubbles. Sonoporation creates transient pores that facilitate molecular transport across the membrane. Mechanotransduction converts mechanical stimuli into biochemical signals that affect cellular functions. When ultrasound waves are applied to the cell membrane, sonoporation promotes the entry of drugs into the cell (4). It is known from the literature that there are two types of sonoporation: reversible sonoporation (RS) and irreversible sonoporation (IRS). In the reversible sonoporation process, the pores formed in the cell membrane are quickly restored. This facilitates the penetration of drugs without causing any damage to the cell. In the irreversible sonoporation process, permanent damage to the cell membrane and cell destruction (through necrosis) occur. Gas-filled microbubbles play an important role in increasing the effect and intensity of the sonoporation process. The interaction of acoustic waves with microbubbles plays a role in increasing the number and size of pores formed in the membrane. The consequences of sonoporation are not limited to physical damage to membranes. As a result of sonoporation,

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the internal stability of the cell, i.e., homeostasis, is disrupted, which leads to changes in the processes occurring inside the cell. Although it is observed that the mechanical effects caused by ultrasound waves initially cause changes only at the membrane level, these effects are later transmitted to the intracellular environment, leading to a number of biochemical and physiological damages [1]. In addition, the destructive forces resulting from the explosion of microbubbles and the acoustic flow create pores in the cell membrane, increasing the permeability of the cell. Thus, as a result of the effect of ultrasound waves, hyperthermia, i.e., an increase in temperature, is observed, which in turn changes the structure of the membrane and causes drugs to penetrate the cell more easily (3-4). When high-intensity ultrasound waves affect the cell, reactive oxygen species (ROS) and light emission are generated. Both events affect the processes occurring inside the cell, reducing the resistance of the transported drug, and increasing the effectiveness of the treatment. In general, the cellular changes caused by ultrasound waves are as follows: decreased lifespan, changes in calcium signaling, changes in membrane potential in the cell, generation of reactive oxygen species, oxidative stress, etc. Thus, membrane modulation studies based on the effect of ultrasound waves are expected to be more widely applied in biomedical engineering.

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MEDICINE AND PHARMACY

Report: Florence Nightingale – the Founder of Modern Nursing

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Introduction

• **Purpose:** To analyze the historical contribution of Florence Nightingale to the establishment of nursing as a professional discipline and evaluate her influence on modern healthcare standards.

• **Relevance:** In the era of modern medical technology, the foundations laid by Nightingale—hygiene, infection control, and care ethics—remain an unshakeable bedrock. Understanding her methods helps future specialists recognize the significance of the nursing process as an independent scientific field.

• **Keywords:** Florence Nightingale, nursing, sanitation, Crimean War, evidence-based medicine, nursing education.

For centuries, caring for the sick was seen as either a family duty or a form of religious service requiring no special training. This changed radically in the mid-19th century due to the work of Florence Nightingale (1820–1910). Born into an aristocratic English family in Italy, she received a brilliant education in languages, mathematics, and philosophy. Despite Victorian social pressures to marry, she claimed at age 17 to hear a "call from God" to serve humanity. After studying in a German Protestant community, she became the first educated female reformer in medicine.

Main Body

1. Heroism in Scutari and the Crimean War

In 1854, Nightingale led 38 volunteers to Scutari to address the catastrophic conditions of field hospitals. She

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implemented a "Sanitary Revolution," which included:

- **Sanitation:** Cleaning sewers, regular linen changes, and disinfecting premises.

- **Dietetics:** Organizing a hospital kitchen for nutritious hot meals.

- **Psychological Comfort:** Utilizing light, fresh air, and compassion as healing tools.

As a result of these reforms, the mortality rate dropped from **42% to 2%** within six months. Her nightly rounds earned her the famous nickname "**The Lady with the Lamp**".

2. Mathematics and Evidence-Based Medicine

Nightingale was a brilliant statistician who used data visualization to convince officials of the need for reform. Her famous "**Rose Diagram**" (a circular histogram) proved that most soldiers died from "preventable causes" (infections) rather than battle wounds. This approach laid the groundwork for **evidence-based medicine**, requiring decisions to be based on statistical data and objective observations.

3. The System of Nursing Education

In 1860, she opened the first secular school for nurses at St. Thomas' Hospital in London. The "Nightingale System" was based on:

- **Secularism:** Education independent of religious institutions.

- **Theory and Practice:** Combining clinical experience with theoretical lectures.

- **Autonomy:** While doctors prescribed treatment, the organization of care was managed by a Head Nurse.

In her work *Notes on Nursing* (1859), she defined nursing not as treating disease, but as "putting the patient in the best condition for nature to act upon him".

4. Ethical Code and the Image of the Nurse

Florence Nightingale formed a unique professional ethic that remains relevant today:

- **Impeccable Reputation:** Before her reforms, caregivers were often perceived by society as uneducated women prone to bad habits. Florence established strict standards of behavior and moral character for her students.

- **Service as a Calling:** She emphasized that nursing is not just a job for profit, but a high art and a calling requiring dedication and continuous learning.

- **Critical Thinking:** Nightingale urged nurses not just to follow a doctor's orders, but to independently observe the patient's condition, analyze changes, and take measures to

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improve the patient's environment.

5. Legacy for the Modern Student

• For the students of the Medical College of Osh State University, the example of Florence Nightingale is a symbol of how perseverance and critical thinking can transform despised labor into a respected scientific discipline. Her approach, based on a combination of mercy and precise scientific calculation, helps future specialists realize the significance of the nursing process as an independent branch of medicine

Conclusion

Florence Nightingale transformed a disparaged labor into a respected scientific discipline. Her legacy lives on in modern disinfection standards and patient monitoring systems. International Nurses Day is celebrated annually on **May 12**, her birthday, honoring the union of mercy and scientific knowledge.

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Side Effects of Gabapentinoids in the Treatment of Congenital Nystagmus

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Congenital nystagmus, known in the modern literature as infantile nystagmus syndrome (INS), is a complex oculomotor disorder characterized by involuntary, rhythmic eye movements that begin in early childhood. The main challenge in the treatment of INS is its heterogeneous etiology and the limited number of specific therapeutic targets. In recent decades, clinical attention has shifted to the use of gabapentinoids, a class of drugs that includes gabapentin and pregabalin, which were originally developed for the treatment of epilepsy and neuropathic pain [1]. The use of these agents in nystagmus is based on their ability to modulate the activity of neural integrators in the brainstem and cerebellum, which theoretically allows for the stabilization of gaze fixation [2].

Clinical trials of gabapentin in nystagmus have demonstrated significant reductions in the amplitude and velocity of eye movements [2]. In a double-blind crossover study of 10 patients with acquired and congenital forms of nystagmus, gabapentin at a dose of 1200 mg/day reduced median eye movement velocity by 32.8% [3]. Similar results were obtained in *Danio rerio* fish models, where gabapentin reduced nystagmus intensity by 59.98% [4].

Despite these positive results, almost all study participants reported adverse events. The most common were dizziness and drowsiness [5]. In patients with pre-existing neurological disorders, such as ataxia in multiple sclerosis, gabapentin may increase unsteadiness in walking and cause falls [3].

In safety reports of gabapentin, "unusual eye movements"

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and nystagmus are mentioned as common side effects (up to 19% of cases in some groups) [6]. This suggests that gabapentinoids may destabilize the oculomotor system at inappropriate concentrations. The main visual complaints of patients are diplopia, blurred vision, and narrowing of the visual fields [5, 7].

Congenital nystagmus usually requires initiation of treatment in childhood, raising questions about the safety of gabapentinoids for the developing nervous system. Studies indicate that children aged 3 to 12 years are most vulnerable to specific behavioral changes when taking gabapentin [5]. Clinical observations describe the development of aggressive behavior and hostility, hyperactivity and agitation, and decreased school performance [5, 8]. The child may become uncontrollable, exhibit physical or verbal aggression [8].

In some cases, these paradoxical reactions are so severe that they require immediate discontinuation of the drug. After discontinuation of therapy, the child's behavior usually returns to normal without long-term psychiatric sequelae [9].

The most fundamental safety concern is the effect of gabapentinoids on the biochemical processes of brain development. As previously noted, these drugs block the interaction of thrombospondin with $\alpha 2\delta$ -1 receptors [10]. In the adult brain, this helps control pain and seizures, but in the infant brain, these receptors play a key role in the formation of new excitatory synapses [11].

The study by Barres and colleagues raised serious concerns that prolonged exposure to gabapentin in early life or in utero may disrupt the normal development of synaptic networks [11]. Although direct clinical evidence of irreversible IQ reduction in humans is currently lacking, experience with other anticonvulsants (e.g., valproate) has led scientists to be cautious. Theoretically, impaired synaptogenesis could lead to subtle cognitive deficits that would only become apparent in adulthood [11].

Although the focus of treatment for congenital nystagmus has been on children, many patients continue to take gabapentinoids into adulthood. Recent data from the BMJ Group (2025) suggest a worrying association between long-term gabapentin use and neurodegeneration [12].

According to a retrospective study:

- Patients who received 6 or more gabapentin prescriptions over a 10-year period had a 29% higher risk of developing dementia.
- The risk of mild cognitive impairment increased by 85%

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in this same group.

- The most vulnerable group was the 18-64-year-old age group, where the risks were twice as high compared to those who did not take the drug [12].

In the search for the optimal treatment for nystagmus, gabapentinoids are often compared with memantine and baclofen. In direct comparisons, gabapentin has been found to be more effective in reducing nystagmus amplitude but has a different side effect profile [2]. Baclofen remains the drug of choice for periodic alternating nystagmus [13]. Compared with gabapentin, baclofen has a stronger muscle relaxant effect, which can lead to muscle weakness, hypotension, and severe sedation [14]. Gabapentin is considered superior for pendular nystagmus because of its ability to improve visual acuity, which baclofen often fails to provide [13].

Gabapentinoids are physically and psychologically addictive. Abrupt discontinuation can lead to severe withdrawal symptoms, with symptoms appearing within 12-48 hours [15]. Clinical manifestations of withdrawal include: anxiety, panic attacks, insomnia [8], nausea, sweating, headache [15], seizures (even in patients without a history of epilepsy) [1], return of nystagmus in an intensified form (the "rebound" effect) [8].

Conclusion. The use of gabapentinoids in the treatment of INS demonstrates significant clinical potential, in particular the ability to significantly reduce the amplitude of eye oscillations and improve visual acuity. However, the therapeutic efficacy of these drugs is correlated with a high frequency of side effects - from widespread dizziness and the risk of destabilization of the oculomotor system to serious long-term threats. Of particular concern are data on the increased risk of dementia and cognitive impairment in adults with long-term use, as well as the likelihood of addiction and severe withdrawal syndrome.

The use of gabapentin in pediatric practice requires extreme caution due to the specific behavioral reactions of the child, such as aggression and hyperactivity, which can critically affect the quality of life. The greatest risk remains the potential interference of the drug in the processes of synaptogenesis, which in theory threatens with irreversible changes in the development of neural networks of the growing brain. Thus, the prescription of gabapentinoids for congenital nystagmus should be based on a careful balance between immediate visual improvement and possible cognitive

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consequences in the future, requiring constant monitoring of the patient's condition.

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Toxicological Characteristics of Iron-Containing Pharmaceutical Preparations

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Although iron supplement poisoning is rare in Azerbaijan, it is relatively common in other countries. In 2015, the American Association of Poison Control Centers (AAPCC) reported 4,072 cases, including 3,211 accidental ingestions and 2,036 cases in children under five; 1,161 patients required medical treatment, and one death occurred. Given the toxic effects of high-dose iron especially in children its chemical-toxicological analysis and laboratory diagnostics are important. Studying, identifying, and evaluating iron supplement poisonings is therefore of practical significance for pharmacists, toxicologists, and clinical laboratory specialists [1].

Iron is an essential trace element involved in key physiological processes, including hemoglobin and myoglobin synthesis, cytochrome enzyme activity, DNA synthesis, and mitochondrial function. It can temporarily bind gas molecules and catalyze redox reactions, which are vital for normal cellular metabolism. We obtain iron from dietary sources, but in cases of significant deficiency, iron supplements are used. These support the proper functioning of the nervous and hematopoietic systems and include ferrous sulfate, ferrous

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gluconate, and ferrous fumarate. Some intravenous iron formulations may cause allergic or anaphylactic reactions, especially at high doses, posing serious health risks [2,3].

Excessive iron accumulation is harmful to the body. Elevated levels of free iron increase the production of reactive oxygen species, leading to damage to DNA, proteins, lipids, and cellular organelles. This results in oxidative stress, impaired cellular function, tissue injury, and the development of organ diseases. High iron levels also increase susceptibility to infections and may worsen the progression of diseases such as COVID-19. Additionally, dysregulation of iron metabolism is observed in various cancers through altered intracellular iron levels, highlighting its significance for understanding cancer pathogenesis and developing treatment strategies [2].

Acute iron toxicity primarily results from excessive ingestion of elemental iron and is a leading cause of poisoning in children. The severity of toxicity is dose-dependent: intake below 20 mg/kg is usually non-toxic, 20–60 mg/kg may produce moderate symptoms, and ingestion above 60 mg/kg can lead to severe, potentially life-threatening toxicity [4].

In cases of iron poisoning, deferoxamine is used as an antidote. Deferoxamine, obtained via fermentation from *Streptomyces pilosus*, binds Fe^{3+} ions to form a pink ferrioxamine complex. This chelation allows both intracellular and extracellular iron to be sequestered and excreted from the body [5].

Summary: In Azerbaijan, the systematic study of the toxicity of iron-containing preparations has received limited attention, despite their widespread use. A thorough understanding of their mechanisms of action, biotransformation, and elimination pathways is essential to ensure safe clinical use and prevent adverse effects. Comparative toxicological assessments of various pharmacological forms of iron, including ferrous sulfate, ferrous gluconate, and ferrous fumarate, can provide valuable insights into dose-dependent toxic effects and help establish safe therapeutic ranges. Such studies are particularly important for vulnerable populations, such as children, who are more susceptible to iron overdose. Therefore, the primary aim of this research is to conduct a comprehensive investigation of the toxicological aspects of iron preparations, including their biochemical, cellular, and

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systemic effects, with the goal of improving clinical safety and guiding healthcare professionals in the effective and responsible use of these compounds.

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Cerebral Blood Flow in Post-traumatic Epilepsy

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Abstract. Transcranial Doppler ultrasonography was used to examine 65 young patients with symptomatic posttraumatic partial epilepsy. Cerebral arterial blood flow velocity and reactivity to functional stress were assessed. Hyporeactivity to vasoconstrictor stress was observed in all clinical groups. Depletion of vasodilator responses was observed in patients with subcompensation and decompensation of the disease. Patients with frequent epileptic seizures showed a significant decrease in reactivity to orthostatic stress. Mild hyperreactivity to the antiorthostatic test was detected in the group of patients with clinical compensation. The hyporeactivity to functional stress in patients with epilepsy is due to the possible parasympathetic influence of the suprasegmental autonomic nervous system.

Keywords: Transcranial Doppler sonography, cerebrovascular reactivity, posttraumatic epilepsy, cerebral hemodynamics.

Introduction

One of the most common consequences of traumatic brain injury (TBI) is posttraumatic epilepsy (PTE), which develops within 3 to 18 months from the time of injury, whether first or repeated [1,2]. Worldwide, TBI is the leading identified cause of symptomatic epilepsy in young adults. Convulsions in

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PTE are accompanied by changes functional indicators organisms that are regulated autonomic nervous system (ANS) [3,4]. Violations regulations precede hemodynamic, metabolic, energetic violation and can be early prognostic sign probabilities development of PTE due to suffered TBI [5]. The state of cerebral hemodynamics in patients with PTE is an important mechanism for ensuring the vital activity of the brain. An epileptic seizure occurs as a result of excessive neural discharges that can affect either part of the brain or spread to the entire brain [6]. The presence of changes in cerebral hemodynamics in patients with epilepsy makes the use of Transcranial Doppler Sonography (TDS) relevant, since the method allows obtaining reliable information on the velocity characteristics of the flow in cerebral vessels and the state of cerebral hemodynamics [7]. The use of TDS with the application of various functional loads of physical and chemical nature seems promising [8]. Today, it seems valuable to study cerebrovascular reactivity in young patients with PTE.

Objective

To study the state of cerebral hemodynamics and vascular regulation using the TDS method.

Materials and Methods

A total of 65 patients with PTE aged 20 to 45 years were examined. According to the frequency of partial epileptic seizures, patients were divided into 3 groups: Group 1 - 22 patients with a frequency of 2-3 seizures per month; Group 2 - 24 patients with a frequency of 1 seizure every 1.5 - 2 months; Group 3 - 19 patients with clinical remission for 6 months. The control group (CG) consisted of 20 healthy subjects of the same gender and age. Cerebral hemodynamics were studied using an Ultima - PA ultrasound scanner manufactured by RADMIR (Kharkiv, Ukraine). Time-averaged maximum blood flow velocity (TAMX) was measured in the anterior (ACA), middle (MCA), posterior (PCA), vertebral (VA), and basilar (BA) arteries. A pulsed transducer with a carrier frequency of 2 MHz (for transcranial imaging) was used. The state of cerebrovascular reactivity was assessed using the following functional loads: 1) hypercapnic load - voluntary breath holding for 40-60 sec; using the reactivity coefficient to hypercapnic load - CrCO₂. 2) hyperventilation load - intensive breathing for one minute; using the reactivity coefficient to hypocapnic load - CrO₂. 3) orthostatic and antiorthostatic loads using the reactivity

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coefficients for orthostatic and antiorthostatic loads - CrOL and CrAOL. Young patients with no history of cerebrovascular diseases or focal brain pathology (according to MRI data) were selected for the study.

Results and Discussion

The study of TAMX velocity indicators in cerebral arteries revealed the following patterns (Table 1). In the first group of patients, no significant differences in TAMX values were observed compared to the control group. TAMX asymmetry in the major arteries of the head was observed in 39.6% of patients; in some patients, the degree of TAMX increase indicated vasospasm in individual vascular beds. A tendency toward vasospasm was observed in patients who were examined after seizures and was noted in the MCA in 21.2% of patients and in the VA in 19.5%. A vasospastic reaction was observed only in patients who were examined shortly after the onset of a grand mal seizure or a series of seizures. In patients of the 2nd group, TAMX in the MCA and ACA did not differ from the normal values. In 30.6% of patients, TAMX asymmetry was detected in the cerebral arteries (25-30%). In 19.3% of patients, TAMX in the BA and one of the VA was moderately increased, in 17.% it was decreased, and in 12.2%, TAMX was increased in both VAs. Asymmetry was observed in the ACA in 8.6% of patients, in the MCA in 13.4%, in the PCA in 14.6%, and in the VA in 18.2%. In patients of group 3, no significant differences in TAMX parameters from the norm were observed. Vasospastic reactions in the vertebrobasilar system vessels occurred in 16.5% of patients, and vasodilatory reactions occurred in 15.2%. Blood flow asymmetry (25-30%) in the MCA was observed in 13.4% of cases, in the VA - in 16.6%, and in the PCA - in 20.1%

Table 1
TAMX values (cm/s) in intracranial arteries in patients with epilepsy

	MCA	ACA	PCA	VA	BA
CG	61.6+11.2	48.9+6.7	38.5+7.7	36.8+10.3	38.5+11.4
Group 1	58.8+9.4	42.8+8.4	40.4+6.2	35.1+12.7	36.7+9.2
Group 2	60.7+9.1	47.4+7.2	43.3+7.4	35.6+6.1	39.8+8.1
Group 3	62.0±7.2	45.4±11.9	44.0±6.3	36.5 ± 7.3	38.8 ± 6.2

* $p < 0.05$

In the subjects of the control group, the CVR indices were: CrOL - 0.87 ± 0.07 ; CrAOL - 1.15 ± 0.04 ; CrCO₂ - 1.36 ± 0.07 ; CrO₂ - 0.52 ± 0.08 . The values of these indices in patients of clinical groups 1, 2 and 3 that were outside the confidence interval in relation to the control group were interpreted as

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hyperreactivity and hyporeactivity (Table 2). A change in the direction vector of the TAMX reaction during exercise was interpreted as CVR inversion.

The CrCO2 values in the 1st and 2nd groups of patients were lower than those in the control group (1.21±0.05 in the 1st group and 1.22±0.03 in the 2nd group; p<0.05). The CrCO2 values in patients of the 3rd group were identical to those in the control group.

Patients exhibit two types of autoregulatory responses to CO2 loading: hyperreactive and hyporeactive. This trend is most pronounced in clinical groups 1 and 2. The hyporeactive response is predominant, occurring in 61.5% of patients in group 1 and 48.4% in group 2. In group 3, normoreactivity was predominant (90.3%).

The CrO2 values were: 0.38±0.05 in group 1, 0.36±0.06 in group 2, and 0.44±0.03 in group 3. Hyporeactivity also predominated in all clinical groups (55.8% in group 1, 86.2% in group 2, and 72.7% in group 3). Thus, a moderate decrease in vasoconstrictor reserve was characteristic of all groups of patients with epilepsy, regardless of the degree of compensation. It can also be concluded that a decrease in the vasoconstrictor component reserves is more significant for patients than similar changes in the vasodilator component.

Table 2

Cerebrovascular reactivity indices in patients with epilepsy				
	CrCO2	CrO2	CrOL	CrAOL
CG	1.36±0.03	0.52±0.04	0.87±0.04	1.19±0.04
Group 1	1.21±0.05*	0.38±0.05*	0.73±0.05*	1.18±0.04
Group 2	1.22±0.03 *	0.36±0.06 *	0.73±0.04*	1.17±0.06
Group 3	1.31±0.05	0.44±0.03*	0.86±0.05	1.27±0.03*

*p <0.05

The neurogenic mechanism of autoregulation was studied using an orthostatic test. TAMX values in the MCA were compared at rest and during orthostatic loading. A decrease in TAMX in the MCA of more than 10 % was interpreted as "orthostatic instability."

In the control group, orthostatic stability (OS) was noted in 91.7 %, in the 1st group in 57.8%, in the 2nd group in 66.8%, in the 3rd group in 84.9%.

A decrease in the prevalence of OU in this category of patients indicates changes in the functional state of the brain stem structures that carry out central regulation of blood circulation.

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The CrOL in the control group was 0.87 ± 0.04 . In patients of groups 1 and 2, CrOL levels were reduced and amounted to 0.73 ± 0.05 and 0.73 ± 0.04 , respectively. These changes were most likely due to the significant parasympathetic influence present in this category of patients. Significant decrease in CrOL levels in patients in Group 3 compared to the control group (0.86 ± 0.05). This result correlates with the autonomic support indicators, indicating the absence of signs parasympathicotonia in the 3rd clinical group.

CrAOL values in groups 1 and 2 (1.18 ± 0.04 and 1.17 ± 0.06) did not differ significantly from those in the control group (1.19 ± 0.04). Mild hyperreactivity to the antiorthostatic load was observed in group 3 patients (1.27 ± 0.03). This hyperreactivity is most likely due to sympathicotonia, which was observed in a significant proportion of patients in group 3 according to the autonomic status study.

Thus, patients from all clinical groups showed changes in reactivity to hypercapnic, hypocapnic, orthostatic and antiorthostatic loads in both vascular basins, which is associated with disturbances in the metabolic and neurogenic circuits of cerebral blood flow regulation.

Conclusions

1. A study of background cerebral hemodynamics in epilepsy patients revealed no statistically significant changes in arterial blood flow. Some patients, primarily after frequently recurring seizures, experienced functional asymmetries in cerebral blood flow velocity and vasospastic reactions.

2. Hyporeactivity to vasoconstrictor loads was observed in all clinical groups. Depletion of vasodilator responses was observed in patients with subcompensated and decompensated disease.

3. In patients with frequent epileptic seizures, a significant decrease in reactivity to orthostatic stress was observed.

4. The hyporeactive response to functional loads in patients with epilepsy is probably due to the possible parasympathetic influence of the suprasegmental autonomic nervous system.

Conflict of interest

The authors of the manuscript consciously declare that there is no actual or potential conflict of interest regarding the results of this work with pharmaceutical companies, biomedical device manufacturers, other organizations whose

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products, services, financial support may be related to the subject of the materials provided, or who sponsored the research conducted.

Compliance with ethical standards

The authors of the manuscript consciously certify that the study was conducted using data from primary medical records and included clinical observations of patients. The study was conducted in accordance with the ethical standards of the Declaration of Helsinki of the World Medical Association on the ethical principles of conducting scientific medical research involving human subjects, the European Society Directive 86/609 on the participation of humans in biomedical research, as well as the Order of the Ministry of Health of Ukraine No 690 of September 23, 2009. Informed consent to participate in the study was obtained from all participants after providing them with clear, complete and accessible information about the purpose, design and methodology of the study, its potential risks, expected benefits and possible alternatives. All participants confirmed their voluntary participation by signing an informed consent document. Participants had the right to refuse participation at any time without giving reasons. In accordance with confidentiality regulations, all data was collected anonymously and processed in compliance with applicable data protection legislation. All information was used exclusively for this study and was summarized for further analysis of the results.

Primary data and materials

The authors of the manuscript consciously declare that the work uses the results of their own clinical studies, which were systematized and analyzed by the authors. Primary data include generalized patient indicators, laboratory results, protocols and obtained quantitative characteristics. All materials are stored in the archive of the research group and can be provided upon reasonable request to the corresponding author, taking into account the requirements of confidentiality and ethical norms.

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Microscopic Structural Organization of
Respiratory Organs: a Histological
Observational Study

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Abstract. The respiratory system exhibits a complex histological organization that supports its primary function of gas exchange. This observational study analyzes the microscopic structure of respiratory organs including the nasal cavity, trachea, bronchi, bronchioles, and alveoli. Using standard Hematoxylin and Eosin-stained slides, key structural features such as epithelial transitions, presence of cartilage, glands, and specialized cells were examined. The findings demonstrate a progressive transition from pseudostratified ciliated columnar epithelium in the upper airways to simple squamous epithelium in alveoli, reflecting functional adaptation. The study highlights the correlation between structure and function and emphasizes the clinical relevance of histological changes in respiratory diseases.
Keywords: *Respiratory histology, alveoli, bronchioles, pneumocytes, gas exchange, respiratory epithelium, lung structure.*

INTRODUCTION

The respiratory system is a highly specialized biological system responsible for gas exchange, ensuring oxygen delivery to tissues and removal of carbon dioxide. The efficiency of this system depends on the precise histological organization of its components. From the nasal cavity to the alveoli, each

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segment of the respiratory tract exhibits distinct structural adaptations that support its functional role.

Histology of the respiratory organs demonstrates a progressive transition from protective and conducting structures to highly specialized gas-exchanging surfaces. The upper respiratory tract primarily functions in filtration, humidification, and warming of inspired air, whereas the lower respiratory tract is responsible for air conduction and gas exchange. This structural-functional relationship is critical for maintaining homeostasis.

Understanding the microscopic architecture of respiratory organs is essential not only for academic purposes but also for clinical practice. Many pathological conditions such as chronic bronchitis, asthma, emphysema, and acute respiratory distress syndrome (ARDS) involve alterations in normal histological features. Therefore, detailed knowledge of normal histology provides a foundation for identifying pathological changes.

This study aims to provide a comprehensive histological analysis of respiratory organs based on observational microscopy, emphasizing the correlation between structure and function.

METHODS

A descriptive observational study was conducted using standard histological slides of respiratory organs. The slides were stained using Hematoxylin and Eosin (H&E), a routine staining technique widely used in histology for visualizing cellular and tissue structures.

Specimens included sections of the nasal cavity, trachea, primary bronchi, bronchioles, and lung alveoli. These samples represent both conducting and respiratory portions of the system.

Microscopic examination was performed using a light microscope at varying magnifications, including low power (10x) for general architecture and high power (40x) for cellular details. Observations focused on epithelial lining, connective tissue components, presence of glands, cartilage, smooth muscle, and vascular structures.

Special attention was given to identifying the transition in epithelial types along the respiratory tract, the distribution of goblet cells, and the structural features of alveoli including pneumocytes and capillaries.

All observations were recorded systematically and

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interpreted in relation to known physiological functions.

RESULTS

Nasal Cavity

The nasal cavity was lined predominantly by pseudostratified ciliated columnar epithelium, commonly referred to as respiratory epithelium. Numerous goblet cells were present, secreting mucus that traps dust and microorganisms. The underlying lamina propria contained a rich vascular network, contributing to warming of inspired air. Seromucous glands were also observed, aiding in humidification.

Trachea

The trachea exhibited a characteristic structure composed of mucosa, submucosa, cartilage, and adventitia. The mucosal lining consisted of pseudostratified ciliated columnar epithelium with abundant goblet cells. The submucosa contained seromucous glands. C-shaped hyaline cartilage rings provided structural support, preventing airway collapse.

Bronchi

Primary bronchi maintained a similar epithelial lining as the trachea but showed notable differences. Cartilage was present in the form of irregular plates rather than continuous rings. Smooth muscle layers were more prominent, allowing regulation of airway diameter. Goblet cells were present but fewer in number compared to the trachea.

Bronchioles

Bronchioles showed a significant transition in structure. The epithelium changed to simple cuboidal, and goblet cells were largely absent. Cartilage and glands were not present. Instead, smooth muscle dominated the wall, allowing fine control of airflow. Clara (club) cells were observed, contributing to detoxification and secretion of protective proteins.

Alveoli

Alveoli represented the most specialized portion of the respiratory system. They were lined by simple squamous epithelium formed by Type I pneumocytes, facilitating rapid gas diffusion. Type II pneumocytes were also present, producing surfactant that reduces surface tension and prevents alveolar collapse.

The alveolar walls were extremely thin and closely associated with capillary networks, forming the blood-air barrier. Alveolar macrophages were observed within the lumen,

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playing a role in immune defense.

DISCUSSION

The findings of this study highlight the remarkable structural adaptations of the respiratory system. The presence of ciliated epithelium and goblet cells in the upper respiratory tract supports its protective function by trapping and clearing inhaled particles.

The gradual reduction of goblet cells and transition to simpler epithelium in distal airways reflect a shift from protection to gas exchange. The absence of cartilage in bronchioles allows flexibility, while smooth muscle enables regulation of airflow.

The alveoli demonstrate the most critical adaptation for gas exchange. The thin squamous lining minimizes diffusion distance, while surfactant production prevents alveolar collapse. The close association of capillaries ensures efficient exchange of gases.

These structural features have significant clinical implications. For example, chronic smoking leads to loss of cilia and goblet cell hyperplasia, impairing mucociliary clearance. In asthma, smooth muscle hypertrophy leads to airway narrowing. In ARDS, damage to alveolar epithelium disrupts gas exchange.

Thus, understanding normal histology is essential for interpreting pathological changes and guiding treatment.

CONCLUSION

The respiratory system exhibits a well-organized histological structure that reflects its functional requirements. From the protective mechanisms of the upper airways to the delicate gas-exchanging surfaces of the alveoli, each component is specialized for its role.

This study emphasizes the importance of histological knowledge in understanding respiratory physiology and pathology. Detailed observation of tissue structure provides valuable insights into disease mechanisms and supports clinical decision-making.

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TB: Tuberculosis

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Abstract. Tuberculosis (TB) remains one of the leading infectious causes of morbidity and mortality worldwide, caused by *Mycobacterium tuberculosis*. Despite the availability of effective treatment, prevention continues to be the cornerstone of TB control strategies. This article provides a comprehensive overview of tuberculosis prevention, focusing on specific prevention measures such as *Bacillus Calmette-Guérin* (BCG) vaccination and chemoprophylaxis, along with their complications. Additionally, it explores broader social prevention strategies aimed at reducing transmission at the population level. The paper also discusses etiology, pathogenesis, clinical manifestations, diagnostic approaches, and practical clinical scenarios. Preventive strategies, when effectively implemented, can significantly reduce disease burden and are essential for achieving global TB elimination goals.

INTRODUCTION

Tuberculosis is a chronic granulomatous infectious disease primarily affecting the lungs but capable of involving multiple organ systems. It is transmitted through airborne droplets and continues to be a major global health problem, particularly in developing countries.

Prevention plays a crucial role in TB control because:

- Infection can remain latent for years
- Active TB is highly contagious
- Drug-resistant TB is increasing
- The main pillars of TB prevention include:
 - Vaccination (BCG)
 - Chemoprophylaxis (preventive therapy)
 - Early detection and treatment
 - Social and environmental interventions

CONTEXT & BACKGROUND

According to global health strategies, TB prevention involves:

- Preventing infection
- Preventing progression from latent TB to active disease
- Reducing transmission in the community □
- World Health Organization
- High-risk populations:
 - Children under 5 years
 - HIV patients
 - Malnourished individuals
 - Close contacts of TB patients
- TB prevention is part of the WHO “End TB Strategy”.

ETIOLOGY AND PATHOGENESIS

- Etiology
 - Causative organism: *Mycobacterium tuberculosis*

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Acid-fast bacillus
Aerobic, slow-growing
Transmission
Airborne droplets (coughing, sneezing)
Close contact exposure
Pathogenesis
Inhalation of bacilli
Entry into alveoli
Phagocytosis by macrophages
Formation of Ghon focus
Spread to lymph nodes → Primary complex
Possible outcomes:
Healing (latent TB)
Progressive primary TB
Reactivation (secondary TB)
SPECIFIC PREVENTION

◆ 1. BCG VACCINATION

Overview
BCG = Bacillus Calmette-Guérin vaccine
Live attenuated vaccine from *Mycobacterium bovis*
Introduced in 1921
Mechanism
Stimulates cell-mediated immunity
Activates T-lymphocytes
Enhances macrophage function
Indications
Given at birth or early infancy
High TB prevalence countries
Protects children from severe TB forms
Effectiveness
Variable (0–80%)
Highly effective against:
TB meningitis
Miliary TB
NCBI
Limitations
Poor protection against adult pulmonary TB
Limited impact on transmission
NCBI
BCG ADMINISTRATION
Intradermal injection (usually left deltoid)
Dose:
Neonates: 0.05 ml

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Older children: 0.1 ml

CONTRAINDICATIONS

Immunocompromised patients (e.g., HIV)

Pregnancy

Severe illness

⚠ BCG COMPLICATIONS

Local Complications

Ulcer at injection site

Abscess formation

Keloid scar

Regional Complications

Lymphadenitis (most common)

Systemic Complications

Disseminated BCG infection (rare, severe)

Osteitis

Others

False-positive Mantoux test ☐

CDC

◇ 2. CHEMOPROPHYLAXIS (PREVENTIVE THERAPY)

Definition

Use of anti-TB drugs to prevent progression from latent infection to active disease.

INDICATIONS

Close contacts of TB patients

Children <5 years

HIV-positive individuals

Latent TB infection (LTBI)

DRUG REGIMENS

Isoniazid (INH)

Duration: 6-9 months

Most commonly used

Alternative Regimens

Rifampicin (4 months)

INH + Rifapentine (weekly)

MECHANISM

Kills dormant bacilli

Prevents reactivation

ADVANTAGES

Reduces risk of active TB

Essential in high-risk populations

SIDE EFFECTS

Hepatotoxicity

Peripheral neuropathy

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Drug resistance (if improper use)

◆ 3. INFECTION CONTROL MEASURES

Hospital Measures

Isolation rooms

N95 masks

Ventilation systems

Community Measures

Early diagnosis

Treatment of active cases

◆ 4. SOCIAL PREVENTION

Social determinants play a major role in TB spread.

KEY SOCIAL FACTORS

Poverty

Overcrowding

Malnutrition

Poor sanitation

SOCIAL PREVENTION STRATEGIES

1. Health Education

Awareness about TB transmission

Cough etiquette

2. Improved Living Conditions

Ventilation

Reduced overcrowding

3. Nutrition Improvement

Balanced diet

Address malnutrition

4. Public Health Programs

DOTS strategy (Directly Observed Treatment)

Contact tracing

5. Screening Programs

High-risk population screening

School health programs

CLINICAL MANIFESTATIONS (Brief Overview)

Pulmonary TB

Chronic cough

Hemoptysis

Fever

Night sweats

Weight loss

Extrapulmonary TB

Lymphadenitis

TB meningitis

Bone TB

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CLINICAL EXAMPLES

Case 1

Child (2 years) exposed to TB-positive parent:

Given BCG at birth

Started on INH prophylaxis

Case 2

HIV-positive adult:

Screened for latent TB

Started preventive therapy

DIAGNOSTIC APPROACH

Screening

Mantoux test

IGRA (preferred in BCG vaccinated)

CDC

Confirmatory Tests

Sputum microscopy

GeneXpert

Chest X-ray

CONCLUSION

Tuberculosis prevention is multifaceted, involving vaccination, chemoprophylaxis, and social interventions. While BCG vaccination provides protection against severe childhood TB, it has limited efficacy in preventing pulmonary TB in adults. Chemoprophylaxis plays a critical role in preventing disease progression in high-risk populations. Social prevention measures addressing poverty, nutrition, and overcrowding are equally important. A combined approach is essential to reduce TB burden and achieve global elimination goals

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Pathophysiological Mechanisms of Excitotoxicity and Neuronal Metabolic Desadaptation in Typical Pathological Processes of the CNS

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Relevance

In modern pathophysiology, Major Depressive Disorder (MDD) is considered a systemic neurometabolic dysfunction based on the disruption of excitatory amino acid homeostasis and immune dysadaptation [1]. The kynurenine pathway (KP) is the primary route of tryptophan degradation (over 90%); however, under conditions of chronic inflammation, it becomes a central pathogenic link in neurodegeneration [2]. The activation of indoleamine 2,3-dioxygenase (IDO) and tryptophan 2,3-dioxygenase (TDO) enzymes by pro-inflammatory cytokines shifts the metabolic flux toward the formation of excitotoxic compounds [5]. This initiates the formation of an excitotoxic phenotype—a typical pathological process characterised by hyperactivation of glutamatergic transmission, progressive neuronal destruction, and secondary mitochondrial insufficiency [2, 7].

Objective

To investigate in depth the pathophysiological links in the realisation of the excitotoxic effect of kynurenine pathway metabolites, their influence on neuronal ionic homeostasis, and their contribution to the development of neuroenergetic collapse based on the analysis of modern biomarkers.

Materials and Methods

A comprehensive analysis of molecular and biochemical

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studies regarding the kinetics of key KP enzymes—IDO, TDO, and kynurenine-3-monooxygenase (QMO)—was conducted [1, 6]. The study is based on assessing calcium signal dynamics, the intensity of free radical oxidation, and the functional state of NAD⁺-dependent cellular repair systems under conditions of pathological accumulation of neurotoxins, specifically quinolinic acid [3, 4].

Results

1. Molecular Mechanism of the Excitotoxic Cascade

The pathogenic cascade is initiated by the ectopic expression of IDO in microglia cells, which shifts tryptophan metabolism toward the synthesis of quinolinic acid (QA). QA acts as a potent selective agonist of NMDA receptors [2]. The primary pathophysiological mechanism is sustained depolarisation of the postsynaptic membrane, leading to a massive, uncontrolled influx of Ca²⁺ ions into the cytosol [3]. Intracellular hypercalcemia becomes a trigger for a "metabolic catastrophe." The accumulation of calcium triggers the activation of Ca²⁺-Dependent proteases (calpains), leading to the cleavage of cytoskeletal proteins (spectrin, tubulin) and the irreversible degradation of neuronal architecture [4]. Simultaneously, phospholipases A2 are activated, destabilising the lipid bilayer of membranes, releasing arachidonic acid, and amplifying the inflammatory response. Hyperactivation of neuronal NO-synthase (nNOS) leads to excessive generation of nitric oxide, which, when interacting with the superoxide radical, forms peroxynitrite (ONOO⁻)—an aggressive oxidant that causes nitrosative stress [4].

2. Free Radical Destruction and Mitochondrial Dysfunction

The oxidative branch of QA pathogenesis is realised through its unique ability to chelate Fe²⁺ ions. The formed QA-Fe complexes catalyse the Fenton reaction, generating the most toxic hydroxyl radical (•OH) [3, 4]. This initiates a chain reaction of lipid peroxidation (LPO) of mitochondrial membranes. Damage to cardiolipin in the inner mitochondrial membrane causes the opening of the mitochondrial permeability transition pore (mPTP) and a drop in transmembrane potential. QA directly inhibits the function of the mitochondrial respiratory chain (complexes I, II, and III), leading to the cessation of ATP synthesis [3]. The release of cytochrome c into the cytosol activates the caspase cascade, switching the neuron from an adaptive state to programmed cell death via apoptosis or necrosis.

3. The NAD⁺ "Metabolic Trap" and Energetic Collapse

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A vital pathophysiological link is the disruption of NAD^+ homeostasis. Fragmentation of nuclear DNA caused by oxidative stress activates the reparative enzyme poly-ADP-ribose polymerase (PARP-1), which uses NAD^+ as its primary substrate [1, 6]. Combined with the low activity of the enzyme quinolinate phosphoribosyltransferase (QPRT), which normally should detoxify QA and convert it into NAD^+ , this leads to a critical depletion of the intracellular pool of nicotinamide cofactors [2]. NAD^+ deficiency prevents glycolysis and the Krebs cycle, closing the vicious cycle of an energetic deficit. The neuron loses its ability to maintain Na^+/K^+ -ATPase function, leading to disruption of the resting membrane potential and making the cell even more vulnerable to excitotoxic stimuli [2]. These changes are particularly pronounced in GABAergic and cholinergic neurons of the prefrontal cortex and hippocampus.

4. The Role of Neuroprotective Antagonism and Biomarker Profile

The counterbalance to excitotoxicity is kynurenic acid (KYNA), which acts as an endogenous NMDA receptor antagonist and modulates $\alpha 7$ -nicotinic acetylcholine receptors [2, 5]. KYNA can block pathological calcium entry and neutralise free radicals. However, in MDD, a pathological decrease in KYNA levels and an increase in QA are observed. A decrease in the KYNA/QA ratio is an objective indicator of the dominance of the neurotoxic KP branch and correlates with treatment resistance and the risk of suicidal behaviour [5, 7]. The efficacy of drugs such as ketamine is largely based on the pharmacological mimicry of KYNA's protective action by directly blocking NMDA channels, thereby breaking the excitotoxicity chain [2].

Conclusions

1. Excitotoxicity in the pathogenesis of depressive disorders is a complex pathophysiological process integrating receptor hyperactivation, osmotic imbalance due to ionic shift, oxidative destruction of organelles, and bioenergetic collapse.

2. The formation of the NAD^+ "metabolic trap" due to PARP-1 hyperactivation and QPRT dysfunction is a key factor in the irreversibility of neuronal damage during chronic inflammation.

3. The pathological decrease in the ratio of neuroprotective kynurenic acid to excitotoxic quinolinic acid

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is a fundamental biomarker of the depth of neurometabolic disturbances.

4. Pathogenetically substantiated therapy should be aimed at restoring NAD⁺ homeostasis and blocking the pathological calcium signal to interrupt the cascade of cell death.

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Исследование биологической активности алкалоидов чистотела большого из флоры Азербайджана

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Алкалоиды проявляют множество свойств и учёные проводят интенсивные исследования, чтобы подробно изучить соединения этой группы. Всё больше возрастает интерес к изучению физиологической, фармакологической и токсикологической активностей алкалоидов. Исследования проводятся в форме сравнения эффективности действий как чистых веществ, так и их экстрактов. Учитывая все эти характеристики, алкалоиды находят широкое применение в медицине, ветеринарии и токсикологии [1].

Данные вещества проявляют цитотоксические, канцерогенные, антибактериальные, противогрибковые, противовирусные и другие свойства. Приблизительно 40% из всех современных лекарственных препаратов имеют природное происхождение. Наиболее широким спектром фармакологического действия обладают алкалоиды. Особого внимания среди них заслуживают алкалоиды изохинолинового ряда [2], которые содержатся во многих растениях, в том числе, и в чистотеле большом [3].

По одному эксперименту, проведённым группой японских учёных, восемь видов дикорастущих маковых растений Японии были исследованы с помощью разбавленного этанольного экстракта на общее содержание неочищенных алкалоидов, на спазмолитическое действие, подобное папаверину, на кишечнике

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мышей и трахее морских свинок, а также на среднюю летальную дозу для мышей. Содержание общего неочищенного алкалоида было наивысшим у *Pteridophyllum racemosum* и наименьшим у растения *Chelidonium japonicum* var. *typicum*. Спазмолитическое действие экстракта в общем было сильнее в трахее, чем в кишечнике, будучи наиболее сильным у *P. racemosum* и наиболее слабым у Чистотела большого (*Ch. majus*). Японский вид *Ch. japonicum* var. *typicum* проявил только сократительное действие. Спазмолитическое действие алкалоидной фракции составило 15~30% от гидрохлорида папаверина во всех восьми растениях, взятых для исследования. Токсичность была сильнее больше всего у *Corydalis decumben* и наиболее слабой у *Ch. Majus* [4]. Мы предоставили данную информацию в связи с тем, что наша работа тоже связана с определением эффективности растения из нашей флоры.

Наряду с изучением токсикологических действий соединений, содержащихся в чистотеле большом, мы стараемся обнаружить алкалоиды противоопухолевого действия в составе этого растения и изучить их уровень эффективности, сопоставив полученные данные с результатами из других стран. Также мы хотим сравнить фармакологические и токсикологические свойства производных этих алкалоидов *in silico*, найти самый благополучный вариант и использовать его в будущем.

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Особенности фармакотерапии у пожилых пациентов кардиологического профиля

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Актуальность: Согласно данных Всемирной организации здравоохранения за 50 лет, начиная с 2000 г. и по 2050 годы, численность населения старше шестидесяти лет в мире увеличится в два раза, то есть с 11-ти % до 22-х % [1].

Стремясь улучшить эффективность лечения с целью приостановления или избавления от развивающихся заболеваний, назначают большое количество лекарственных средств, что является полипрагмазией. Безусловно, назначение сразу значительного количества ЛС представляет собой огромный фактор риска нежелательных побочных реакций, ибо увеличивается частотность взаимодействия лекарств [2].

Цель: Изучить распространенность и структуру лекарственных взаимодействий в фармакотерапии пациентов старшей возрастной группы.

Материалы и методы исследований: Ретроспективный анализ 94 выписок из медицинских карт стационарных больных кардиологического стационара г.Семей в возрасте 65 лет и старше. Средний возраст 71 год, 68, М= 69,50 (95% ДИ:70,50–72,86) СО=5,776. Минимальный возраст– 65 лет. Максимальный возраст– 83 года. Из них 36% женщин, 64% мужчин.

Результаты исследования. Среднее количество ЛС получаемых одним пациентом –10,5 препаратов, 6 препаратов – 4 (4,2%), 7–8 препаратов – 21 (22,4%), 9–10 препаратов–28 (29,8%), 11 и более–41 (43,6%). Наиболее часто использованные препараты: антиагреганты, антикоагулянты, статины, ингибиторы АПФ, препараты калия, ингибиторы протонной помпы.

Так же, проводилась оценка фармакотерапии по критериям

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STOPP /START (Ирландия 2014г.). По их результатам применялись следующие препараты, которые нежелательны для лиц старшей возрастной группы: гипотензивные препараты центрального действия (метилдопа, клонидин, моксонидин) 16 (17%), спиронолактон+Инг.АПФ без контроля калия плазмы 40 (42,5%), НПВП+антог.вит.К, прямой ингиб.тромбина, ингиб.ф.Ха (высокий риск кровотеч.) 10 (10,6%), НПВП при АГ средней и тяжелой степени 9 (9,5%), НПВП при хронической сердечной недостаточности 10 (10,6%), НПВП при СКФ <20-50 мл/мин/1,73м²- 2 (2%).

Оценка фармакотерапии пациентов пожилого возраста согласно критериям Бирса (США 2015г.): амиодарон - 7 (7,4%), кеторолак - 7 (7,4%), диклофенак - 3 (3,1%), метоклопрамид - 4 (4,2%), НПВП при ХБП IV-V стадии (СКФ <30 мл/мин/1,73м²) - 1 (1,1%), аспирин для первичной профилактики сердечных событий (риск>польза у пациентов >80лет) 8 (8,5%), мочегонные (у пациентов >80лет могут усугубить гипонатриемию) - 8 (8,5%).

Выводы.

1. У больных старшей возрастной группы кардиологического стационара наблюдается наличие в среднем 5,3 нозологий.

2. Лекарственная нагрузка на одного пациента страшей возрастной группы от 6 до 11 и более препаратов. В среднем 10,5 препаратов.

3. Наиболее часто назначаются препараты, которые в этой возрастной группе противопоказаны.

4. Практически не проводится контроль безопасности назначаемых лекарственных средств.

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Менопауза и рабочая среда: риски для здоровья, профессиональной эффективности и психологического климата коллектива

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Аннотация. Менопауза представляет собой значимый физиологический переход, который оказывает комплексное влияние на профессиональную жизнь женщин в период среднего возраста. В данном обзоре анализируется взаимосвязь между симптомами менопаузы и рисками для соматического здоровья сотрудников, включая вазомоторные и когнитивные нарушения. Рассматриваются механизмы снижения профессиональной эффективности, проявляющиеся через презентизм и рост числа дней нетрудоспособности. Особое внимание уделяется влиянию психологического климата в коллективе на выраженность стресса и адаптацию женщин к возрастным изменениям. Проведенный анализ литературы выявляет дефицит организационной поддержки и стигматизацию данной темы в корпоративной культуре. Работа подчеркивает необходимость внедрения инклюзивных политик и стратегий управления здоровьем для сохранения кадрового потенциала. В заключении обосновывается роль благоприятной рабочей среды как ключевого фактора профессионального долголетия женщин.

Ключевые слова: менопауза, рабочая среда, профессиональная эффективность, психологический климат, женское здоровье.

Введение

Современные демографические тренды указывают на

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значительное увеличение доли женщин в возрасте старше 45 лет в структуре экономически активного населения, что делает вопросы сохранения их здоровья приоритетными для здравоохранения и менеджмента. Как отмечают Rees et al., менопаузальный переход сопровождается широким спектром симптомов, которые могут длиться годами и существенно влиять на качество жизни. В рабочей среде эти физиологические изменения часто сталкиваются с высокими требованиями к продуктивности, создавая дополнительные риски для психосоматического состояния сотрудниц. Понимание менопаузы не только как медицинского, но и как социально-экономического феномена критически важно для формирования устойчивых трудовых ресурсов [1].

Влияние симптомов менопаузы на профессиональную эффективность проявляется через снижение концентрации внимания, повышенную утомляемость и нарушения сна. Исследования, проведенные Hardy et al., демонстрируют, что женщины, сталкивающиеся с тяжелыми вазомоторными проявлениями («приливами»), чаще сообщают о снижении уверенности в своих компетенциях и трудностях при выполнении многозадачных функций. Этот феномен, известный как презентизм, когда сотрудник физически присутствует на месте, но не может работать в полную силу, наносит скрытый, но ощутимый экономический ущерб организациям. Таким образом, менопауза становится фактором риска для профессиональной эффективности, требующим пересмотра подходов к эргономике и организации труда [2].

Психологический климат внутри коллектива играет решающую роль в том, как женщина переживает период менопаузы на рабочем месте. К сожалению, во многих организациях сохраняется табу на обсуждение возрастных изменений, что ведет к социальной изоляции и повышению уровня тревожности среди сотрудниц. По данным Hickey et al., отсутствие поддержки со стороны руководства и эйджистские установки в команде усугубляют психологическое давление, снижая лояльность к компании. Формирование открытой и поддерживающей корпоративной культуры, свободной от стигмы, способно не только улучшить ментальное здоровье женщин, но и гармонизировать межличностные отношения в коллективе в целом [3, 4].

Результаты

Глобальные эпидемиологические данные указывают на то, что менопаузальный переход совпадает с пиком профессиональной активности женщин. В Великобритании масштабное исследование, проведенное Fawcett Society, показало, что примерно 10%

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женщин покинули свои рабочие места из-за тяжести симптомов менопаузы, что эквивалентно потере сотен тысяч квалифицированных специалистов. В США, согласно отчету Mayo Clinic, ежегодные потери производительности из-за симптомов менопаузы оцениваются в 1,8 миллиарда долларов, а общие экономические издержки (включая прямые медицинские расходы) достигают значительно более высоких цифр. В Австралии исследования Bariola et al. выявили, что женщины с выраженными симптомами в 1,4 раза чаще сообщают о намерении выйти на пенсию раньше срока, чем их сверстницы без симптомов. В странах ЕС, по данным европейских опросов, до 45% работающих женщин признают, что симптомы менопаузы негативно сказываются на их карьере, однако лишь небольшая часть обсуждает это с руководством [5, 6, 7].

Таблица 1

Экономические и социальные последствия менопаузы на рабочем месте
(сводные данные)

Страна / Организация	Показатель влияния	Экономический/социальный эффект
Великобритания (Fawcett Society)	Преждевременное увольнение	~10% женщин покидают рынок труда
США (Mayo Clinic)	Снижение производительности	\$1,8 млрд прямых потерь ежегодно
Австралия (Bariola et al.)	Намерение уйти на пенсию	Риск выше в 1,4 раза при тяжелых симптомах
Европейский Союз (ЕС)	Карьерная стагнация	45% отмечают негативное влияние на рост

Клиническая картина менопаузы включает вазомоторные, когнитивные и психоэмоциональные нарушения, которые напрямую коррелируют с работоспособностью. Как подчеркивают Zhang et al., вазомоторные симптомы (ВМС), такие как приливы и ночная потливость, приводят к фрагментации сна, что в свою очередь вызывает дневную сонливость и снижение концентрации. Когнитивные нарушения, часто описываемые пациентками как «туман в голове», включают ухудшение кратковременной памяти и трудности с подбором слов, что критично для женщин на руководящих должностях. Психологические проявления — тревожность, депрессивные состояния и эмоциональная лабильность — снижают стрессоустойчивость в условиях корпоративной многозадачности. Исследования Kling et al.

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подтверждают, что тяжесть этих симптомов ассоциирована с ростом ошибок при выполнении когнитивно сложных задач и снижением самооценки профессиональной компетентности [8,9].

Анализ мировой практики показывает, что внедрение «Menopause Policy» (политики в отношении менопаузы) становится стандартом для социально ответственных компаний. Эффективные программы включают три уровня: изменение физической среды, обучение менеджмента и гибкий график. Исследование Beck et al. демонстрирует, что даже минимальные изменения – обеспечение доступа к холодной воде, настольным вентиляторам и регулируемым термостатам – существенно снижают дискомфорт сотрудников с ВМС. Крупные корпорации (например, Vodafone, HSBC) внедряют тренинги для линейных руководителей, направленные на дестигматизацию темы и обучение навыкам ведения конфиденциальных бесед. По данным Hickey et al., организации, предоставляющие право на гибкий график или дистанционную работу в периоды обострения симптомов, отмечают рост лояльности сотрудников и снижение текучести кадров среди опытного персонала [3,10].

Особое место в современных исследованиях занимает работа Cronin et al., представляющая собой комплексный анализ организационной культуры на примере крупного медицинского учреждения Великобритании [11]. Авторы подчеркивают, что в секторах с преобладанием женского персонала (81,9%), таких как здравоохранение, более 40% сотрудников находятся в возрастной группе от 41 до 55 лет, что делает управление менопаузальным переходом критически важным аспектом кадровой политики. Как отмечают в своем отчете Bazeley et al., женщины часто сталкиваются со стигмой и страхом дискриминации на рабочем месте, что вынуждает их скрывать симптомы и отказываться от поиска поддержки. Исследование выявило прямую зависимость между тяжестью симптоматики и намерением покинуть профессию: 47% женщин с выраженными нарушениями рассматривают возможность увольнения, что согласуется с данными Newson et al., указывающими на реальный уход из профессии около 10% женщин именно по причине менопаузы. Важным аспектом работы является анализ роли менеджмента: авторы, опираясь на глобальные рекомендации Rees et al., указывают на дефицит компетенций у линейных руководителей в вопросах охраны здоровья женщин среднего возраста. В качестве решения предлагается внедрение стратегии «Talk, Track, Treat» (Говорить, Отслеживать, Лечить), направленной на дестигматизацию темы и создание открытой среды, где гибкий график и минимальные изменения условий труда (например,

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температурный контроль) могут существенно снизить уровень презентизма и сохранить квалифицированные кадры. Таким образом, исследование подтверждает тезис о том, что менопауза является не личной медицинской проблемой сотрудника, а системным организационным вызовом, требующим пересмотра корпоративной этики и культуры [1,2,12,13].

Существенный вклад в понимание взаимосвязи между менопаузальным переходом и трудовой деятельностью внесло исследование Hickey et al. [3], проведенное на выборке из 1092 женщин, работающих в системе здравоохранения. В отличие от ряда предыдущих работ, данное исследование не обнаружило статистически значимой связи между репродуктивной стадией (пре-, пери- или постменопауза) и такими критическими показателями, как вовлеченность в работу, организационная приверженность, удовлетворенность работой и восприятие поддержки со стороны руководства. Авторы отмечают, что, несмотря на высокую распространенность симптомов, большинство женщин оценивают свою профессиональную эффективность как высокую и не считают, что менопауза критически снижает их трудоспособность. В то же время, исследование детализирует структуру жалоб: если для перименопаузального периода наиболее характерны нарушения сна (инсомния), то в постменопаузе на первый план выходят дискомфорт в суставах и мышцах, а также физическое и ментальное истощение. Опираясь на критерии STRAW +10, авторы подтверждают, что лишь приливы и вагинальная сухость являются симптомами, достоверно учащающимися при переходе к постменопаузе. Авторы также подчеркивают важность модифицируемых факторов рабочей среды, ссылаясь на рекомендации Griffiths et al., и указывают на высокую востребованность таких мер поддержки, как контроль температуры в помещениях, доступ к холодной воде и зонам отдыха, а также гибкий рабочий график [14]. Резюмируя, работа демонстрирует парадокс: при объективном наличии симптоматики женщины стремятся сохранять высокую продуктивность, однако их психоэмоциональное благополучие напрямую зависит от готовности организации обеспечить инклюзивную и адаптивную среду.

Заключение. Результаты проведенного обзора свидетельствуют о том, что менопаузальный переход является критическим фактором, определяющим устойчивость современной рабочей среды. Традиционная медицинская модель восприятия менопаузы должна быть замещена междисциплинарным подходом, интегрирующим принципы охраны труда, корпоративной психологии и управления человеческим капиталом. Игнорирование симптомов

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менопаузы ведет к существенным финансовым потерям организаций за счет презентизма и «утечки мозгов» в лице высококвалифицированных женщин-лидеров. Внедрение «Menopause Policy» – это не факультативная мера социальной ответственности, а необходимый элемент обеспечения операционной эффективности. Переход от стратегии «умолчания» к открытому диалогу в рамках стратегии «Talk, Track, Treat» является первичным условием дестигматизации и снижения уровня психологического дискомфорта в коллективе. Дальнейшие исследования должны быть сфокусированы на разработке и валидации специфических инструментов оценки влияния менопаузы на производительность труда в различных профессиональных группах, а также на анализе долгосрочной эффективности корпоративных программ поддержки. Создание инклюзивной среды, учитывающей возрастные физиологические изменения, является залогом профессионального долголетия и гармоничного развития современного общества.

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Біофізика «холодного світла» у сучасній лазерній корекції зору

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Актуальність. Порушення рефракції (міопія, гіперметропія та астигматизм) належать до найпоширеніших офтальмологічних патологій і охоплюють понад 30% населення планети. Сучасний розвиток медицини потребує переходу від паліативних методів (окуляри, контактні лінзи) до прецизійної рефракційної хірургії. Актуальність теми зумовлена необхідністю глибокого розуміння фізичних процесів взаємодії лазерного випромінювання з колагеновою структурою рогівки для забезпечення прогнозованого клінічного результату та біомеханічної стабільності ока.

Вступ. Лазерна корекція зору ґрунтується на зміні геометричних параметрів рогівки – головного заломлюючого елемента оптичної системи ока. Оптична сила рогівки (близько 43 діоптрій) визначається її радіусом кривизни та показником заломлення. Порушення рефракції виникають унаслідок невідповідності між фокусною відстанню оптичної системи ока та його аксіальною довжиною. Впровадження ексимерних лазерів стало революційним етапом розвитку біофотоніки, оскільки дало можливість проводити високоточне моделювання поверхні рогівки без значного термічного ушкодження тканин.

Мета. Метою роботи було вивчення фізико-хімічних принципів лазерної корекції зору, аналіз механізмів фотоабляції та математичного моделювання профілів абляції з використанням алгоритму Муннерліна.

Результати та обговорення. В основі процесу лазерної корекції зору лежить явище фотоабляції – «холодного» випаровування тканини [1, 2]. З фізичної точки зору це руйнування міжмолекулярних зв'язків під дією енергії фотонів,

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а не внаслідок нагрівання тканини. Термін «холодне світло» стосується самого принципу взаємодії лазерного випромінювання з тканинами ока. На відміну хірургічних лазерів термічного типу (наприклад, хірургічних лазерів-скальпелів), ексимерний лазер не спалює і не розрізає тканину за допомогою високої температури, а викликає пряме фотохімічне руйнування молекулярних структур.

Енергія фотона ексимерного лазера становить близько 6,4 еВ, що перевищує енергію зв'язків у молекулах колагену (3,5 – 4,5 еВ). Така висока енергія ультрафіолетового випромінювання здатна розривати молекулярні зв'язки в тканинах рогівки миттєво. В результаті молекули випаровуються швидше, ніж тепло встигає поширитися на сусідні ділянки. Температура в зоні впливу практично не підвищується, що запобігає утворенню рубців і помутнінь.

Лазер вибиває мікроскопічні порції тканини (на рівні часток мікрона), перетворюючи їх на газ. Точність абляції становить 0,25 мкм за один імпульс, що гарантує субмікронну прецизійність втручання.

Ексимерні лазери працюють у далекому ультрафіолетовому діапазоні (зазвичай це довжина хвилі 193 нм). Це світло не проникає глибоко всередину ока, а поглинається в найтоншому поверхневому шарі рогівки. Оскільки проникнення мінімальне, внутрішні структури ока (кришталік, сітківка) залишаються у безпеці. Саме завдяки «холодному» принципу рогівка не отримує опіків, зберігається прозорість тканин після операції, мінімізується ризик появи рубців або помутнінь.

Математичне планування операції базується на використанні формули Муннерліна [1], за допомогою якої визначають глибину абляції – товщину шару рогівки, який лазер має «випарувати»:

$$t = \frac{d^2 S}{3},$$

де t – глибина абляції (мкм);

d – діаметр оптичної зони – області, на яку впливає лазер, (мм);

S – рефракційна сила корекції (діоптрії).

Константа $\frac{1}{3}$ була виведена геометрично для середнього значення радіуса кривизни рогівки людини.

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Алгоритм Муннерліна дозволяє розрахувати і індивідуалізувати точний профіль необхідного лазерного впливу залежно від типу аметропії: кривизна рогівки корегується в потрібних зонах. Зокрема, при корекції короткозорості лазер видаляє більший об'єм тканини в центральній зоні рогівки, роблячи її плоскішою і зменшуючи її надмірну заломлючу силу. При корекції далекозорості абляція лазером проводиться переважно на периферії (кільцева зона), що призводить до відносного випинання центру. Рогівка стає більш опуклою і сильніше заломлює світло. При астигматизмі корекція здійснюється вибірково по різних меридіанах.

Основними методами лазерної корекції зору, які використовують ексимерний лазер для зміни форми рогівки з метою виправлення короткозорості, далекозорості та астигматизму, є фоторефракційна кератектомія (ФРК) (англ. Photorefractive Keratectomy, PRK) та лазерний інтрастромальний кератомілез (англ. Laser-Assisted in Situ Keratomileusis, LASIK). Обидва методи є ефективними, проте вибір між ними залежить від індивідуальних особливостей ока, товщини рогівки та способу життя пацієнта. LASIK є швидшим та безболісним методом (реабілітація продовжується 1-2 дні), однак передбачає формування рогівкового клаптя. PRK (ФРК) – це поверхневий метод без створення клаптя, що доцільно при тонкій рогівці, але така методика супроводжується довшим та дискомфортнішим періодом відновлення (3-5 днів).

Безпека сучасної лазерної корекції [3] додатково забезпечується системами Eye-tracking, які відстежують, контролюють мікроруки ока і нівелюють людський фактор (мимовільні рухи пацієнта). Система сканує положення зіниці з частотою до 1000 Гц, тобто 1000 разів на секунду. Якщо пацієнт різко відведе погляд або чхне, система автоматично заблокує роботу лазера. Процедура відновиться лише тоді, коли око знову повернеться у правильне положення, що гарантує вплив саме на розраховану зону рогівки.

Висновки. Лазерна корекція зору є високотехнологічним методом реконструктивної офтальмології, що базується на точному керуванні фотоабляцією рогівки. Зміна її радіуса кривизни дозволяє відновити оптичний баланс ока та забезпечити стабільний рефракційний результат. Використання математичних алгоритмів планування, зокрема, алгоритму Муннерліна, сучасних систем контролю та фізичних принципів «холодної» абляції забезпечує індивідуалізацію лікування, мінімізує ризики ускладнень і підвищує ефективність лікування. Розуміння всіх механізмів дії та принципів

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проведення фотоабляції є критично важливим для офтальмологів, оскільки забезпечує прогнозування стабільного зорового результату.

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Удосконалення електропривода токарно-карусельного верстата

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Анотація. Проведено аналіз роботи системи керування електропривода подачі токарно-карусельного верстата.

Ключові слова: токарно-карусельний верстат, електропривод, перехідна характеристика, математичне моделювання, показники якості системи керування, нелінійна система.

Верстати із використанням ЧПК мають більш різноманітні технологічні можливості, порівняно зі звичайними, при цьому зберігаючи високу надійність роботи. Конструкція верстатів із ЧПК повинна, як правило, забезпечувати сполучення різних способів обробки, зручність завантаження заготовок, вивантаження деталей, автоматичне або дистанційне керування зміною інструмента і т.п[1]. Найбільш відомі класифікації верстатів із ЧПК:

- за рівнем технічних можливостей;
- за технологічним призначенням;

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- за числом потоків інформації;
- за принципом завдання програми;
- за типом електропривода;
- за числом одночасно керованих координат.

Верстат одностійковий токарно-карусельний моделі 1512Ф3 призначений для токарної обробки деталей складної конфігурації. Він відноситься до класу точності Н[2]. На верстаті виконується обробка поверхонь з прямолінійними та криволінійними утворюючими методами точення та розточування; проводиться свердління, зенкерування та розгортання центральних отворів; виконується прорізування кільцевих канавок, а також нарізування різних видів різьблення різцями.

Пристрій ЧПК типу Н55-2 забезпечує автоматичне керування по заданій програмі вертикальним супортом і приводом головного руху. Число координат – 2. Дискретність відліку по осях X і Z . дорівнює 0,01 мм. Передбачено корекцію положення інструмента, величин подач і частот обертання планшайби[3]. Від програми відбувається автоматична зміна частот обертання шпинделя, керування повздовжніми і поперечними рухами інструмента, вибір подач, нарізування різьблень, установка інструмента в нульове положення, поворот і фіксація револьверної головки.

Для привода подач у верстаті використовується електродвигун постійного струму серії ПБВ, який виготовляється із незалежним збудженням, без стабілізуючої та послідовної обмотки. Стійка робота двигуна постійного струму забезпечується схемою керування електропривода. Вони призначені для роботи із діапазоном регулювання 1÷10000 в широко регульованих електроприводах. Для короточасних режимів (до 5 хвилин) використовується зміна напруги на якорі. Двигуни ПБВ допускають роботу із малими частотами обертання (0,5 – 1,5 об/хв) при номінальному збудженні і момент, який не перевищує номінального.

Для системи керування приводом подач було обрано електропривод ЕТУ-3601. Він розроблений для побудови на базі високомоментних двигунів постійного струму приводів швидкодіючих з широким діапазоном регулювання (від 1 до 10000). Такі приводи застосовуються у металорізальних верстатах, включаючи обладнання з числовим програмним керуванням (ЧПК).

Для приводу подач була реалізована система підпорядкованого регулювання, яка являє собою багатоконтурну систему з каскадним включенням регуляторів.

Після розрахунку параметрів системи керування, були

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отримані данні, які зведено в таблиці 1.

Таблица 1

Параметри системи керування										
T_{pc}	K_{pc}	T_e	T_{μ}	$K_{рш}$	$K_{рш1}$	$T_{рш}$	$K_{ззш}$	$T_{\mu ш}$	$T_{гп}$	$k_{гп}$
0,0054	0,94	0,0051	0,00396	3,69	3,68	0,009	0,048	0,00858	0,0033	15,02

Побудуємо модель системи керування електроприводом подачі верстата у модулі *Simulink* програмного пакету *Matlab* на основі розрахованої математичної моделі. Структурна схема, яка включає до свого складу П – регулятор, ПІ –регулятор та фільтр показана на рис. 1.

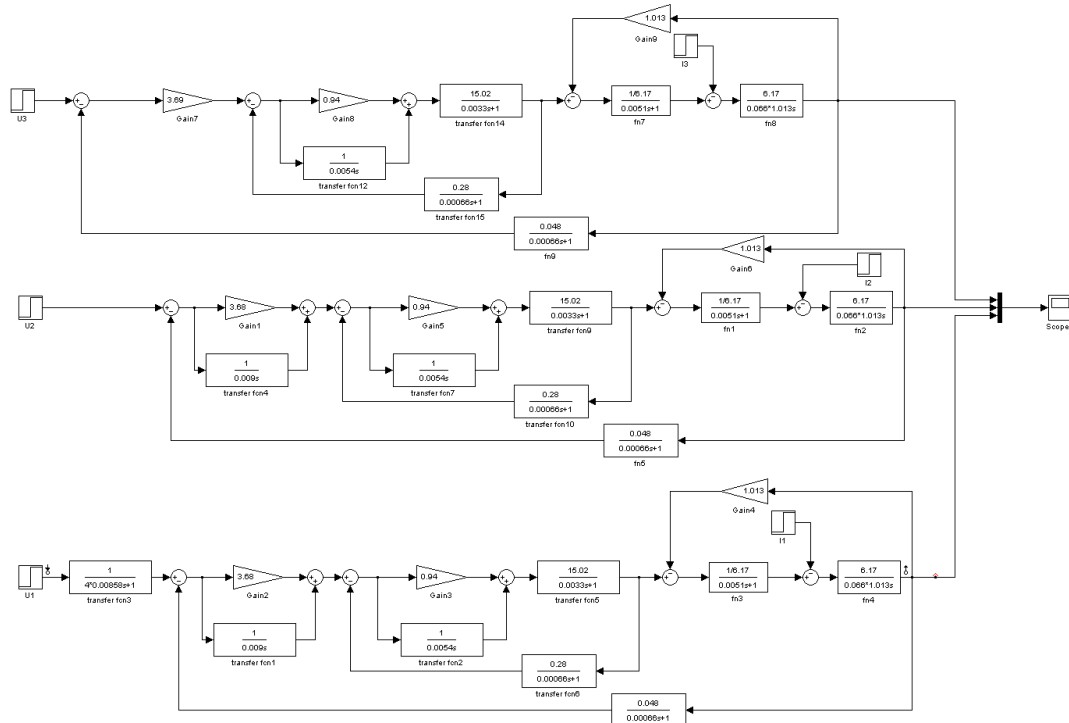


Рисунок 1

Також, використовуючи модель системи керування, зображену на рис.1 отримаємо перехідні характеристики за кутовою швидкістю для всіх типів регуляторів. Результат представлений на рис. 2, де 1 – система з П-регулятором швидкості, 2 – система з ПІ-регулятором швидкості, 3 – система з ПІ-регулятором швидкості з фільтром на вході.

З рис. 2 отримуємо: що система з П-регулятором статичної помилки не має, час регулювання $t_p = 0,0998$ с, перерегулювання $\sigma = 0\%$; система з ПІ-регулятором статичної помилки не має,

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час регулювання $t_p = 0,149$ с, перерегулювання $\sigma = 22,2\%$;
система з ПІ-регулятором та фільтром статичної помилки не
має, час регулювання $t_p = 0,177$ с, перерегулювання $\sigma = 10,2\%$.

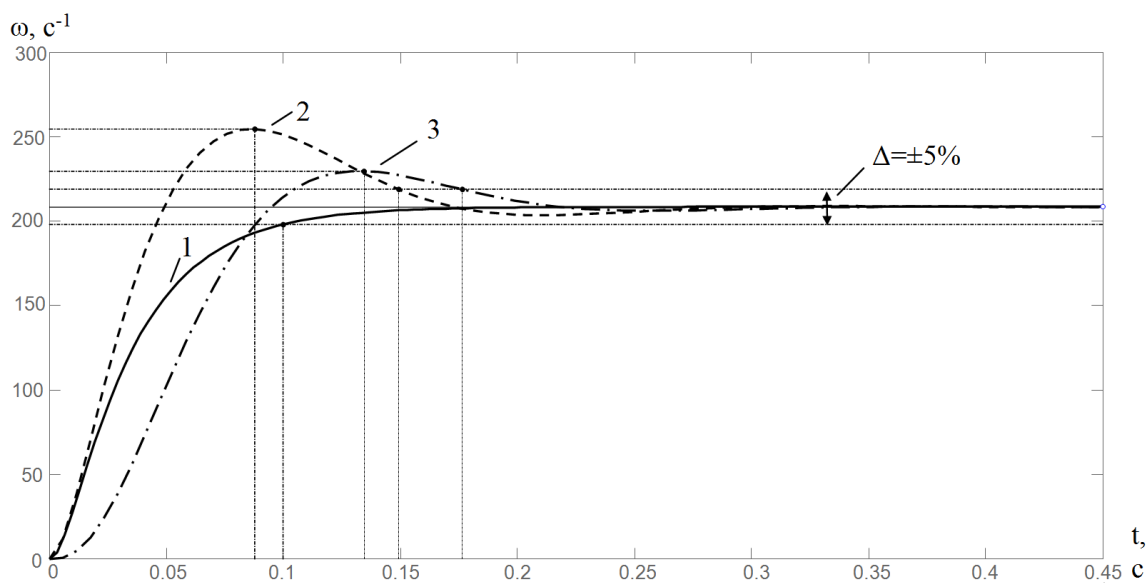


Рисунок 2

Висновок

Метою роботи був аналіз системи керування привода подач токарно-карусельного верстата [4, 5]. В результаті роботи було вирішено наступні задачі:

- Для аналізу був обраний верстат 1512Ф3 та розглянуто його технічні параметри та склад електрообладнання.

- Побудована математична модель роботи системи керування та обчислені її параметри.

- За отриманими даними побудували структурну схему підпорядкованого регулювання та промодельовали її для трьох варіантів виконання системи керування електроприводом: з П-регулятором; ПІ-регулятором; та ПІ-регулятором із фільтром на вході.

- Отримали статичні та динамічні характеристики системи. Результати дослідження показують:

1. П-регулятор не усуває усталену помилку керування, тому не може бути ефективним рішенням.

2. ПІ-регулятор усуває усталену помилку керування, але має занадто великий показник перерегулювання $\delta\delta=22\%$.

3. ПІ-регулятор із фільтром на вході системи також усуває усталену помилку керування, але має найкращі якісні показники керування: час перехідного процесу $TT=0,177$ с та

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перерегулювання $\delta\delta=10,2\%$.

Тому робимо висновок, що оптимальний вибір – ПІ-регулятор із фільтром на вході.

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Investigation of the Molecular and Structural Properties of Cotton and Silk Fibers using Raman Spectra

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Abstract. In this study, the molecular and structural properties of cotton and silk fibers were analyzed using Raman spectroscopy. The Raman spectra were acquired at room temperature within a spectral range of 50÷1200 cm⁻¹, utilizing a 785 nm wavelength laser. The obtained spectral data were processed using OriginLab and Fityk software to determine the center, intensity, area, and full width at half maximum (FWHM) of the main Raman modes. In the cotton fiber spectrum, peaks were identified around 274, 300, 335, 426, 472, 540, 618, 1090, 1125, and 1159 cm⁻¹, which were analyzed in relation to the molecular vibrations and structural arrangement characteristic of the fiber. In the Raman spectrum of the silk fiber, the presence of a series of vibrational modes was observed in the 280–1654 cm⁻¹ range, which was attributed to the ordered and less-ordered regions of the fibroin-based protein structure. These findings demonstrate that Raman spectroscopy is an effective non-destructive method for evaluating the internal molecular structure, structural state, and vibrational modes of natural polymer fibers such as cotton and silk.

Keywords: cotton fiber, silk fiber, natural polymer, Raman spectroscopy, molecular structure, structural features, cellulose, fibroin, vibrational modes, FWHM.

In the present day, natural polymer materials, particularly cotton and silk fibers, are becoming increasingly important not only in the textile industry but also in modern science for creating biomaterials, ecologically safe materials, and functional materials. The natural origin, renewability, biocompatible properties, and complex internal structure of these materials necessitate their in-depth research [1]. The electrophysical properties of cotton and silk fibers are likely linked to their molecular structure, degree of internal ordering, the ratio of crystalline to amorphous regions, and the intermolecular

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interactions within the fibers [2,3]. Therefore, determining the molecular-structural state of these fibers holds significant scientific importance for explaining their physical and functional properties.

Raman spectroscopy is an effective method for studying the molecular and structural properties of natural fibers, as it allows for non-destructive analysis [4-6]. This technique provides information about molecular vibrations, structural ordering, phase states, and intermolecular interactions within a substance [6]. The molecular and structural state of cotton and silk fibers is evaluated based on the position, intensity, and width of the peaks in their Raman spectra [4, 7, 8]. In this context, analyzing the molecular and structural properties of cotton and silk fibers using their Raman spectra is crucial for elucidating the internal structure of natural polymeric materials and drawing scientific conclusions about their physical properties.

Materials and methods

Prior to Raman analysis, cotton and silk fibers were specially prepared. The cotton fibers underwent chemical treatment in an alkaline medium. For this, the samples were immersed in aqueous solutions of various concentrations of potassium hydroxide (KOH) and sodium hydroxide (NaOH) at 100°C for 3 hours. Following the chemical treatment, the samples were washed in a 1.5% aqueous solution of hydrogen peroxide. In the next stage, the cotton fibers were dried for at least 72 hours in a sealed chamber, protected from external factors. The dried samples were then made ready for Raman spectroscopic analysis. Raman spectroscopic studies were conducted at room temperature using a Raman microscope based on a high-sensitivity QE Pro spectrometer. A laser with a wavelength of 785 nm was utilized as the excitation source, and the spectral analyses were performed in the 50÷1200 cm⁻¹ range. The initial processing of the obtained spectral data, graphical representation, and peak separation were carried out using OriginLab software. For a more detailed analysis of the spectra, including peak fitting and determining their center, height, area, and full width at half maximum (FWHM) parameters, Fityk software was used.

Results and Discussion

Based on the analysis of the Raman spectrum of cotton fibers presented in Figure 1, the primary peaks corresponding to values of 274, 300, 335, 426, 472, 540, 618, 1090, 1125, and 1159 cm⁻¹ were identified (Table 1). These peaks are

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characterized by the vibrational modes specific to the molecular structure, crystal lattice elements, and functional groups of natural cellulose polymer fibers. The identified peaks allow for an assessment of the structural state of the cotton fiber, particularly the nature of its chemical bonds, inter-chain interactions, and degree of crystallinity. The peaks at 274, 300, and 335 cm^{-1} , observed in the low-frequency range of 250–350 cm^{-1} , correspond to the collective vibrations of cellulose molecular compounds, namely the bending modes of C-C-O and C-O-C bonds. This range is typically characterized by the overall deformational vibrations of the crystal lattice and molecular chains, representing vibrations inherent to the entire structure rather than a single specific bond [9,10].

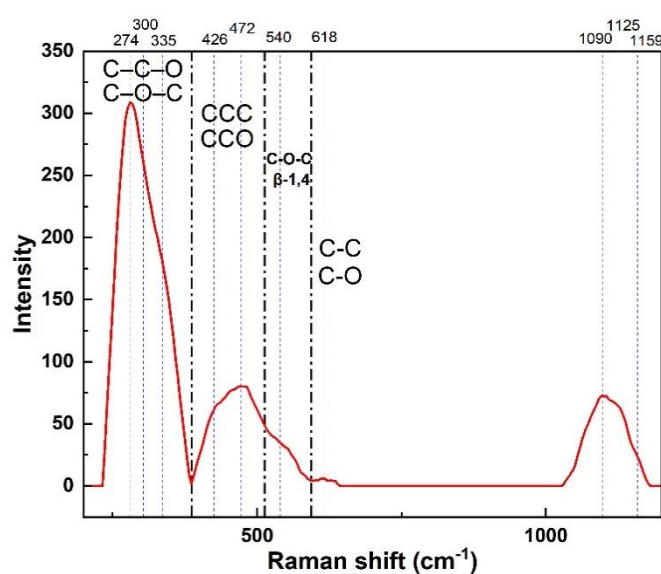


Figure 1
Raman spectrum of cotton fiber

The peaks in the 426 and 472 cm^{-1} range are associated with the deformational vibrations of the cellulose ring structure, corresponding to the bending modes of CCC and CCO-type bonds. Specifically, the peaks in the 458–475 cm^{-1} range are characteristic of the pyranose ring deformation in cellulose, and these results are in good agreement with the literature data [10, 11]. The peak observed at approximately 540 cm^{-1} is attributed to the vibrational modes of the C-O-C glycosidic bond, which characterizes the β -1,4 linkages of the cellulose chains. This peak is considered one of the main identifying features of cellulose. The peak in the 618 cm^{-1}

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range, however, is explained by the mixed combination vibrations of C-C and C-O bonds. This range usually appears in a broad form due to the overlap of several vibrational modes and is considered sensitive to the structural disorder of the fibers.

Table 3.1

Parameters of the Raman modes identified in cotton fiber			
Center:	Area:	Height:	FWHM:
274.7916082	6212.57	215.756	27.0505
300.8974324	10670.6	246.873	40.6052
335.9710761	5268.78	150.1	32.9759
426.3649219	1528.99	41.7544	34.401
472.5337887	5829.67	81.3717	67.3035
540.2255938	2021.33	31.0273	61.2012
618.6740648	172.785	5.40838	30.0129
1090.09312	3096	59.6925	48.7246
1125.120722	2763.24	58.4889	44.3826
1159.140027	247.173	12.5731	18.4683

The peaks at 1090, 1125, and 1159 cm⁻¹, detected in the high wavenumber range of 1000-1200 cm⁻¹, represent the main “fingerprint region” of cellulose. The 1090 cm⁻¹ peak corresponds to the stretching vibrations of C-O and C-C bonds. The 1125 and 1159 cm⁻¹ peaks are associated with the symmetric and asymmetric stretching vibrations of the C-O-C glycosidic bond, which are important for determining the degree of order and crystallinity of the cellulose chain.

The analysis results demonstrated that the Raman spectroscopy method is highly effective in evaluating the structural state of cotton fibers, specifically the nature of chemical bonds, interchain interactions, and the degree of crystallinity. Thus, the Raman method was confirmed to be a reliable, rapid, and informative research technique for determining the molecular and structural properties of natural polymer fibers.

In this study, the structural properties of silk fiber were analyzed using Raman spectra (Figure 2). The resulting spectrum indicates a protein structure characteristic of silk fiber, particularly a state where fibroin's β -sheet structure is predominant, with the additional presence of less-ordered amorphous components. In Raman analysis, the most important diagnostic regions for silk are typically around Amide III (approximately 1229 and 1266 cm⁻¹) and Amide I (approximately 1666 cm⁻¹); these zones correspond to the β -sheet and helical structure components (Table 2) [12]. The peaks at 1223 cm⁻¹

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and 1270 cm^{-1} in the graph correspond exactly to the Amide III region. In the literature, the peak at $\sim 1229\text{ cm}^{-1}$ is considered the most crucial marker for identifying the β -sheet conformation in silk fibroin, while the component around $\sim 1266\text{ cm}^{-1}$ is associated with helical structures or less-ordered regions. The spectrum's relatively strong peak at 1223 cm^{-1} and the distinct separation of the component around 1270 cm^{-1} lead to the conclusion that the sample has a large proportion of β -sheets, but also contains an amorphous or low-ordered phase. This indicates that silk fiber is not entirely single-phase but is rather a combination of ordered crystalline domains and flexible amorphous domains [13].

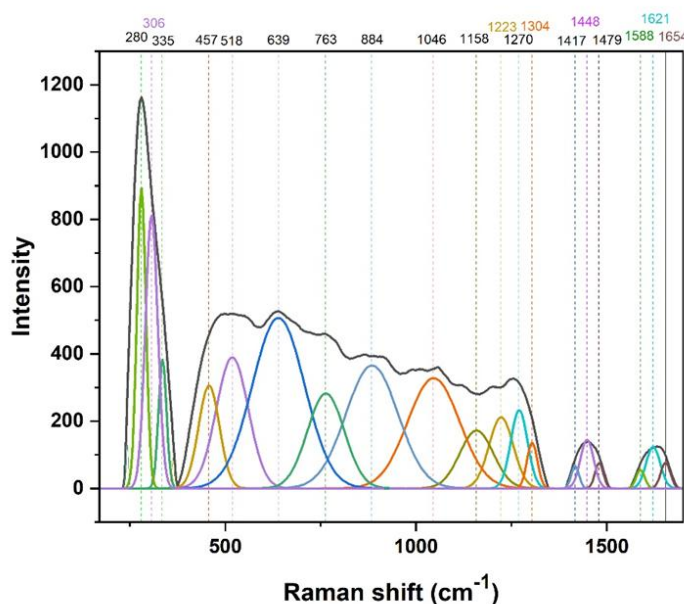


Figure 2
Raman spectrum of a silk fiber

The 1654 cm^{-1} peak in the upper region of the spectrum corresponds to the Amide I band of the protein. For silk fiber, the Raman Amide I maximum is typically observed at $\sim 1666\text{ cm}^{-1}$ and is interpreted in relation to the overall secondary structure of the silk, particularly its β -sheet character. The apparent shift of the peak center to 1654 cm^{-1} can be explained by several factors, such as its orientation and dependence on the cocoon type. For this reason, the 1654 cm^{-1} peak can be interpreted as the primary Amide I component of the silk protein [14]. The 1621 cm^{-1} peak observed

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in the spectrum is often considered to represent strongly hydrogen-bonded ordered regions, additional secondary structural components, or an adjacent shoulder resolved during the fitting process. Therefore, the 1621 cm^{-1} peak indicates that the internal structure of the sample is not homogeneous and that the Raman Amide I band is composed of at least two to three overlapping components [15].

The peaks at 763 cm^{-1} , 884 cm^{-1} , and partially within the 1417÷1479 cm^{-1} range, may be associated with amino acid residues and side-chain vibrations in silk. In the Raman spectrum of silk fibroin, aromatic amino acids-particularly tyrosine, tryptophan, and phenylalanine-make a significant contribution. In scientific literature, the 830850 cm^{-1} range is cited as the classic “doublet peak” zone for tyrosine and is used as a basis in research to assess the hydrogen bonding state of tyrosine phenoxyl groups and the degree to which they are “buried/exposed”. In the spectrum, the 884 cm^{-1} peak does not fully correspond to the classic 829-854 cm^{-1} doublet; however, it is known that aromatic side chains and skeletal vibrations in silk contribute to the 830-900 cm^{-1} region [16]. The line around 1555 cm^{-1} is associated in the literature with the tryptophan indole ring; building on this, the 1588 cm^{-1} peak in the spectrum may also have a contribution from C-substituted benzene ring residues [17].

Table 2

Raman Spectral Parameters of Silk Fiber				
Nº	Center:	Area:	Height:	FWHM:
1	280.2790471	26228.1	893.865	27.5653
2	306.9380758	33002.1	814.188	38.079
3	335.5786902	10050	383.235	24.636
4	457.4734489	20983.4	306.193	64.3797
5	518.4693682	41051	389.782	98.9397
6	639.512394	87176.8	507.067	161.511
7	763.8322876	34206.6	282.264	113.847
8	884.6838585	62705.7	365.394	161.218
9	1046.362886	56022.8	327.768	160.571
10	1158.787153	19012.1	171.966	103.862
11	1223.212883	16840.4	211.485	74.8064
12	1270.359884	12760.6	232.842	51.4847
13	1304.447308	4669.42	135.901	32.2781
14	1417.273303	1675.91	66.3491	23.7293
15	1448.231224	6266.22	145.088	40.5734
16	1479.996847	2065.91	75.5752	25.6802
17	1588.420195	1548.69	55.0423	26.4323
18	1621.664917	5737.4	123.394	43.6807
19	1654.151719	2411.29	76.6696	29.5457

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The range between 1417, 1448, and 1479 cm^{-1} is typically associated with CH_2/CH_3 deformation vibrations in proteins and specific amino acid side chains. Research has shown that the peak around 1404 cm^{-1} is related to serine, and also that deformations of the methyl ($-\text{CH}_3$) and methylene ($-\text{CH}_2$) groups are sensitive to orientation and modification [18]. Therefore, the multi-component structure in the 1417–1479 cm^{-1} region of the spectrum indicates not just a single simple vibration in the silk fiber, but also the presence of overlapping vibrations from serine, alanine-glycine segments, and CH groups ($\text{CH}_3-\text{CH}_2-\text{CH}_2-\text{CH}_3$). This zone changes significantly, especially if the fiber has been treated or if sericin (the natural adhesive protein in silk fiber) has not been completely removed.

The 280, 306, 335, 457, and 518 cm^{-1} peaks in the low-frequency region of the Raman spectrum may be convoluted with the general backbone vibrations of the silk fiber (C-C, C-N, C-O) and with additional substances on the sample surface, such as sericin residue, mineral impurities, or even instrumental artifacts [19].

In summary of the overall structure, the Raman spectrum of the silk fiber showed a distinct peak at 1223 cm^{-1} , which is characteristic of a β -sheet structure where protein macromolecules are arranged side-by-side and stabilized by mutual H-bonds. The presence of a low-order component around 1270 cm^{-1} and the strong appearance of the Amide I band at 1654 cm^{-1} indicate that fibroin is predominant in the silk fiber, and within it, ordered regions with a β -sheet structure constitute the main share. At the same time, the peaks at 1270 cm^{-1} and 1621 cm^{-1} , along with the broad 1400–1600 cm^{-1} region corresponding to multiple vibrations, suggest that the sample is not completely monophasic. This indicates the presence of disordered structures, flexible segments, and side chains, possibly with sericin residues. In other words, this spectrum confirms that silk fiber is a classic semi-crystalline protein material.

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INFORMATION AND WEB TECHNOLOGIES

Sentiment Analysis of Social Media Texts using NLP and Machine Learning

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Abstract. The rapid growth of social media platforms has generated a massive amount of textual data reflecting public opinion on various topics such as products, services, and social events. Analyzing these opinions manually is inefficient due to the scale and speed of information generation. Sentiment analysis, a subfield of Natural Language Processing, enables automated detection of emotional tone in textual content. This study proposes a machine learning-based approach for analyzing sentiments in social media texts. The research integrates NLP preprocessing techniques with machine learning algorithms to classify sentiments into positive, negative, and neutral categories. Text data were processed using tokenization, stop-word removal, and feature extraction methods such as TF-IDF. Classification models including Naive Bayes and Support Vector Machine were applied to evaluate sentiment patterns. Experimental results demonstrate that machine learning models can effectively classify social media sentiments with high accuracy. The findings highlight the potential of combining NLP techniques with machine learning methods for large-scale opinion mining and decision support systems.

Keywords: *sentiment analysis, natural language processing, machine learning, social media analytics, text classification.*

INTRODUCTION

The increasing popularity of social media platforms has transformed the way individuals express opinions and share experiences online. Platforms such as Twitter, Facebook, and Instagram generate large volumes of textual information containing valuable insights into public sentiment regarding products, services, and social issues. Extracting meaningful information from such data requires automated analytical approaches.

Sentiment analysis has become an important research area within Natural Language Processing. It focuses on identifying emotional attitudes expressed in textual content and classifying them into categories such as positive, negative, or neutral. This technique enables organizations to better

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understand user opinions and improve decision-making processes.

Traditional text analysis methods often struggle with the complexity and variability of natural language. However, recent developments in Machine Learning have significantly improved the accuracy of automated sentiment classification. By combining NLP preprocessing techniques with machine learning algorithms, large volumes of unstructured social media data can be efficiently analyzed [2–3].

This study aims to develop a machine learning-based framework for sentiment analysis of social media texts. The research investigates the effectiveness of several NLP preprocessing techniques and evaluates the performance of machine learning classifiers for sentiment prediction.

The main objectives of this research are:

- to preprocess social media text data using NLP techniques;
- to extract relevant textual features;
- to apply machine learning algorithms for sentiment classification;
- to evaluate the performance of the proposed models.

METHODOLOGY

The proposed approach for sentiment analysis consists of several stages including data collection, text preprocessing, feature extraction, machine learning classification, and evaluation.

2.1 Data Collection

A dataset of social media texts was collected from publicly available sources containing user comments and opinions. The dataset includes texts labeled according to sentiment categories: positive, negative, and neutral [1].

2.2 Text Preprocessing

Before applying machine learning algorithms, raw text data must be cleaned and normalized. The following NLP preprocessing steps were applied:

- **Tokenization** – dividing text into individual words or tokens
- **Lowercasing** – converting all characters to lowercase
- **Stop-word removal** – removing frequently occurring words without semantic meaning
- **Stemming / Lemmatization** – reducing words to their base forms

These steps help reduce noise in the dataset and improve model performance.

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Social media texts contain noise such as punctuation, emojis, hyperlinks, and informal language. Therefore, text preprocessing is required before applying machine learning algorithms. The preprocessing stage includes tokenization, normalization, stop-word removal, and stemming [8].

Let the dataset of textual documents be represented as:

$$D = \{d_1, d_2, d_3, \dots, d_n\}$$

where

d_i represents the i -th document in the dataset and n is the total number of documents.

Each document is transformed into a sequence of tokens [5]:

$$d_i = \{\omega_1, \omega_2, \omega_3, \dots, \omega_m\}$$

2.3 Feature Extraction using TF-IDF

To apply machine learning algorithms, textual data must be converted into numerical feature vectors. In this study, the Term Frequency-Inverse Document Frequency (TF-IDF) method was used [10].

The term frequency (TF) is defined as:

$$TF(t, d) = \frac{f_{t,d}}{\sum_k f_{k,d}}$$

where

$f_{t,d}$ – frequency of term t in document d

The inverse document frequency (IDF) is calculated as:

$$IDF(t) = \log \frac{N}{n_t}$$

where

N – total number of documents

n_t – number of documents containing term t

The TF-IDF weight is computed as:

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$$TFIDF(t,d)=TF(t,d)\times IDF(t)$$

This transformation produces a numerical feature matrix used for classification.

2.4. Sentiment Classification Models

Two machine learning models were applied for sentiment classification.

The Naive Bayes classifier is based on Bayes' theorem, which calculates the probability of a sentiment class given the observed features [12].

$$P(c|x)=\frac{P(x|c)P(c)}{P(x)}$$

where

c – sentiment class

x – feature vector

The predicted sentiment class is determined as:

$$\hat{c} = \underset{c}{\operatorname{argmax}} P(c) \prod_{i=1}^n P(x_i | c)$$

This probabilistic approach is widely used in text classification due to its computational efficiency.

2.5 Performance Evaluation

To evaluate the performance of the models, the following metrics were used:

- Accuracy:

$$Accuracy = (TP + TN) / (TP + TN + FP + FN)$$

- Precision

$$Precision = (TP) / (TP + FP)$$

- Recall

$$Recall = (TP) / (TP + FN)$$

- F1-score

$$F1 = 2 \times \frac{Precision \times Recall}{Precision + Recall}$$

These metrics provide a comprehensive assessment of classification effectiveness.

RESULTS

The machine learning models were trained and tested using

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the processed dataset. The performance results of the classification models are summarized below [15].

Table 1
Performance Evaluation of Machine Learning Models for Sentiment Classification

Model	Accuracy	Precision	Recall	F1-score
Naive Bayes	82%	80%	81%	80%
SVM	88%	87%	86%	87%

The experimental results indicate that both models are capable of detecting sentiment patterns in social media texts. However, the SVM classifier demonstrates higher accuracy compared to the Naive Bayes model.

The results also show that the use of NLP preprocessing techniques significantly improves classification performance. Feature extraction using TF-IDF helps highlight informative words that contribute to more accurate sentiment prediction.

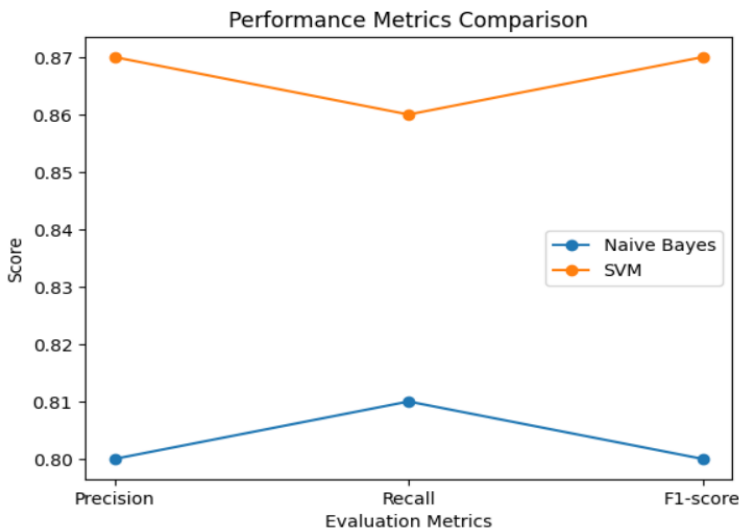


Figure 1
Comparison of Evaluation Metrics for Sentiment Classification Models

Figure 1 presents a comparison of evaluation metrics for both classification models. The results demonstrate that the SVM model consistently outperforms the Naive Bayes classifier across all metrics, including precision, recall, and F1-score [9].

DISCUSSION

The findings of this study demonstrate the effectiveness of combining NLP techniques with machine learning algorithms

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for sentiment analysis tasks. Social media platforms generate large volumes of unstructured text data, making automated analysis essential for extracting meaningful insights.

The results confirm that machine learning models can successfully identify sentiment patterns within textual data. Among the tested models, the Support Vector Machine classifier achieved the highest accuracy. This result aligns with previous research indicating that SVM performs well in high-dimensional text classification problems.

Another important observation is the impact of text preprocessing on model performance. Techniques such as tokenization, stop-word removal, and TF-IDF feature extraction help reduce noise and improve classification accuracy [14].

Despite the promising results, several limitations should be noted. Social media texts often contain slang, abbreviations, and informal language, which can complicate sentiment detection. Additionally, sarcasm and contextual meaning remain challenging for traditional machine learning models.

Future research may explore deep learning architectures such as recurrent neural networks and transformer-based language models to further improve sentiment classification performance [13].

CONCLUSION

This study investigated the application of NLP and machine learning techniques for sentiment analysis of social media texts. The proposed framework includes text preprocessing, feature extraction using TF-IDF, and sentiment classification using machine learning algorithms.

Experimental results show that both Naive Bayes and Support Vector Machine models can effectively classify social media sentiments. The SVM classifier achieved the highest accuracy, demonstrating its suitability for sentiment analysis tasks.

The integration of NLP preprocessing methods significantly enhances the effectiveness of sentiment classification. These findings highlight the potential of automated sentiment analysis systems for analyzing large-scale social media data.

Future work may focus on incorporating deep learning models and multilingual datasets to improve sentiment detection accuracy and extend the applicability of the proposed approach.

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Detection of Phishing Attacks using Machine Learning

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Abstract. Phishing attacks remain a significant cybersecurity threat, exploiting human vulnerabilities to obtain sensitive information such as login credentials and financial data. This study proposes a machine learning-based approach for phishing detection using artificial intelligence techniques. Experimental results demonstrate high performance of the Random Forest model.

Keywords: Machine Learning, Artificial Intelligence, Phishing Detection, Random Forest, Cybersecurity.

Introduction

Phishing is one of the most widespread cybersecurity threats. Traditional methods such as blacklist systems are insufficient for detecting new attacks. The rapid expansion of internet technologies and online services has led to an increase in sophisticated cybersecurity threats. Among these, phishing attacks are one of the most prevalent and dangerous forms of cybercrime. Phishing involves deceiving users into revealing sensitive information, such as usernames, passwords, and financial details, by impersonating legitimate entities through fraudulent communications.

Traditional phishing detection methods, including blacklist-based and rule-based systems, have been widely used. However, these approaches suffer from significant limitations. Blacklist systems fail to detect newly generated phishing URLs, while rule-based methods lack the adaptability required to respond to evolving attack techniques. Consequently, there is a growing demand for more intelligent and adaptive detection mechanisms.

Artificial Intelligence (AI) and Machine Learning (ML)

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have emerged as effective solutions for complex cybersecurity challenges. By learning patterns from large datasets, ML models can distinguish between legitimate and malicious instances with high accuracy. This study proposes a machine learning-based framework for phishing detection and provides a comparative analysis of different classification algorithms [1-2-3].

Phishing detection has been extensively studied using various approaches. Early methods relied on blacklist-based systems, which block known malicious URLs but are ineffective against new threats. Heuristic-based techniques attempted to identify phishing characteristics using predefined rules; however, these approaches often resulted in high false positive rates and limited flexibility.

Recent research has focused on machine learning techniques, which utilize features derived from URLs, webpage content, and domain information. Traditional classifiers such as Decision Trees, Naïve Bayes, Support Vector Machines (SVM), and Logistic Regression have shown promising results. Ensemble methods, particularly Random Forest, have gained attention due to their robustness and ability to handle complex datasets.

Deep learning approaches, including Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs), have further improved detection performance by automatically learning feature representations. However, these methods require large datasets and high computational resources. Despite advancements, challenges such as zero-day attack detection, false positives, and real-time performance remain unresolved [4-5-6].

Methodology

The dataset consists of phishing and legitimate samples. Features are extracted from URLs and content. Models such as Random Forest and Logistic Regression are applied. In this paper, a dataset consisting of both phishing and legitimate samples is utilized to train and evaluate the proposed models.

Dataset and Preprocessing. A dataset consisting of phishing and legitimate samples is used in this study. The data may include URLs or email-based instances collected from public sources or simulated environments. Each sample is labeled accordingly and preprocessed to remove duplicates, handle missing values, and normalize features. The dataset is divided into training (80%) and testing (20%) subsets.

Feature Extraction. Feature extraction is essential for

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effective classification. Three categories of features are considered:

URL-Based Features:

- URL length
- Number of special characters (e.g., "@", "-", "_", "/")
- Presence of IP address instead of domain name
- Number of subdomains
- Use of HTTPS protocol
- Domain age (if available)

Such features help identify suspicious patterns commonly used in phishing URLs.

Content-Based Features:

- Presence of sensitive keywords (e.g., "login", "verify", "password")
- HTML structure analysis (e.g., number of forms, external links)
- Use of JavaScript for redirection
- Mismatch between displayed and actual links
- Content-based features provide deeper insight into the intent and behavior of the webpage.

Behavior-Based Features:

- Redirection frequency
- Page loading behavior
- User interaction patterns
- Time-based activity patterns

These features are particularly useful for detecting sophisticated or dynamic phishing attacks [7-8-9-10].

Machine Learning Models. The following models are implemented and evaluated:

Random Forest: An ensemble method combining multiple decision trees for improved accuracy and robustness.

Logistic Regression: A linear classification model suitable for binary outcomes

Support Vector Machine (SVM): Effective for complex decision boundaries.

Neural Network: Capable of modeling nonlinear relationships in data.

Evaluation Metrics. Model performance is evaluated using standard metrics: Accuracy, Precision, Recall, F1-score, and ROC-AUC.

- Accuracy
- Precision
- Recall
- F1-score

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- ROC-AUC score

These metrics provide a comprehensive assessment of the model’s ability to correctly identify phishing and legitimate instances.

Results

The experimental results indicate that all models can effectively classify phishing and legitimate samples. However, the Random Forest classifier consistently achieves superior performance across all evaluation metrics.

Table 1

The Receiver Operating Characteristic (ROC) curves models

Model	Accuracy	Precision	Recall	F1-score.
Random forest	98.15	98.12	98.42	98.19
Logistic Regression / Support Vector Machine (SVM)	91.24	89.52	92.72	91.14
Neural Network	91.12	89.22	92.42	91.24

ML-Based Phishing Detection

```
import numpy as np
import pandas as pd
import re
import random

from sklearn.model_selection import train_test_split
from sklearn.ensemble import RandomForestClassifier
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import accuracy_score,
precision_score, recall_score, f1_score, roc_auc_score,
roc_curve
import matplotlib.pyplot as plt

# -----
# 1. SIMULATED DATASET
# -----

def generate_url(phishing=True):
    """Generate a simulated phishing or legitimate URL."""
    if phishing:
```

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```
        return f"http://{random.choice(['login', 'secure',
'verify'])}-
{random.randint(100,999)}.com/account{random.randint(1,100)}
"

    else:
        return f"https://www.{random.choice(['google', 'amazon',
'facebook'])}.com/home"

# Create dataset
data = []

# Phishing URLs
for _ in range(500):
    url = generate_url(phishing=True)
    data.append((url, 1))

# Legitimate URLs
for _ in range(500):
    url = generate_url(phishing=False)
    data.append((url, 0))

# Shuffle dataset to mix phishing and legitimate URLs
random.shuffle(data)

df = pd.DataFrame(data, columns=["url", "label"])

# -----
# 2. FEATURE EXTRACTION
# -----

def extract_features(url):
    """Extract basic features from a URL for ML model."""
    features = {}

    features['url_length'] = len(url)
    features['num_digits'] = len(re.findall(r'\d', url))
    features['has_https'] = 1 if url.startswith("https")
else 0
    features['num_special_chars'] = len(re.findall(r'[@\-\
_./]', url))
    features['has_login_word'] = 1 if "login" in url.lower()
else 0
    features['num_subdomains'] = url.count('.') - 1 #
Subtract 1 for main domain
    return features
```

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```
# Apply feature extraction
features_df =
pd.DataFrame(df['url'].apply(extract_features).tolist())

X = features_df
y = df['label']

# -----
# 3. TRAIN / TEST SPLIT
# -----

X_train, X_test, y_train, y_test = train_test_split(
    X, y, test_size=0.2, random_state=42, stratify=y
)

# -----
# 4. MODELS
# -----

rf_model = RandomForestClassifier(n_estimators=100,
random_state=42)
lr_model = LogisticRegression(max_iter=1000,
random_state=42)

# Fit models
rf_model.fit(X_train, y_train)
lr_model.fit(X_train, y_train)

# -----
# 5. PREDICTIONS
# -----

rf_preds = rf_model.predict(X_test)
lr_preds = lr_model.predict(X_test)

rf_probs = rf_model.predict_proba(X_test)[:,-1]
lr_probs = lr_model.predict_proba(X_test)[:,-1]

# -----
# 6. EVALUATION
# -----

def evaluate_model(name, y_true, preds, probs):
    print(f"\n{name} Results:")
```

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```
print(f"Accuracy: {accuracy_score(y_true, preds):.4f}")
print(f"Precision: {precision_score(y_true,
preds):.4f}")
print(f"Recall: {recall_score(y_true, preds):.4f}")
print(f"F1 Score: {f1_score(y_true, preds):.4f}")
print(f"ROC-AUC: {roc_auc_score(y_true, probs):.4f}")

# Evaluate models
evaluate_model("Random Forest", y_test, rf_preds,
rf_probs)
evaluate_model("Logistic Regression", y_test, lr_preds,
lr_probs)

# -----
# 7. ROC CURVE
# -----

rf_fpr, rf_tpr, _ = roc_curve(y_test, rf_probs)
lr_fpr, lr_tpr, _ = roc_curve(y_test, lr_probs)

plt.figure(figsize=(8,6))
plt.plot(rf_fpr, rf_tpr, label="Random Forest",
linewidth=2)
plt.plot(lr_fpr, lr_tpr, label="Logistic Regression",
linewidth=2)
plt.plot([0,1], [0,1], linestyle='--', color='gray')
plt.xlabel("False Positive Rate")
plt.ylabel("True Positive Rate")
plt.title("ROC Curve Comparison")
plt.legend()
plt.grid(True)
plt.show()

# -----
# 9. COMBINED ROC + FEATURE IMPORTANCE FIGURE
# -----

import matplotlib.pyplot as plt
import matplotlib.gridspec as gridspec
import seaborn as sns
from sklearn.metrics import roc_curve, roc_auc_score

# Prepare feature importance data
importances = rf_model.feature_importances_
```

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```
feature_names = X.columns
feat_df = pd.DataFrame({
    'feature': feature_names,
    'importance': importances
}).sort_values(by='importance',      ascending=True)      #
ascending for horizontal bar

# Create figure with 2 subplots side by side
plt.figure(figsize=(14,6))
gs = gridspec.GridSpec(1, 2, width_ratios=[1,1])

# ----- ROC CURVES -----
plt.subplot(gs[0])
rf_fpr, rf_tpr, _ = roc_curve(y_test, rf_probs)
lr_fpr, lr_tpr, _ = roc_curve(y_test, lr_probs)

plt.plot(rf_fpr, rf_tpr, label=f"Random Forest
(AUC={roc_auc_score(y_test, rf_probs):.2f})", linewidth=2)
plt.plot(lr_fpr, lr_tpr, label=f"Logistic Regression
(AUC={roc_auc_score(y_test, lr_probs):.2f})", linewidth=2)
plt.plot([0,1], [0,1], linestyle='--', color='gray')

plt.xlabel("False Positive Rate", fontsize=12)
plt.ylabel("True Positive Rate", fontsize=12)
plt.title("ROC Curve Comparison", fontsize=14)
plt.legend(fontsize=10)
plt.grid(True, linestyle='--', alpha=0.7)

# ----- FEATURE IMPORTANCE -----
plt.subplot(gs[1])
sns.barplot(
    x='importance',
    y='feature',
    data=feat_df,
    palette='viridis',
    edgecolor='black'
)
plt.title("Random Forest Feature Importances",
fontsize=14)
plt.xlabel("Importance", fontsize=12)
plt.ylabel("Feature", fontsize=12)
plt.grid(axis='x', linestyle='--', alpha=0.7)

plt.tight_layout()
```

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```
plt.show()
```

Conclusion

This paper presented an artificial intelligence-based approach for phishing detection using machine learning techniques. The proposed system effectively distinguishes between phishing and legitimate instances using extracted features and classification models.

Among the evaluated models, Random Forest achieved the best performance due to its ability to capture complex data patterns. Logistic Regression also provided satisfactory and interpretable results. Overall, the study demonstrates that machine learning is a powerful tool for enhancing phishing detection systems and supports the development of real-time cybersecurity solutions.

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The Impact of Interactive Design on User Experience in VR/AR Technologies

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Abstract. This investigation explores the influence of interactive design principles on user experience in Virtual Reality (VR) and Augmented Reality (AR) environments. The rapid advancements in immersive technologies have led to the widespread adoption of VR and AR across diverse sectors, including education, healthcare, entertainment, and engineering. Within this technological landscape, interactive design emerges as a pivotal factor influencing user perception and engagement within these virtual environments. The primary objective of this research is to undertake an analysis of interactive design principles and to assess their subsequent influence on user experience within VR/AR systems. This investigation employs a qualitative research methodology, encompassing both a theoretical analysis of extant literature and a comparative evaluation of prevalent design approaches. The findings suggest that the integration of user-centered design, intuitive interfaces, real-time feedback mechanisms, and immersive elements demonstrably contributes to enhanced user satisfaction and improved usability. Conversely, deficiencies in interaction model design have been observed to induce user confusion, diminish engagement levels, and foster adverse user experiences, notably encompassing phenomena such as cybersickness. This research underscores the imperative of optimizing interactive design strategies to enhance both the usability and overall effectiveness of VR/AR applications. The derived findings possess implications for the development of more efficient and ergonomically sound immersive systems. Furthermore, this study furnishes recommendations tailored for designers and delineates prospective avenues for future inquiry within this dynamically evolving domain.

Keywords: *Virtual Reality (VR), Augmented Reality (AR), Interactive Design, User Experience (UX), Immersive Technologies, User-Centered Design, Interface Design, Cybersickness, Human-Computer Interaction.*

INTRODUCTION

The proliferation of digital technologies in recent years has facilitated the broader integration of Virtual Reality (VR) and Augmented Reality (AR) across diverse sectors. These immersive platforms are fundamentally altering user engagement with digital content through the provision of interactive and perceptually rich environments. Their utility

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spans a broad spectrum, from educational and clinical contexts to entertainment and industrial operations, where they are increasingly recognized for their capacity to augment user involvement and optimize learning and functional efficiencies.

Within this framework, the principles of interactive design have assumed a significant role in establishing the efficacy of VR and AR systems. These immersive environments necessitate interaction paradigms that are inherently more intricate than those employed in conventional interfaces, demanding careful consideration of spatial awareness, user perception, and immediate responsiveness. Consequently, the development of intuitive, user-centric, and immersive interfaces is paramount in influencing the overarching user experience (UX).

The objective of this investigation is to delineate the principles of interactive design within VR and AR environments and to assess their influence on user experience. Central to this inquiry is the identification of pivotal design elements that enhance usability, foster engagement, and contribute to user satisfaction. Furthermore, the study addresses the inherent challenges in conceiving interactive systems for immersive settings, including considerations such as technical constraints and phenomena like cybersickness.

The methodology adopted for this research is predominantly qualitative, encompassing an extensive review of extant literature and a comparative analysis of diverse design methodologies. The anticipated outcomes of this study are projected to yield substantive insights for designers, developers, and researchers engaged with immersive technologies, thereby contributing to the advancement of VR/AR applications that are both more efficacious and intrinsically user-centered.

METHODOLOGY

The present investigation adopts a qualitative research methodology to explore the influence of interactive design on user experience within Virtual Reality (VR) and Augmented Reality (AR) environments. This qualitative approach is selected to yield a comprehensive understanding of pertinent design principles, user interaction patterns, and experiential elements inherent in immersive systems.

Fundamentally, this research draws extensively from a thorough review and analytical examination of extant academic literature. This body of literature encompasses scholarly

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articles, conference proceedings, and foundational texts across the domains of Human-Computer Interaction (HCI), immersive technologies, and user experience design. Such a theoretical framework is instrumental in identifying pivotal concepts, established models, and recognized best practices germane to interactive design in VR/AR contexts.

Complementing the literature review, a comparative analysis method is also employed to assess diverse interactive design approaches prevalent in VR and AR applications. This involves scrutinizing a range of case examples to ascertain the impact of specific design elements—including user-centered design principles, interface intuitiveness, feedback mechanisms, and immersion levels—on resultant user experience outcomes. These illustrative cases serve to delineate both efficacious and less effective design strategies.

Furthermore, the study integrates a conceptual analysis of critical user experience (UX) factors, with a focus on usability, engagement, user satisfaction, and cognitive load. Specific consideration is extended to prevalent challenges, such as cybersickness, interaction complexity, and inherent technological limitations, all of which demonstrably influence the overall efficacy of VR/AR systems.

The gathered findings are subsequently synthesized through a rigorous analytical interpretation, thereby enabling the formulation of practical recommendations aimed at enhancing interactive design within immersive environments. This comprehensive methodological framework is structured to provide a systematic evaluation of the intricate relationship between interactive design and user experience within VR/AR technologies.

Theoretical Foundations of Virtual and Augmented Reality Technologies

Virtual Reality (VR) and Augmented Reality (AR) represent pivotal elements within immersive technologies, profoundly reshaping human-computer interaction in recent decades. These technologies facilitate user interaction with digital environments in modalities extending beyond conventional screen-based interfaces, thereby enhancing engagement, interactivity, and sensory immersion. As posited by Milgram Paul and Fumio Kishino (1994), VR and AR occupy positions along a continuum ranging from entirely real environments to fully virtual ones, designated as the "Reality-Virtuality Continuum."

Virtual Reality is characterized as a fully immersive,

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computer-generated environment where users engage with 3D worlds leveraging specialized hardware, including head-mounted displays (HMDs), motion controllers, and tracking systems. As defined by Burdea Grigore and Philippe Coiffet (2003), VR is principally defined by three attributes: immersion, interaction, and imagination. Immersion affords users the perception of physical presence within a virtual space, while interaction facilitates real-time manipulation of virtual objects.

In contrast, Augmented Reality augments the real-world environment through the superimposition of digital content, such as images, textual information, and animated sequences, onto physical surroundings. Unlike VR, AR does not supersede physical reality; rather, it complements it, thereby preserving users' awareness of their physical surroundings. Ronald Azuma (1997) delineates AR according to three criteria: the amalgamation of real and virtual elements, real-time interactivity, and 3D registration of virtual objects within the physical world. This hybrid interaction paradigm renders AR particularly efficacious in applications necessitating contextual data and seamless integration with the physical world.

The technological infrastructure of VR and AR systems is predicated upon an amalgamation of hardware and software components. Essential hardware constituents encompass head-mounted displays, depth sensors, cameras, and motion tracking systems, facilitating precise detection of user locomotion and environmental alterations. Software frameworks, such as real-time rendering engines and spatial mapping algorithms, enable the seamless integration of virtual and physical elements. According to IEEE (2020), advancements in graphics processing, sensor accuracy, and machine learning have markedly enhanced the performance and accessibility of immersive technologies.

VR and AR technologies have achieved broad applicability across various domains. In educational contexts, they facilitate experiential learning modalities via simulations and virtual laboratories, thereby improving knowledge retention and student engagement (Radianti et al., 2020). Within healthcare, VR is employed for surgical training and therapeutic interventions, while AR aids in real-time visualization during clinical procedures (Barsom et al., 2016). The entertainment industry, particularly gaming, has emerged as a principal catalyst for VR/AR adoption, furnishing

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highly interactive and immersive experiences.

Notwithstanding their accelerated development, VR and AR technologies encounter several inherent challenges. Technical limitations such as latency, restricted field of view, and hardware constraints may adversely affect user experience. Furthermore, concerns such as cybersickness and cognitive overload persist as notable considerations within immersive environments (LaViola, 2000). These challenges underscore the imperative for meticulously designed interactive systems that achieve an optimal equilibrium between immersion and usability.

In conclusion, VR and AR technologies furnish a robust foundational framework for the development of immersive digital environments. Their efficacy is contingent not solely upon technological progress but also upon the judicious integration of user-centered design principles. A comprehensive understanding of the theoretical underpinnings of these technologies is thus paramount for the development of interactive systems capable of enhancing user experience and actualizing the full potential of immersive applications.

Principles of Interactive Design in VR/AR Environments

The design of interactive elements within Virtual Reality (VR) and Augmented Reality (AR) environments fundamentally shapes how users perceive, interpret, and engage with immersive systems. Distinct from conventional 2D interfaces, VR/AR platforms necessitate interaction models—spanning spatial, behavioral, and sensory domains—that are closely aligned with human cognitive and perceptual processes. As Don Norman (2013) posits, efficacious design prioritizes usability, discoverability, and robust feedback mechanisms to facilitate meaningful interaction between users and systems.

A foundational principle in the interactive design of immersive environments is user-centered design (UCD). This approach underscores the imperative to develop systems grounded in user needs, behaviors, limitations, and expectations, rather than being solely driven by technological capabilities. In VR/AR contexts, this principle assumes heightened importance, given that users interact within a three-dimensional space utilizing gestures, voice commands, and motion tracking. As outlined by ISO (ISO 9241-210), integrating users throughout the design and evaluation phases enhances system usability and overall user satisfaction.

Another critical principle is intuitive interaction

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design, which aims to ensure that users can naturally comprehend how to manipulate virtual objects without necessitating extensive learning curves. Within VR environments, interaction frequently leverages natural mapping techniques, such as hand tracking or gaze-based control. Bowman et al. (2012) indicate that intuitive interaction substantially mitigates cognitive load and improves task performance in immersive systems. Conversely, inadequately designed interaction models may engender confusion, diminish engagement, and impair task efficiency.

Feedback mechanisms are equally indispensable in VR/AR interactive design. Feedback constitutes the system's response to user actions, which can manifest as visual, auditory, or haptic signals. Effective feedback aids users in discerning the consequences of their actions, thereby supporting learning and adaptation within the system. Research by Bowman Doug A and McMahan Ryan P (2012) demonstrates that real-time feedback significantly enhances task accuracy and user confidence within virtual environments.

Furthermore, the concepts of immersion and presence are crucial, describing the psychological and perceptual experience of occupying a virtual environment. Immersion pertains to a system's technical capacity to render a realistic experience, whereas presence refers to the user's subjective conviction of "being there." Slater and Sanchez-Vives (2016) found a strong correlation between elevated levels of immersion and presence and increased user engagement and emotional response. However, an imbalance where immersion is excessive without commensurate usability considerations can precipitate discomfort or cybersickness.

Spatial interaction design represents a unique dimension of VR/AR systems. Unlike traditional interfaces, users manipulate objects in 3D space, which demands precise tracking of body movements and a keen sense of spatial awareness. The efficacy of spatial interaction is contingent upon factors such as system latency, tracking precision, and ergonomic design. Suboptimal spatial alignment or delayed responses can markedly degrade user experience and induce motion-related discomfort.

In addition, consistency and predictability are salient principles in interactive design. Users ought to be able to anticipate system behavior based on prior interactions. Consistent interface behavior reduces cognitive effort and

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enhances usability. As articulated in Nielsen's usability heuristics (Nielsen, 1994), consistency is a core tenet for designing effective interactive systems, a principle that retains substantial relevance in VR/AR environments.

Finally, accessibility and inclusivity are increasingly vital considerations in VR/AR design. Systems should be engineered to accommodate users with diverse physical abilities, cognitive capabilities, and sensory limitations. Adaptive interfaces, customizable controls, and multimodal interaction techniques are essential to ensure that immersive technologies are accessible to a broad spectrum of users (W3C XR Accessibility Guidelines, 2021).

In summary, interactive design within VR/AR systems constitutes a multidisciplinary endeavor, integrating principles from human-computer interaction, cognitive psychology, and advanced computing technologies. The effectiveness of immersive systems is largely predicated on the diligent implementation of these design principles. A meticulously designed VR/AR interface improves usability, intensifies engagement, and contributes to a coherent user experience, whereas deficiencies in design can substantially diminish system effectiveness and cause user discomfort.

The Impact of Interactive Design on User Experience in VR/AR Systems

User experience (UX) within Virtual Reality (VR) and Augmented Reality (AR) environments constitutes a multifaceted construct, incorporating aspects such as usability, user engagement, satisfaction, cognitive load, and emotional responses. In contrast to conventional digital interfaces, immersive systems necessitate user interaction within spatially and sensorially rich environments, thereby introducing considerable complexity into the design of user experience. As posited by Hassenzahl (2010), user experience extends beyond mere usability to encompass the comprehensive emotional and psychological reactions elicited during system interaction.

A fundamental outcome of efficacious interactive design is the enhancement of usability. Within VR/AR contexts, usability specifically denotes the efficiency and comfort with which individuals accomplish tasks in a virtual domain. Interaction models that are judiciously designed—for instance, natural gesture control, gaze-based navigation, or voice commands—are instrumental in reducing learning curves and elevating task performance.

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Empirical evidence suggests that user satisfaction within immersive environments is substantially predicated upon the simplicity and responsiveness of the interface. As documented in IEEE studies (2020), systems that furnish instantaneous feedback and intuitive interaction paradigms demonstrably augment user engagement and mitigate error frequencies.

User engagement serves as a critical metric within VR/AR systems, indicative of the profoundness of user immersion in the virtual environment. Judiciously implemented interactive design fosters engagement through the cultivation of presence and emotional resonance. Conversely, suboptimal design may precipitate cognitive overload, a state where users contend with an excessive influx of visual or spatial information simultaneously.

Cognitive load theory, as articulated by Sweller (1988), posits that human working memory possesses a finite capacity. Within VR/AR systems, manifestations such as egregious interface complexity, ambiguous navigation, or discordant interaction paradigms have the potential to overwhelm users and consequently diminish learning efficacy. Consequently, the strategic minimization of superfluous interface elements and the provision of a distinct visual hierarchy are imperative for achieving optimal user experience.

Immersion and presence constitute foundational constructs within the realm of VR/AR user experience. Immersion is defined by a system's technical capacity to render a realistic environment, whereas presence characterizes the psychological sensation of "being situated within" that environment. As established by Slater (2016), presence functions as a primary determinant of emotional engagement and behavioral fidelity in virtual settings.

Interactive design exerts a direct influence upon both immersion and presence. The incorporation of high-resolution graphics, responsive control mechanisms, and coherent spatial interaction contributes to an elevated perception of realism. Conversely, latency in system responses or incongruous interaction methodologies are capable of disrupting immersion and diminishing user satisfaction.

Notwithstanding its inherent advantages, VR/AR technology is also capable of inducing adverse physiological manifestations, cybersickness being the most frequently reported. Cybersickness manifests as symptoms including dizziness, nausea, ocular strain, and disorientation, arising from discrepancies between visual motion stimuli and the

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user's vestibular system.

As articulated by LaViola (2000), the etiology of cybersickness is primarily linked to system latency, incongruent sensory input, and anomalous motion within virtual environments. For instance, when an individual perceives motion within a VR environment without corresponding physical displacement, a sensory conflict ensues, which can culminate in discomfort.

Recent empirical investigations conducted by Rebenitsch and Owen (2016) underscore several design factors identified as mitigants for cybersickness:

- The reduction of system latency.
- The stabilization of frame rates.
- The avoidance of excessive virtual camera movement.
- The provision of fixed reference points within the environment.

Consequently, interactive design necessitates a meticulous equilibrium between the pursuit of realism and the preservation of user comfort, thereby aiming to cultivate a favorable experience.

In summary, interactive design constitutes a pivotal determinant of user experience within VR/AR systems. Efficacious design enhances usability, fosters engagement, and augments emotional satisfaction, whereas suboptimal design precipitates confusion, user fatigue, and physical discomfort. The interplay between design quality and user experience exhibits a strong interdependence, implying that superior hardware specifications alone cannot fully ameliorate deficiencies in interaction design.

The successful implementation of a VR/AR system necessitates the integration of human-centered design principles with comprehensive technical optimization. This encompasses the establishment of intuitive interactions, the minimization of cognitive load, the sustenance of profound immersion, and the prevention of adverse phenomena like cybersickness. As immersive technologies undergo continuous evolution, the salience of optimized interactive design is poised to intensify, fundamentally influencing the trajectory of future digital user experiences.

CONCLUSION

The present study examined the influence of interactive design on user experience within Virtual Reality (VR) and Augmented Reality (AR) environments. Our analysis indicated

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that while immersive technologies rely on advanced hardware and software infrastructures, their efficacy is also substantially shaped by the quality of their interaction design. Given the ongoing proliferation of VR and AR applications across diverse domains, including education, healthcare, entertainment, and engineering, the necessity of a robust, user-centered design framework is increasingly evident.

This research suggests that interactive design critically influences several fundamental dimensions of user experience, encompassing usability, engagement, immersion, and cognitive load. Systems incorporating intuitive interaction models, well-defined feedback mechanisms, and spatial consistency frequently contribute to elevated levels of user satisfaction. Conversely, interfaces characterized by inadequate design often induce user confusion, diminish operational efficiency, and may precipitate adverse psychological or physical outcomes, such as cybersickness.

A primary finding of this investigation underscores the indispensability of user-centered design principles for the successful development of VR/AR systems. By actively considering user requirements, cognitive constraints, and behavioral patterns, designers possess the capacity to substantially enhance the overall interactive quality. Furthermore, the levels of immersion and presence experienced are significantly modulated by the responsiveness and naturalness inherent in the interaction techniques employed, thereby emphasizing the critical role of real-time feedback and ergonomic interface design.

Moreover, this study corroborates that cybersickness persists as a considerable impediment within immersive environments. Contributing factors, including system latency, erratic motion tracking, and non-physiological camera movements, demonstrably diminish user comfort. Consequently, the mitigation of sensory conflict and the optimization of system performance are paramount for establishing a secure and ergonomically sound user experience.

In summation, it is evident that interactive design constitutes a foundational element for efficacious VR/AR applications. Although technological advancements furnish the requisite infrastructure for immersive systems, it is unequivocally the caliber of interaction design that dictates their operational effectiveness and user adoption. Subsequent investigations ought to prioritize areas such as adaptive

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interaction models, the integration of artificial intelligence, and the development of personalized user experiences to further augment the utility of immersive technologies.

Recommendations

Based on the findings of this study, several recommendations are posited for the refinement of interactive design within Virtual Reality (VR) and Augmented Reality (AR) systems, with the ultimate aim of augmenting overall user experience.

Firstly, developers and designers are advised to prioritize user-centered design principles consistently throughout the entirety of the development process. Sustained user engagement, realized through systematic testing, comprehensive feedback collection, and an iterative design methodology, has the potential to significantly enhance usability and ensure that system functionalities are closely aligned with actual user needs and expectations. The deployment of early-stage prototyping and rigorous usability testing is particularly crucial for identifying potential design deficiencies prior to full implementation.

Secondly, a judicious focus on simplicity and intuitiveness in interaction design is recommended. VR/AR environments should endeavor to avoid superfluous complexity, opting instead for natural interaction paradigms such as gesture-based control, eye tracking, and vocal commands. The establishment of a clear visual hierarchy and predictable interface behaviors contributes to a more facile user comprehension of system functions and concurrently attenuates cognitive load.

Thirdly, the improvement of system performance and responsiveness is paramount. Elevated latency and diminished frame rates represent significant determinants adversely impacting user experience, frequently culminating in the onset of cybersickness. Consequently, the prioritization of optimizing rendering pipelines, enhancing tracking system efficacy, and refining hardware performance is critical within the domain of VR/AR development.

Fourthly, designers ought to implement effective feedback mechanisms. The provision of real-time visual, auditory, and haptic feedback facilitates user comprehension of action consequences and concurrently augments interaction precision. Such consistent feedback, moreover, fosters elevated user confidence and heightened engagement within immersive

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contexts.

Fifthly, particular emphasis ought to be directed towards reducing cybersickness and physical discomfort. This objective may be realized through several strategies: judicious minimization of abrupt camera transitions, consistent maintenance of stable frame rates, and the strategic placement of fixed reference points within the virtual environment. The implementation of gradual transitions and meticulously controlled motion design has the potential to substantially enhance user comfort levels.

Sixthly, the integration of accessibility and inclusivity features in VR/AR systems is recommended. By incorporating adaptive interfaces, offering customizable control settings, and providing robust support for individuals possessing diverse physical and cognitive capabilities, a broader spectrum of usability and inclusivity can be assured.

Finally, future developmental endeavors ought to investigate the potential for integrating artificial intelligence and adaptive systems into interactive design. Such AI-driven personalization holds the promise of augmenting user experience through the dynamic adaptation of interface behaviors, predicated upon an analysis of individual user preferences, established behavioral patterns, and observed performance metrics.

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Broker-based Architecture for Third-party Tool Integration in Air-gapped DevSecOps Environments

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Abstract. Integrating third-party security tools into air-gapped or network-restricted DevSecOps pipelines presents a persistent operational challenge, as these environments are designed to block connectivity such tools require. To address this, the paper proposes a broker-based architecture that facilitates secure and traceable interaction between internal pipeline infrastructure and external vendor services, as a result the need for inbound network exceptions could be eliminated. Core broker components, associated security properties, Kubernetes-based deployment approaches, and operational factors are examined. The analysis confirms that the broker pattern can bridge existing connectivity limitations while sustaining the network isolation that regulated environments demand.

Keywords: *DevSecOps, broker architecture, air-gapped environments, CI/CD security, secure integration.*

1. INTRODUCTION

Current DevSecOps workflows rely on external security utilities, such as SAST (Static Application Security Testing) scanners, SCA (Software Composition Analysis) engines and vulnerability databases. As these tools usually operate as SaaS (Software-as-a-Service), the internal development pipeline requires consistent inbound network access to communicate with remote vendor APIs.

Despite the prevalence of cloud-based solutions, enterprise CI/CD pipelines are isolated within air-gapped or highly restricted network zones. These architectures frequently use strict firewall policies that permit egress only through validated gateways, or they utilize private cloud deployments that lack public routing. Moreover, stringent regulatory mandates within sectors like finance and critical infrastructure often forbid build systems from establishing direct external connections [1].

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As a result, there is a fundamental conflict: while security teams aim to implement comprehensive security tool integration, network policies prevent conventional integration methods. To address this issue, organizations usually either accept a fragmented security posture with limited tool coverage or permit broad network bypasses. Both alternatives introduce significant architectural risk.

This research suggests a broker-based integration pattern as a solution to aforementioned challenges. Broker acts as a lightweight, outbound-only relay agent deployed inside the restricted environment. It maintains persistent, authenticated tunnels to external services, proxying requests and responses while enforcing strict allowlists, credential injection, and audit logging. This approach successfully bridges the gap between functional necessity and network security, allowing for comprehensive toolchain operation without the traditional vulnerabilities associated with inbound firewall modifications.

2. PROBLEM STATEMENT AND MOTIVATION

During the integration of third-party security tools, air-gapped DevSecOps environments encounter with 3 recurring problems:

Connectivity failure is the most visible of these three issues. When pipeline stages attempt outbound HTTPS communication with vendor APIs, network restrictions cause these requests to fail before reaching their destination. If the pipeline treats these outcomes as non-critical, the affected stages are skipped without raising an alarm, and the resulting gap in security coverage may go entirely undetected.

The second failure mode involves the risk of credential exposure. When direct outbound access is restricted, organizations often utilize HTTP proxies as a temporary solution. However, as standard proxies lack the specialized capability to dynamically inject credentials for specific tools, engineers are frequently forced to hard-code static API tokens into their pipeline scripts. This practice might introduce several vulnerabilities, as these sensitive credentials can be inadvertently captured in build logs, cached on intermediate servers, or exposed through proxy metadata [1]. Such integration difficulties are well-documented within DevSecOps research as a major barrier to implementation [2].

The third failure mode is the absence of audit transparency. Conventional proxy solutions are not built to

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produce structured, tamper-resistant logs that capture which security integrations were called, from which pipeline, and under what conditions. Without this forensic-level data, it becomes much harder to meet compliance standards or for security teams to conduct a thorough analysis after an incident.

The broker pattern could address all three failure modes within a single architectural component.

3. BROKER-BASED ARCHITECTURE

The broker pattern consists of five foundational elements, each playing a specific role in the integration workflow. At its center is Broker Agent, a containerized process situated within the isolated network to manage local traffic. It intercepts requests from CI/CD pipelines through secure local channels like UNIX sockets and directs them via an encrypted tunnel. In addition to routing, the agent serves as a critical security checkpoint by performing essential tasks like token verification and request filtering. Most importantly, the agent is never reachable from the outside world; since it exclusively initiates outbound connections, the integrity of the internal network is maintained without the need for inbound firewall configurations [3].

The second component is Connection Manager which maintains persistent outbound tunnels to external vendor infrastructure. Connections rely on mutual TLS (mTLS), where both the broker and the remote endpoint authenticate each other through certificates, preventing man-in-the-middle attacks. Even if the outbound egress path is compromised, an attacker cannot inject a fraudulent endpoint. For continuous security, the system automates certificate rotation and integrates expiration monitoring directly into existing organizational alerting workflows.

The third component is called Credential Store. It is responsible for dynamic injection of secrets at the time of each request. Rather than requiring pipeline jobs to provide API credentials explicitly, the broker identifies the target service and the requesting pipeline to select and inject the correct token automatically. As a result, credentials are never written to memory, never logged, and never exposed to the pipeline job itself.

The fourth component, Allowlist Engine, implements a strict positive-security model by permitting only pre-approved API routes, HTTP methods, and parameter patterns to pass through the broker. Any request that does not align with

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allowlist is rejected with a structured error response. This control ensures that even if a pipeline job is compromised, the broker prevents it from being used as a pivot point for lateral movement or unauthorized data exfiltration.

The final component Audit Logger maintains append-only record of every proxied interaction. It captures essential metadata, including precise timestamps, pipeline identities, targeted API routes, status codes, and data volumes. These logs could be forwarded to a centralised SIEM in near real-time, producing complete audit trail suitable for compliance reporting [1][5].

4. KUBERNETES DEPLOYMENT CONSIDERATIONS

In Kubernetes-based environments, the broker could be configured as a dedicated Deployment resource in its own dedicated namespace. Access to the broker service endpoint is governed by NetworkPolicy rules that restrict inter-pod communication. Only pipeline workloads with a designated label which is assigned by the CI/CD admission controller are permitted to establish a connection.

Since broker acts as a lightweight relay rather than a compute-intensive service, its resource requirements are minimal. However, the use of liveness and readiness probes is mandatory to ensure system reliability. If the outbound tunnel fails, these probes trigger Kubernetes to restart the pod and restore connectivity. Furthermore, CI/CD pipelines must apply retry logic to handle these brief outages to guarantee that any connectivity issues result in a visible error rather than a silent failure that creates an undetected gap in security coverage.

Broker credentials, namely the client certificate and private key required for mTLS, should be managed through the platform's native secret store. Storing them as environment variables or ConfigMaps is discouraged, as neither approach provides adequate protection for sensitive cryptographic assets. In Kubernetes-based systems where HashiCorp Vault is present, Vault Agent Sidecar can be adopted to handle credential retrieval and renewal on behalf of the broker pod. This removes the need for manual intervention when certificates approach expiry and ensures that the broker remains operational throughout the rotation process [4].

For high-availability deployments, it is suggested to configure multiple broker replicas at the same time. Each replica manages its own independent tunnel, and traffic is distributed across replicas via Kubernetes Service. This

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design makes the system resilient against individual pod failures while avoiding the need for complicated leader-election logic.

5. SECURITY ANALYSIS

The broker pattern establishes a well-defined security boundary by focusing on few key areas. Since all tunnel establishment is outbound-initiated, there is no need for inbound firewall rules, which removes a major target for external attackers. An attacker with access to the external network has no socket to target and therefore cannot initiate a connection to the broker. At the application layer, allowlist engine enforces limits each pipeline job to its permitted API surface, containing the blast radius of any compromised job regardless of how the compromise occurred. Credential isolation adds a further layer of protection by pipeline jobs never handling vendor API tokens directly. Credentials exist solely in the broker process memory and are never written to any storage accessible to pipeline workloads and eliminates the risk of token exposure through logs, artifacts, or environment variable inspection. The primary residual risk is a direct compromise of the broker container itself, which can be mitigated through read-only root filesystems, non-root execution, strict pod security policies, and continuous vulnerability scanning of the broker image [5].

6. OPERATIONAL CONSIDERATIONS

Deploying a broker-based integration in a production environment requires proactive management of several operational factors. Certificate lifecycle management is a primary concern, as manual renewals frequently lead to system downtime. Consequently, automated rotation using a short-lived credential bootstrap mechanism is suggested over relying on scheduled human intervention. Similarly, allowlist maintenance should be managed through formal change-control procedures rather than informal updates. By tracking all entries and performing regular audits to remove obsolete rules, organizations can prevent the gradual expansion of the attack surface hence the system remains secure.

7. CONCLUSION

This paper examined how a broker-based architecture could safely integrate third-party security tools into air-gapped DevSecOps environments. The proposed design addresses three fundamental integration challenges, namely connectivity failure, credential exposure, and auditability gaps, through

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components deployed entirely within the restricted network perimeter. By utilizing features, such as outbound-only connections, automated secret injection, and strict allowlists, DevSecOps teams could maintain their security tools running without violating network isolation rules.

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Analysis of the Efficiency and Limitations of Serverless Architectures in Modern Software Development

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Abstract. The article explores the paradigm of serverless computing as one of the leading approaches to designing cloud-based systems. The economic and operational advantages of Function-as-a-Service (FaaS) models are analyzed. Architectural challenges are examined in detail, including the "cold start" problem, limitations when integrating with relational databases, observability, and security issues. Criteria for the appropriate application of serverless architectures in modern software projects compared to traditional containerized solutions are formulated.
Keywords: *Serverless, cloud computing, AWS Lambda, Azure Functions, cold start, FaaS, databases, scaling, microservices.*

Introduction and Evolution of Cloud Computing. Modern software engineering has undergone a rapid evolution from managing physical servers (On-Premises) to virtual machines (IaaS) and container orchestration (CaaS). The next logical step in infrastructure abstraction became the concept of serverless computing. This paradigm allows developers to focus exclusively on writing business logic, fully delegating the tasks of server initialization, operating system configuration, and load balancing to the cloud provider.

The core of Serverless consists of Function-as-a-Service (FaaS) solutions, with AWS Lambda, Azure Functions, and Google Cloud Functions being the industry leaders. Despite the declarative simplicity of the approach (NoOps), the practical implementation of serverless architectures requires a deep understanding of the internal mechanisms of cloud platforms [1]. The purpose of this paper is to objectively analyze both the undeniable advantages and the hidden limitations of serverless architectures that directly affect the stability, performance, and cost of software development.

Architectural Principles and Economic Efficiency. The

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FaaS model is based on an Event-Driven Architecture [2]. The computational process is initiated solely in response to a specific event (trigger): an HTTP request via an API Gateway, an file upload to storage (e.g., Amazon S3), a new message in a message broker (RabbitMQ, SQS), or a scheduled execution (CRON).

The key advantages of this architecture include:

- **True Auto-scaling.** Unlike Kubernetes clusters, where scaling occurs at the node level and requires metrics and reaction time, serverless platforms scale instantly. Each new event triggers the launch of an isolated container with the function. The system can scale linearly from zero to tens of thousands of concurrent executions in seconds.

- **Pay-as-you-go Economic Model.** Billing is calculated with millisecond granularity (e.g., in AWS Lambda). A company pays exclusively for the actual execution time of the code and the allocated RAM. The financial burden for idle resources is completely eliminated, which is critical for applications with unpredictable or spiky traffic.

- **Accelerated Time-to-Market.** The elimination of the need to configure CI/CD pipelines for basic infrastructure allows teams to deliver value to the end user faster, focusing entirely on business requirements.

Technical Challenges: The "Cold Start" Problem. The most widely discussed architectural drawback of FaaS is the "Cold Start" [3]. It occurs when a cloud provider receives a request but does not have an active ("warmed-up") container available to execute the function. In this case, a complex initialization chain takes place:

1. Finding an available compute node in the provider's cluster.
2. Downloading the function code or Docker image from internal storage.
3. Starting the runtime environment for the selected programming language.
4. Executing initialization code (importing libraries, establishing connections with external APIs or databases).

This process can add anywhere from 200 milliseconds to 5-10 seconds to the overall response time (latency). The duration directly depends on the chosen technology stack. Environments based on Java (due to JVM startup) or .NET traditionally demonstrate the longest cold starts, whereas compiled languages (Go, Rust) or lightweight scripting engines (Node.js, Python) initialize much faster.

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Mitigation Strategies:

- **Deployment Package Optimization:** Reducing the size of dependencies (removing unused libraries, minifying code).

- **Using Provider Tools:** Technologies like AWS Provisioned Concurrency allow maintaining a fixed number of function instances always ready to work. However, this negates the main financial advantage of Serverless—the elimination of paying for idle time.

- **AWS SnapStart Technology:** Caching the state of an initialized Java virtual machine (Snapshot) for instantaneous resumption during subsequent invocations.

Integration of Serverless and Relational Databases (DBA Aspect). A fundamental contradiction arises when attempting to combine the "limitless" scaling of serverless functions with the static nature of classic relational database management systems (RDBMS) such as Microsoft SQL Server, PostgreSQL, or MySQL.

Traditional web servers utilize a Connection Pool to reuse open TCP connections to the database. In the Serverless paradigm, each function instance is isolated. During a sharp traffic spike, thousands of Lambda instances will simultaneously attempt to establish a new connection to the relational database. This inevitably leads to Connection Exhaustion, database performance degradation (due to CPU time spent on continuous TCP handshakes and authorization), and ultimately, a denial of service [4].

Architectural Solutions:

- **Implementing Proxy Servers:** Utilizing services like Amazon RDS Proxy, which act as an intermediary layer. They maintain a persistent connection pool with the RDBMS and efficiently multiplex thousands of requests from serverless functions [5].

- **Migration to NoSQL / Serverless DBs:** Using databases designed to operate in cloud environments over HTTP protocols (e.g., Amazon DynamoDB, Azure Cosmos DB). They scale synchronously with the compute layer and do not suffer from TCP connection limits.

- **Data API:** Some providers (such as Amazon Aurora Serverless) provide HTTP endpoints for executing SQL queries without the need to manage persistent connections.

Observability and Monitoring. A microservices architecture based on FaaS complicates debugging and monitoring processes. Because the infrastructure is abstracted, developers cannot connect to a server via SSH or

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install traditional monitoring agents. A user request may pass through an API Gateway, several Lambda functions, a message broker, and multiple databases.

To ensure the effective operation of such systems, the implementation of Distributed Tracing is mandatory. Tools like AWS X-Ray, Datadog, or Azure Application Insights allow assigning a unique identifier (Trace ID) to each incoming request and tracking its path through all system components, visualizing bottlenecks and analyzing the causes of delays.

Furthermore, proper log aggregation (e.g., via Amazon CloudWatch or the ELK stack) is critically important, as the logic is dispersed among hundreds of small functions.

Security, Quotas, and Vendor Lock-in. Although Serverless shifts the responsibility for operating system security, application security remains the developer's responsibility. The key principle here is the Principle of Least Privilege. Each function must have its own IAM (Identity and Access Management) role that grants access only to the resources (e.g., a specific database table or a storage folder) strictly necessary for its execution.

It is crucial to account for platform Quotas. Every provider limits the maximum function execution time (15 minutes in AWS Lambda), code size, and the maximum number of concurrent executions within a single account. Uncontrolled scaling of a single function can exhaust regional quotas, blocking the operation of other critical services within the company (the "noisy neighbor" effect).

Finally, serverless architecture carries the highest level of Vendor Lock-in. While transferring a Docker container from AWS to Azure is a relatively trivial task, migrating a serverless project requires completely rewriting function initialization code, trigger integrations, IAM policies, and Infrastructure as Code configurations (Terraform, Serverless Framework).

Conclusions. The analysis demonstrates that Serverless is a powerful and highly cost-effective paradigm, which, however, demands a shift in engineering mindset. It is not a universal replacement for classic architectures.

Serverless architecture is highly recommended for:

- Tasks with highly pronounced uneven load distributions (traffic spikes).
- Asynchronous data processing (ETL processes, uploaded file processing, message queues).
- Developing MVPs (Minimum Viable Products), where time-

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to-market is critical and the initial budget is limited.

FaaS should be avoided if:

- The system experiences a consistently high, predictable load 24/7 (in this case, classic virtual machines or containers will be significantly cheaper).
- There are strict requirements for ultra-low latency, where the "cold start" problem is unacceptable.
- Long-running computational processes are anticipated (exceeding FaaS platform time limits).
- The project requires the use of specific or legacy RDBMS versions without the possibility of implementing specialized proxy layers for connection pooling.

The optimal approach in modern development is a hybrid architecture, where latency-critical and long-running services are deployed in containers (e.g., EKS or ECS), while event-driven and irregular tasks are delegated to Serverless components.

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Концептуальная основа для систем SIEM следующего поколения в управлении кибербезопасностью в режиме реального времени

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Аннотация. Современные организации сталкиваются с экспоненциальным ростом киберугроз и объемов событий безопасности, что делает традиционные системы управления информационной безопасностью и событиями (SIEM) недостаточно эффективными для работы в режиме реального времени. Данная статья представляет концептуальную основу для SIEM следующего поколения, ориентированную на адаптивную обработку событий, контекстно-осведомлённый анализ и интеграцию с автоматизированными механизмами реагирования. В работе проводится системный анализ ограничений классических SIEM-систем, предлагается многоуровневая архитектурная модель и определяется набор ключевых функциональных компонентов, необходимых для обеспечения эффективного управления безопасностью в реальном времени. Предложенный подход направлен на снижение ложных срабатываний, повышение скорости обнаружения угроз и улучшение качества принятия решений в центрах мониторинга безопасности.

Ключевые слова: Системы SIEM, кибербезопасность в реальном времени, методы корреляции событий, контекстно-ориентированная безопасность, управление информацией и событиями безопасности, обнаружение угроз, автоматизированное реагирование, SOAR, аналитика безопасности, архитектура киберзащиты.

Введение

Цифровая трансформация привела к значительному увеличению количества источников данных безопасности, включая сетевые устройства, облачные сервисы, пользовательские системы и IoT-инфраструктуры. В этих условиях традиционные SIEM-системы, основанные преимущественно на сигнатурных правилах и статической корреляции событий, сталкиваются с рядом ограничений, включая высокую долю ложных срабатываний, задержки в обработке данных и ограниченную способность к

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адаптации. Режим реального времени становится критическим требованием для современных систем кибербезопасности, особенно в условиях сложных атак, таких как APT и атаки с использованием методов социальной инженерии. Однако существующие подходы к построению SIEM-систем не обеспечивают необходимой гибкости и масштабируемости.

В данной работе предлагается концептуальная модель SIEM следующего поколения, ориентированная на преодоление этих ограничений за счёт интеграции контекстного анализа, адаптивной корреляции и автоматизации реагирования.

Ограничения традиционных SIEM-систем

Классические SIEM-системы формировались в условиях, когда объёмы данных были относительно ограниченными, а характер угроз – более предсказуемым и детерминированным. Их архитектура традиционно строится вокруг централизованного сбора и хранения журналов событий с последующим применением заранее определённых правил корреляции. Такой подход был эффективен на ранних этапах развития информационной безопасности, однако в современных условиях цифровой трансформации он демонстрирует существенные ограничения. Рост количества источников данных, появление облачных инфраструктур и распределённых систем делают централизованную модель обработки менее гибкой и масштабируемой. Одной из наиболее существенных проблем является высокая доля ложных срабатываний. Это связано с тем, что традиционные SIEM-системы, как правило, анализируют события без учёта контекста. Отсутствие информации о поведении пользователей, критичности активов, бизнес-процессах и временных зависимостях приводит к тому, что система интерпретирует многие легитимные действия как потенциальные угрозы. В результате аналитики центров мониторинга безопасности сталкиваются с перегрузкой, что снижает эффективность реагирования и увеличивает вероятность пропуска действительно значимых инцидентов [1].

Дополнительным ограничением является неспособность традиционных SIEM-систем эффективно обрабатывать потоковые данные в режиме реального времени. Архитектура, ориентированная на пакетную обработку, предполагает накопление событий с последующим анализом, что неизбежно приводит к задержкам. В условиях современных атак, которые могут разворачиваться в течение минут или даже секунд, такие задержки становятся критическими. Особенно это касается многоэтапных атак, где важна не только фиксация отдельных событий, но и их последовательная корреляция во времени. Также

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следует отметить проблему масштабируемости. По мере увеличения объёмов логов традиционные системы требуют значительных вычислительных ресурсов и усложнения инфраструктуры, что повышает стоимость владения и снижает гибкость системы. Это делает их менее пригодными для использования в динамичных и высоконагруженных средах [2].

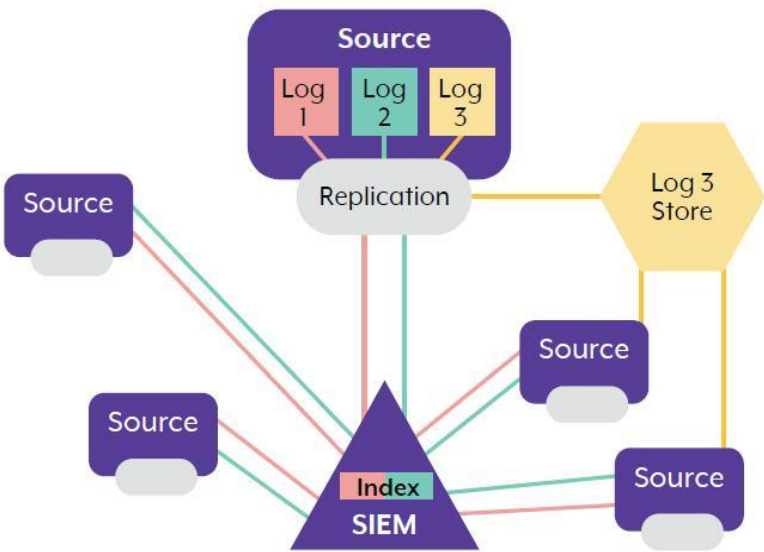


Рисунок 1

Архитектура традиционной SIEM-системы с централизованной агрегацией и индексированием журналов событий

Ниже представлена сравнительная характеристика традиционных SIEM-систем и SIEM следующего поколения, отражающая ключевые различия в подходах к обработке и анализу данных.

Таблица 1

Сравнение традиционных и SIEM следующего поколения

Характеристика	Традиционный SIEM	SIEM следующего поколения
Обработка данных	Пакетная	Потоковая (stream processing)
Корреляция событий	Статическая	Адаптивная
Контекст	Ограниченный	Контекстно-осведомлённый
Ложные срабатывания	Высокие	Сниженные
Реакция	Ручная	Автоматизированная
Масштабируемость	Ограниченная	Высокая

Таким образом, анализ ограничений традиционных SIEM-систем показывает необходимость перехода к новым архитектурным и аналитическим подходам. Ключевыми

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направлениями развития становятся обработка данных в реальном времени, использование контекстной информации и внедрение адаптивных механизмов корреляции, что формирует основу для построения SIEM-систем следующего поколения.

Концептуальная модель SIEM следующего поколения и контекстно-осведомлённый анализ с автоматизированным реагированием

Предлагаемая концептуальная модель SIEM следующего поколения основана на многоуровневой архитектуре, ориентированной на обработку событий безопасности в режиме реального времени, использование контекстной информации и автоматизацию реагирования. В отличие от традиционных подходов, где основное внимание уделяется сбору и хранению логов, данная модель рассматривает SIEM как интеллектуальную систему принятия решений, способную адаптироваться к изменяющимся условиям и угрозам. Архитектура начинается с уровня источников данных, который включает широкий спектр компонентов: сетевые устройства, серверы, рабочие станции, облачные сервисы, системы управления доступом и другие элементы инфраструктуры. На этом уровне формируется первичный поток событий, характеризующий текущее состояние информационной системы. Особенностью современных условий является высокая гетерогенность источников, что требует унификации форматов и структур данных [3].



Рисунок 2
Интеграция UEBA с SIEM, SOAR, DLP и XDR в системе управления
кибербезопасностью

Следующий уровень представлен слоем агрегации и нормализации данных, где осуществляется сбор, фильтрация и приведение данных к единому формату. Это позволяет обеспечить

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согласованность последующего анализа и устранить избыточность информации. Важной задачей данного уровня является обеспечение высокой пропускной способности и устойчивости к нагрузкам. Ключевым отличием SIEM следующего поколения является использование механизма потоковой обработки, который обеспечивает анализ событий в режиме реального времени. В отличие от пакетной обработки, потоковый подход позволяет обрабатывать данные по мере их поступления, минимизируя задержки и обеспечивая своевременное выявление угроз. Это особенно важно для обнаружения сложных атак, разворачивающихся в короткие промежутки времени [4].

На уровне корреляции и аналитики осуществляется объединение событий в логические цепочки. В данной модели используется адаптивная корреляция, которая учитывает не только заранее заданные правила, но и динамические зависимости между событиями. Это позволяет выявлять сложные сценарии атак, которые невозможно обнаружить с помощью статических правил. Особое значение в предлагаемой архитектуре имеет модуль обогащения контекста. В отличие от традиционных систем, где события анализируются изолированно, здесь каждое событие дополняется дополнительной информацией, включающей характеристики пользователя, уровень критичности актива, географическое положение, временные параметры и поведенческие паттерны. Это позволяет существенно повысить точность анализа и снизить количество ложных срабатываний.

Контекстно-осведомлённый анализ становится ключевым элементом всей системы. Он обеспечивает интерпретацию событий с учётом их окружения и взаимосвязей. Например, попытка входа в систему с нового устройства может рассматриваться как нормальная, если она соответствует поведению пользователя, либо как подозрительная, если наблюдаются отклонения от типичных паттернов. Таким образом, контекст позволяет перейти от формального анализа событий к более глубокому пониманию происходящих процессов. Следующий уровень архитектуры представлен механизмом принятия решений, который интерпретирует результаты аналитики и определяет приоритетность инцидентов. Здесь осуществляется оценка риска, классификация угроз и выбор стратегии реагирования. Важной особенностью данного уровня является возможность динамической адаптации правил и сценариев на основе накопленного опыта и изменений в инфраструктуре.

Финальный уровень модели связан с интеграцией SIEM с системами автоматизации реагирования SOAR. В современных условиях обнаружение угроз без последующего оперативного

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реагирования теряет свою эффективность. Интеграция с SOAR позволяет автоматизировать выполнение сценариев реагирования, таких как блокировка учетных записей, изоляция устройств, изменение политик безопасности и уведомление ответственных специалистов. Автоматизация существенно снижает время реагирования и уменьшает нагрузку на аналитиков SOC. При этом важным аспектом является возможность гибкой настройки сценариев, что позволяет учитывать специфику организации и уровень критичности инцидентов. В результате достигается баланс между автоматизацией и контролем со стороны специалистов [5].

Для более наглядного представления различий между уровнями архитектуры SIEM следующего поколения приведена таблица, отражающая их функциональные особенности.

Таблица 2

Уровни архитектуры SIEM следующего поколения

Уровень архитектуры	Основные функции
Источники данных	Генерация событий - сети, серверы, облака, приложения
Сбор и нормализация	Агрегация, фильтрация, приведение данных к единому формату
Потоковая обработка	Анализ событий в реальном времени
Корреляция и аналитика	Объединение событий, выявление зависимостей
Обогащение контекста	Добавление информации о пользователях, активах, рисках
Принятие решений	Оценка угроз, приоритизация инцидентов
Автоматизированное реагирование	Выполнение сценариев реагирования с помощью SOAR

Предложенная концептуальная модель демонстрирует переход от традиционных SIEM-систем к интеллектуальным платформам управления безопасностью, способным эффективно функционировать в условиях реального времени. Интеграция потоковой обработки, контекстного анализа и автоматизированного реагирования позволяет существенно повысить качество обнаружения угроз и снизить нагрузку на специалистов, обеспечивая более высокий уровень защищённости информационных систем [6].

Заключение

Предложенная в работе концептуальная модель SIEM-систем следующего поколения демонстрирует значительный потенциал повышения эффективности управления кибербезопасностью за счёт перехода от статических методов анализа к адаптивным и контекстно-ориентированным подходам. В условиях

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стремительного роста объемов данных и усложнения киберугроз традиционные SIEM-системы оказываются недостаточно гибкими и оперативными, что обуславливает необходимость внедрения новых архитектурных решений.

В рамках исследования показано, что интеграция потоковой обработки данных, механизмов корреляции событий, контекстного обогащения и автоматизированного реагирования позволяет существенно повысить точность обнаружения угроз, снизить количество ложных срабатываний и сократить время реагирования на инциденты. Особое значение приобретает использование контекстной информации, обеспечивающей более глубокое понимание событий безопасности и их взаимосвязей. Вместе с тем реализация предложенной модели связана с рядом практических вызовов, включая необходимость обеспечения масштабируемости систем, поддержания высокого качества обрабатываемых данных и интеграции с уже существующей инфраструктурой организаций. Не менее важным остаётся вопрос баланса между автоматизацией процессов реагирования и контролем со стороны специалистов, особенно в критически важных информационных системах.

Предложенная концептуальная основа может служить базой для дальнейших научных исследований и разработки практических решений в области SIEM. Перспективными направлениями развития являются формализация процессов корреляции событий, применение методов машинного обучения для анализа поведения пользователей и систем, а также создание адаптивных механизмов реагирования, способных динамически подстраиваться под изменяющийся ландшафт киберугроз.

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ARCHITECTURE, CONSTRUCTION AND DESIGN

The Influence of 20th-century Graphic Design Styles on Modern Digital Design

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Abstract. The 20th century represents a transformative period in the history of graphic design, during which several influential movements fundamentally reshaped visual communication theory and practice. Styles such as the Bauhaus, Swiss Style (International Typographic Style), Pop Art, and Postmodernism introduced new and systematic approaches to composition, typography, color theory, and visual hierarchy. These movements not only redefined aesthetic values but also established functional, experimental, and structured frameworks that continue to guide contemporary design methodologies. Beyond their historical significance, these movements contributed to the professionalization of graphic design as a discipline grounded in both artistic expression and scientific principles of communication. The Bauhaus emphasized functionality and reduction of form, while the Swiss Style introduced rigorous grid systems and typographic clarity. In contrast, Pop Art expanded visual language through popular culture and mass media, and Postmodernism challenged established conventions by encouraging pluralism, fragmentation, and stylistic experimentation. In the digital era, graphic design has extended beyond static print media into dynamic and interactive environments such as websites, mobile applications, user interfaces, and digital branding ecosystems. This transition has significantly increased the importance of usability, accessibility, and user-centered design. Despite rapid technological advancements, the core principles developed during the 20th century remain essential in shaping effective digital experiences. This study examines the key characteristics of major 20th-century design movements and critically analyzes their continuing influence on modern digital design practices. Particular attention is given to UI/UX systems, typographic structure, visual hierarchy, and interaction design, highlighting how historical design philosophies are reinterpreted within contemporary digital contexts. The analysis demonstrates that modern digital design is not a rupture from the past but rather a continuation and evolution of established visual and conceptual frameworks.

Keywords: *Graphic design, Bauhaus, Swiss Style, Postmodernism, digital design, UI/UX, typography, visual communication, interaction design, visual hierarchy.*

Theoretical Foundations of Visual Communication

Visual communication, as a fundamental aspect of graphic art, conveys information through elements such as typography, color, layout, and the organization of space. The structured

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arrangement of visual communication elements ensures the success of communication activities. Many believe that Gestalt theory proves that individuals perceive visual elements not as separate parts but as a unified whole. Principles such as proximity, similarity, balance, and contrast are used to create effective artistic compositions. In digital environments, these principles become even more significant due to interactive user behavior. Designers must consider both aesthetic quality and usability, ensuring that information is presented clearly, efficiently, and intuitively. Studies indicate that these fundamental design principles strongly influence user perception in digital interfaces, particularly in navigation and content readability.

Major Graphic Design Movements of the 20th Century

Bauhaus: Functionality and Minimalism

Founded in Germany in 1919 by Walter Gropius, the Bauhaus school is widely regarded as one of the most influential movements in the history of modern design. Its core objective was to synthesize art, craft, and technology into a unified design philosophy grounded in functionality, simplicity, and rationality. Emerging in the socio-economic context of post-World War I Germany, Bauhaus responded to industrial challenges by rejecting excessive ornamentation in favor of clarity and efficiency. Designers prioritized forms suitable for mass production, thereby democratizing access to well-designed everyday objects. The defining characteristics of Bauhaus include geometric abstraction, the use of primary color palettes, functional composition, and the integration of typography with visual imagery. Its emphasis on standardization and production efficiency established a design language that remains foundational to contemporary practice. In the context of digital design, Bauhaus principles are particularly evident in minimalist interface aesthetics, where clarity, usability, and reduction of visual noise are prioritized. Modern UI/UX systems continue to reflect this legacy through simplified layouts and function-driven design decisions.

Swiss Style: Structure and Clarity

The Swiss Style, also known as the International Typographic Style, emerged in the mid-20th century in Switzerland and Germany. It introduced a rigorously structured approach to design, grounded in mathematical grid systems and typographic precision. This movement emphasized objectivity and neutrality, seeking to communicate

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information clearly and efficiently without subjective or emotional interference. Designers adopted systematic layouts to ensure consistency and readability across visual compositions. Its primary features include grid-based structures, sans-serif typography, asymmetrical layouts, and a deliberate use of white space to enhance visual hierarchy and balance. These elements collectively contribute to a highly organized and legible design framework. The influence of Swiss Style is particularly evident in contemporary digital environments, where grid systems underpin responsive web design and interface architecture. Its principles remain essential for ensuring consistency, navigational clarity, and user comprehension in complex digital systems.

Pop Art: Visual Culture and Mass Media Influence

Pop Art emerged in the mid-20th century as a critical response to consumer culture and the proliferation of mass media. In contrast to the restrained aesthetics of modernist movements, Pop Art embraced bold colors, familiar imagery, and references drawn from advertising, comics, and popular culture. Characterized by high-contrast color schemes, repetition, and the appropriation of commercial symbols, Pop Art blurred the boundaries between fine art and mass-produced imagery. Its experimental approach to typography and composition introduced a more expressive and visually provocative design language. In digital design, Pop Art's legacy is reflected in visually engaging branding strategies, advertising campaigns, and social media content. Its emphasis on immediacy and recognizability aligns with the demands of contemporary visual communication, where capturing user attention is paramount.

Postmodernism: Challenging Design Conventions

Postmodern graphic design emerged as a reaction against the rigidity and universalism of modernist principles. Rather than adhering to strict rules, it embraced plurality, ambiguity, and experimentation. Postmodern design is characterized by layered compositions, non-linear typography, stylistic hybridity, and the deconstruction of traditional visual hierarchies. By incorporating historical references and diverse visual languages, it challenged the notion of a single, objective design standard.

Its impact on digital design is evident in experimental interfaces, dynamic branding, and interactive media, where creative freedom and user engagement are prioritized. Postmodernism has expanded the boundaries of design, allowing

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for more diverse and personalized visual expressions.

Impact on Modern Digital Design

Contemporary digital design is fundamentally rooted in the principles established by 20th-century design movements. Core concepts such as grid systems, visual hierarchy, typographic clarity, and functional simplicity continue to shape UI/UX practices. Bauhaus minimalism informs the reduction of visual complexity, while Swiss Style provides the structural framework necessary for organizing digital content. Together, they underpin responsive design systems and modular interface architectures. At the same time, Pop Art and Postmodernism introduce elements of visual dynamism and experimentation, enabling designers to create more engaging and emotionally resonant user experiences. Thus, modern digital design can be understood not as a departure from historical practices, but as an evolution of them. The integration of these diverse design philosophies demonstrates that technological innovation operates in continuity with established visual principles rather than in isolation from them.

Conclusion

The graphic design movements of the 20th century have left a profound and lasting impact on the contemporary digital ecosystem. This period should not be understood merely as an era of visual experimentation; rather, it represents the foundational stage in which the theoretical and methodological principles of modern UI/UX design and digital branding were established. Within the scope of this study, these movements have been examined from both fundamental and applied perspectives, demonstrating that contemporary information architecture relies heavily on historically developed design principles. Visual aesthetics alone does not define digital design; its effectiveness is grounded in the scientific and systematic frameworks underlying these aesthetic choices. The Bauhaus movement, with its principle of "form follows function," remains central to modern interface design. Its emphasis on simplicity and usability directly informs user experience (UX), as reduced visual complexity enhances accessibility and interaction efficiency. Contemporary design trends such as Flat Design and Material Design can be interpreted as digital extensions of Bauhaus minimalism, reflecting its continued relevance in structuring rational and user-centered digital products. Similarly, the Swiss Style has contributed significantly to the structural

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organization of digital design through the introduction of grid systems and typographic discipline. These principles form the backbone of responsive web design and complex interface layouts. The effective management of typographic hierarchy and white space ensures readability and facilitates user navigation, making structured design an essential component of accessible digital environments. In contrast, Pop Art and Postmodernism have introduced expressive and experimental dimensions to digital design. Emerging as reactions to the rigidity of modernist principles, these movements expanded the visual language of design by incorporating color intensity, cultural references, and compositional diversity. In contemporary digital branding and interface design, these influences enable the creation of emotionally engaging and visually dynamic experiences, strengthening the connection between users and digital products. Despite rapid technological advancements, including artificial intelligence and VR/AR systems, the fundamental principles of visual communication developed in the 20th century remain highly relevant. Rather than replacing these principles, new technologies extend their application into more interactive and adaptive contexts. Motion graphics, personalized interfaces, and immersive environments all build upon this established theoretical foundation. Ultimately, the success of modern digital designers depends not only on technical proficiency in tools such as Figma and Adobe but also on a deep understanding of historical design frameworks. The synthesis of historical knowledge and contemporary technology enables the creation of intuitive, functional, and aesthetically coherent digital environments. This study reaffirms that the core principles of design are not transient; rather, they persist as enduring guidelines that continue to shape the evolution of digital design.

Recommendations

The findings of this study indicate that the sustainable development of modern digital design and the preparation of qualified professionals require the implementation of several strategic measures. These measures are essential in shaping the future direction of the field and ensuring its continuous and adaptive growth in response to technological advancements.

Study of Design History and Conceptual Foundations

A comprehensive understanding of design history remains a fundamental requirement for design professionals. Reliance

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solely on contemporary digital trends is insufficient for developing a deep and critical design perspective. The study of historical movements such as Bauhaus and Modernism enables designers to grasp the conceptual and philosophical foundations underlying visual elements. This knowledge not only enhances analytical thinking but also allows designers to move beyond execution toward strategic decision-making. A strong theoretical foundation contributes to the creation of more sustainable and enduring design solutions.

Achieving a Balance Between Aesthetics and Functionality

Effective digital design requires a careful balance between visual appeal and usability. A successful product must simultaneously attract user attention and facilitate task completion in an efficient manner. Design should not prioritize aesthetics at the expense of functionality; rather, visual elements must support usability and enhance the overall user experience. When aesthetic qualities align with functional objectives, digital products become both engaging and practical, resulting in higher levels of user satisfaction.

Innovative Interpretation of Traditional Principles

Classical design principles, such as grid systems and color theory, should not be replicated without adaptation. Instead, they must be reinterpreted in accordance with the requirements of contemporary technologies and media environments. As digital platforms continue to evolve, designers are expected to apply historical knowledge in innovative ways. This reinterpretation is particularly important in emerging fields such as artificial intelligence and interactive media, where traditional frameworks must be translated into new design contexts.

Integration of Theory and Practice in Education

Design education should be restructured to ensure the integration of theoretical knowledge and practical skills. Alongside foundational design theory, proficiency in industry-standard tools such as Figma and Adobe Creative Suite is essential. The simultaneous development of conceptual understanding and technical competence prepares students for the demands of the professional environment. Bridging the gap between "why" and "how" in design education enhances both critical thinking and practical application.

Promotion of Multidisciplinary Collaboration

Contemporary design practice is inherently interdisciplinary. Collaboration between design, technology,

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and behavioral sciences—particularly psychology—plays a crucial role in the development of effective digital solutions. An understanding of human behavior enables designers to create more intuitive and user-centered interfaces, while knowledge of programming enhances the feasibility and implementation of design concepts. The integration of multiple disciplines leads to more innovative, functional, and impactful design outcomes.

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Dynamic Analysis of Protective Shell of Fuel Tank from Shock Wave Action of Explosive Device

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Currently there is a need to create new approaches to assessing the load bearing capacity of protective military and civil structures under the action of explosive devices. The protective shell of fuel reservoir under ground shock wave from an explosive device was researched according to numeral method [1]. The steel protective shell was 6,58 m high, 6,96 m in diameter, and 5 mm thickness. The shell wall was designed as belts whose sizes corresponded to the rolled sheets using the shell finite elements with six degrees of freedom in a node [2]. Geometrical model of shock wave whose characteristics calculated by the Sadovsky's analytic formulas was presented as a hemisphere. The shell surface areas with the concrete values of overpressure and positive impulse from an explosive device with a TNT equivalent of explosive mass 250 kg were determined for different distances 14,5 m, 36 m and 72 m to the epicenter of explosion. Overpressure was given as evenly distributed load on the affected shell elements, the positive impulse – the triangles with a certain time of action and a delay time for each shell surface areas. Modal analysis of shell was done by the Lanczos method [2]. The first ten natural frequencies had values from 13,947 Hz to 23,438 Hz. The natural modes had from 7 to 15 regular half-waves in the circular direction and one along

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the shell generating. Shell stability from the overpressure was investigated in the nonlinear formulation by the Newton-Raphson method taking into account the dynamic coefficient 0,51 [3]. The forced oscillations of protective shell were investigated by the fourth-order Runge-Kutta method. The integration time equaled two maximal periods of natural oscillations of shell 0,143 s. The step of integration was accepted as hundred times smaller than minimum action time of positive impulse which had value from 0,0162 s to 0,023 s. This research showed that protective shell of fuel tank lost its stability from the shock wave of this explosive device for all of distances to the epicenter of explosion. The stresses and strains in several elements of shell frontal area were higher than the stresses and strains of destruction.

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Technical Aesthetics in Modern Design: the Interaction of Functionality and Aesthetic Values

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Abstract. In the modern design environment, the concept of technical aesthetics acts as a unity of functionality and aesthetic values. Technical aesthetics covers not only the visual appearance of an object, but also its ease of use, technological compatibility and interaction with humans. As a result of globalization, digitalization and technological development, design is no longer considered only as a field of artistic creativity, but also as a complex field of activity aimed at solving functional problems. The article comprehensively analyzes the essence of technical aesthetics in modern design, its interaction with functionality and aesthetic principles. At the same time, the features of the application of technical aesthetics in industrial design, urban planning and the digital environment are examined. As a result of the study, it is determined that functionality and aesthetics are complementary and inseparable components. Their balanced application ensures that design products are both effective in terms of use and visually attractive. Consequently, technical aesthetics acts as one of the main directions of modern design, and the correct approach in this area increases the quality of design and user satisfaction.

Keywords: *technical aesthetics, functionality, aesthetic values, modern design, user experience.*

Introduction

In the modern era, design is not limited to the creation of aesthetically beautiful objects. The main goal of design is to create functional and at the same time aesthetically attractive products that meet human needs. In this regard, the concept of technical aesthetics is of particular importance.

Technical aesthetics involves creating harmony between the functional properties of design objects and their aesthetic appearance. This approach is widely used, especially in the fields of industrial design, architecture

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and digital design. The modern user takes into account not only the functionality of the product, but also its visual qualities and emotional impact.

Technical aesthetics issues are becoming increasingly relevant in the Azerbaijani design environment. Balancing functionality and aesthetics in modern projects acts as a quality indicator of design (Hasanov, 2020, p. 92).

This article extensively analyzes the theoretical foundations of technical aesthetics, the interaction of functionality and aesthetic values, and the directions of its application in the modern design environment.

1. The essence and theoretical foundations of technical aesthetics

Technical aesthetics is a scientific and theoretical direction that ensures the unity of both functional and aesthetic properties of design objects. This concept became more widespread in the 20th century with the development of industrial design and has become one of the main components of design in the modern era.

The main goal of technical aesthetics is to create an optimal relationship between people, technology and the environment. This relationship is determined not only by visual beauty, but also by the ease of use and effectiveness of the object.

Azerbaijani researchers note that technical aesthetics requires a systematic approach to the design process, and this approach ensures the mutual compatibility of all functional and visual components of the object (Aliyev, 2018, p. 74).

In this regard, technical aesthetics is not only an aesthetic category, but also a complex approach aimed at solving functional and technological problems.

2. The interaction of functionality and aesthetic values

In modern design, functionality and aesthetics are inseparable concepts. Functionality determines the suitability of the product for its intended use, and aesthetics determines its visual and emotional impact.

In successful design examples, these two components are combined in a balanced way. If the product is only functional, but not aesthetically attractive, user interest decreases. On the contrary, objects that are only aesthetically beautiful but not functional lose their practical value.

Studies show that users consider aesthetically attractive products to be more convenient and effective (Guliyev, 2019,

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p. 61). This phenomenon has been extensively studied in design psychology.

At the same time, functionality also affects the creation of aesthetic form. In modern design, minimalism and simplicity arise from functional requirements, and this approach is also highly appreciated from an aesthetic point of view.

Thus, functionality and aesthetics interact to create a single design concept.

3. Application of technical aesthetics in modern design fields

Technical aesthetics is widely applied in various fields of modern design.

In industrial design, the ergonomics, ease of use and visual appeal of products are among the main priorities. The shape, material and color of the product are matched to functional requirements.

In architectural and urban design, technical aesthetics play an important role in shaping the urban environment. In the planning of urban spaces, aesthetic factors are also taken into account along with functional solutions (Mammadov, 2017, p. 145).

In the field of digital design, technical aesthetics manifests itself in the formation of user interface (UI) and user experience (UX). Simple, intuitive and aesthetically appealing interfaces increase user satisfaction.

The application of technical aesthetics in these areas increases the quality and functional effectiveness of design.

4. Modern development trends of technical aesthetics

In the modern era, technical aesthetics is developing under the influence of new technologies. Digital technologies, artificial intelligence and virtual reality create new opportunities for the design process.

The principles of minimalism, ecological design and sustainability act as one of the main directions of technical aesthetics. Modern design takes into account not only aesthetic and functional, but also ecological factors.

These trends are also observed in the Azerbaijani design environment, and the principles of functionality, aesthetics and sustainability are applied together in new projects (Hasanov, 2020, p. 98).

Thus, technical aesthetics acts as one of the main factors determining the development directions of modern design.

Conclusion

The analysis shows that technical aesthetics is an

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integral part of modern design and is based on the interaction of functionality and aesthetic values. The balanced application of these two components determines the quality and effectiveness of the design.

While functionality ensures the suitability of the product for its intended use, aesthetic values shape its visual and emotional impact. The unity of these factors increases user satisfaction and determines the success of the design.

The role of technical aesthetics in the modern design environment is increasingly increasing, and new technological and conceptual approaches are emerging in this field. In this regard, the study of the scientific foundations of technical aesthetics and its practical application are of great importance for the development of the design field.

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Design Concept and Aesthetic Transformation of Shopping Malls in Baku: a Comprehensive Analysis in the Context of Modern Approaches and Consumer Behavior

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Abstract. This study is devoted to a comprehensive analysis of the design concepts and aesthetic transformation of shopping malls in the city of Baku. The article systematically examines the historical stages of the development of shopping centers, the theoretical foundations of design and technical aesthetics, as well as the principles of forming modern design concepts. The main objective of the research is to evaluate the architectural and design characteristics of existing shopping malls in Baku, determine their impact on consumer behavior, and substantiate directions for future development. The findings reveal that modern shopping malls are not only places for retail activities but also multifunctional urban complexes combining social, cultural, and aesthetic functions. Shopping centers in Baku are distinguished by contemporary architectural styles, the application of innovative technologies, and efficient functional planning principles. The harmony of interior and exterior design elements, proper lighting and color solutions, and the creation of spacious public areas have been identified as key factors enhancing their attractiveness. The study also shows that the aesthetic appearance of shopping malls directly influences consumer behavior. High-quality design increases the duration of visits, stimulates purchasing activity, and improves overall customer satisfaction. Therefore, design is not only a visual component but also a strategic tool ensuring economic efficiency. In conclusion, it is essential to enhance the design of shopping malls in Baku through the integration of innovative technologies, the application of sustainable design principles, and the development of consumer-oriented concepts.

Keywords: shopping malls, design concept, aesthetic appearance, consumer behavior, urban environment.

INTRODUCTION

The design of shopping centers is not limited only to visual beauty; factors such as functionality, comfort, impact on human behavior, and the formation of an emotional environment also play a major role. Elements such as the proper organization of interior and exterior design,

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lighting, color solutions, material selection, and spatial planning directly affect consumers' behavior, shopping duration, and overall satisfaction levels. In this regard, the design of shopping centers carries strategic importance from both architectural and marketing perspectives.

The relevance of the research stems from the rapid development of shopping centers in Baku and the need for a comprehensive scientific study of their growing role in the urban environment. Systematic analysis of the design and aesthetic features of existing shopping centers allows for the identification of their strengths and weaknesses, as well as the application of more efficient and innovative approaches in future design processes. The objective of this research is to analyze the design concepts and aesthetic features of shopping centers operating in Baku, investigate their impact on consumer behavior, and identify directions for improvement in line with modern requirements. To achieve the set objective, tasks such as studying the theoretical foundations of shopping centers, conducting a comparative analysis of existing examples in Baku, and researching modern design trends have been established.

Thus, investigating the issue of the design concept and aesthetic appearance of shopping centers is significant from both theoretical and practical perspectives. Research conducted in this field can contribute significantly to improving the quality of urban planning, architectural, and design activities, as well as the formation of consumer-oriented environments

Theoretical and Methodological Foundations of Shopping Center Design

The acceleration of urbanization processes during the Industrial Revolution caused significant changes in the structure of trade spaces. The arcades that emerged in Europe in the 19th century—glass-roofed shopping passages—acted as the initial prototypes of modern shopping centers. In these objects, aesthetic appearance and functionality developed in parallel, with natural lighting and visual appeal becoming core design elements. At this stage, design began to take shape as one of the primary factors influencing the efficiency of commercial activity [3, p.460].

From the mid-20th century onwards, a new phase began with the emergence of modern-type shopping malls in the USA. These indoor complexes, covering vast areas and integrating various functions, began to fulfill not only retail but also leisure

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and entertainment roles. The placement of shopping centers in suburban areas and their integration into automotive infrastructure during this period led to the emergence of new approaches in their planning [4, p.25].

In the 21st century, the development of shopping centers is characterized by the application of innovative technologies and modern design approaches. Modern shopping centers no longer function merely as retail spaces but as "experience environments." Digital technologies, interactive systems, smart lighting, and sustainable design principles are widely applied here. This influences the emotional reactions of consumers, shaping their behavior models and increasing the efficiency of the commercial process [5, p.258].

Table 1

Development Stages and Design Characteristics of Shopping Centers

Development Stage	Time Period	Core Characteristics	Design Characteristics
Initial Market Stage	Ancient Period - Middle Ages	Open bazaars, caravanserais, social interaction	Simple planning, climate-adapted structure
Medieval Stage	Middle Ages	City-centered trade system	Covered bazaars, functional architecture
Industrial Era	19th Century	Arcades and urban passages	Glass constructions, aesthetic design
Modern Stage	20th Century	Indoor complexes, multifunctionality	Zoning, parking, large-scale volume
Innovative Stage	21st Century	Technology and experience-orientedness	Smart design, interactive systems

Source: Compiled by the author based on [1, s.128; 2, s.45; 4, s.25].

In conclusion, the development history of shopping centers shows their transformation from simple market spaces into complex, multifunctional urban objects with high aesthetic qualities. This evolutionary process can be evaluated as a continuous transformation from economic, architectural, and design perspectives.

Analysis of design and aesthetic features of shopping centers in Baku

In recent years, Baku has emerged as one of the regional centers distinguished by rapid urban development and modern architectural transformation. A key component of this

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development is the increase in the number of shopping centers and their diversification in terms of functional structure. Modern shopping centers in Baku serve not only as areas of economic activity but also as important urban spaces that shape the social and cultural dynamics of city life. The integration of shopping, entertainment, catering, and service functions within these facilities indicates their operation as multifunctional complexes.

The general characteristics of major shopping centers in Baku can be analyzed in terms of their location principles, dimensions, functional zoning, and architectural-design solutions.

Among the main shopping centers operating in Baku, large-scale complexes designed according to international standards predominate. In these centers, stores of world brands, cinemas, entertainment zones, restaurants, and service facilities are combined within a unified concept. This approach not only increases the functional load of the shopping centers but also enhances their attractiveness. At the same time, modern technologies used in these facilities—centralized air conditioning systems, smart lighting, security, and surveillance systems—ensure their management efficiency and create a comfortable environment for users.

From an architectural perspective, shopping centers in Baku are characterized by a synthesis of various styles. While futuristic and high-tech design elements predominate in some facilities, a modern interpretation of classical architectural elements is observed in others. This diversity adds dynamism to the city's overall architectural landscape and shapes the individual visual identification of each shopping center. In particular, the extensive use of glass facades, open-space compositions, and large-scale atriums serve as the main architectural features of modern shopping centers.

One of the characteristic features of Baku's shopping centers is the spacious and functional planning of their interior spaces. In these facilities, wide passages, directional elements, and open-plan areas have been created for the comfortable movement of visitors. Lighting and color solutions are selected with particular care to make the space appear visually wider. At the same time, the integration of recreation zones, green elements, and decorative components into the interior increases the emotional comfort of users. Furthermore, the changing behavior of consumers plays an

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important role in the development of shopping centers in Baku. Modern consumers visit these spaces not only to purchase products but also to spend time, have fun, and engage in social interaction. For this reason, the concept of shopping centers is transforming from a "shopping place" toward an "experience place." This transformation necessitates the application of new approaches in their planning and further increases the strategic importance of design.

Table 2

General Characteristics of Major Shopping Centers in Baku

Indicators	Characteristic Features
Location	Distribution across city center and peripheral zones
Functionality	Integration of shopping, entertainment, public catering, and services
Architectural Style	Synthesis of modern, futuristic, and classical elements
Infrastructure	Parking, transport accessibility, and security systems
Technological Provision	Smart lighting, air conditioning, and surveillance systems
Consumer Orientation	Comfortable planning, relaxation zones, and social spaces

Source: Compiled by the author based on [6; 7; 8].

Directions for Improving Shopping Center Design in Baku

In the modern era, the design of shopping centers is not limited solely to the creation of aesthetically appealing spaces but is characterized by the integration of functionality, technology, and user experience. Global urban development and digitalization processes have also influenced the design approaches of shopping centers operating in Baku. In this context, modern design trends are distinguished primarily by the application of innovative technologies, ecological sustainability, and the creation of human-oriented spaces.

In recent years, the primary focus in the planning of shopping centers has shifted toward the "experience economy" concept. According to this approach, consumers visit shopping centers not only to purchase products but also to gain emotional and social experiences. Therefore, interactive zones, entertainment areas, thematic interiors, and open public spaces are widely applied in design solutions. Such

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spaces encourage users to spend more time in the center and lead to an increase in shopping activity.

Technological innovations serve as one of the key directions in the design of modern shopping centers. Smart building technologies, digital signage systems, sensor-based lighting, and energy management systems enhance the functionality of these facilities. Simultaneously, it becomes possible to offer personalized services to users through mobile applications and interactive screens. This ensures the integration of design not only with the physical space but also with the digital environment.

Ecological sustainability principles also occupy an important place in modern shopping center design. The use of energy-efficient materials, maximizing natural lighting, creating green zones, and applying eco-friendly technologies are considered major trends in this field. In Baku, the application of these principles has been observed in recently constructed shopping centers, contributing to the preservation of the city's ecological balance and its sustainable development. Furthermore, modern design approaches involve the creation of personalized spaces. Basing each shopping center on a unique conceptual idea ensures its differentiation in the market. To this end, modern interpretations of national elements, thematic zoning, and the use of unique decorative components are employed in architectural and design solutions. This approach both increases aesthetic value and strengthens the brand identification of the center.

The following table is presented to systematically summarize modern design trends.

Table 3

Design Trends and Innovative Approaches in Modern Shopping Centers

Design Direction	Characteristic Features	Application Result
Experience-Oriented Design	Entertainment zones, interactive areas	Increase in the duration of consumer visits to the center
Digitalization	Smart systems, interactive screens	Improvement in service quality
Ecological Design	Energy efficiency, green areas	Sustainable development and resource conservation
Personalization	Thematic interiors, unique design	Strengthening of brand identification
Functional Optimization	Zoning, comfortable movement possibilities	Enhancement of user comfort

Source: Compiled by the author based on modern design concepts.

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The data presented in the table indicates that the primary goal in the design of modern shopping centers is not only to ensure aesthetic appearance but also to optimize the user experience to the maximum extent. In this regard, the application of innovative approaches plays a crucial role in increasing the competitiveness of shopping centers operating in Baku.

Balancing aesthetic and functional factors in the design of shopping centers is one of the key conditions for their successful operation. While aesthetic attractiveness draws the attention of users, functionality ensures their comfort and satisfaction. The proper integration of these two factors increases the efficiency of shopping centers and ensures their long-term development. To optimize aesthetic design, special attention should be paid primarily to the selection of color, light, and materials. Proper configuration of lighting systems not only enhances the visual impact of the space but also positively affects the psychological state of users. Simultaneously, the balanced application of decorative elements and design accents ensures the harmony of the interior. The improvement of functional design is directly related to spatial planning. Wide passages, clear orientation systems, and optimal zoning ensure the comfortable movement of users. At the same time, the correct placement of service areas and optimization of logistics flows increase the overall operational efficiency of the shopping center.

In the context of the development of shopping centers in Baku, the application of these optimization approaches is of particular importance. Considering the city's urban structure and population density, design solutions are required to be built adaptively. This allows for more effective results both aesthetically and functionally. To achieve the future development of shopping centers in Baku, the formation of a conceptual design model requires the application of approaches consistent with modern urban and economic requirements. This model should be prepared considering the city's architectural features, population behavior, and global design trends. One of the main elements of the conceptual model is the principle of multifunctionality. Shopping centers should be planned not only as shopping areas but also as complex spaces where social and cultural activities are carried out. For this purpose, it is necessary to expand entertainment, recreation, and public activity zones. Another important element is the integration of

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technology. Through digital platforms and smart management systems, it becomes possible to personalize the user experience. This is one of the main factors increasing the competitiveness of modern shopping centers. At the same time, the conceptual model should consider principles of ecological sustainability. The application of green technologies, increasing energy efficiency, and protecting the ecological environment serve as the main components of this model.

Thus, the proposed conceptual design model for shopping centers in Baku is based on the integration of aesthetic, functional, and technological factors. This approach serves to form a modern and sustainable commercial environment in line with the city's urban development strategy.

CONCLUSION

Based on the analysis, it was determined that the main directions in the design of shopping centers in the modern era are related to the application of innovative technologies, ecological sustainability, and the creation of experience-oriented spaces. It is observed that these trends are gradually being applied in Baku as well. Nevertheless, it is necessary to optimize aesthetic and functional design, create personalized concepts, and widely apply digital technologies in existing shopping centers.

Based on the research conducted, the following main results and proposals are put forward:

- Balancing aesthetic and functional factors should be considered a primary priority in the design of shopping centers;
- Design elements affecting consumer behavior (lighting, color, spatial planning) should be applied on a scientific basis;
- The application of modern technologies, especially smart management systems and digital services, should be expanded;
- Energy-efficient and "green" design solutions should be preferred, taking into account the principles of ecological sustainability;
- Unique conceptual design models should be prepared considering the architectural features and national elements of Baku;
- Shopping centers should be developed as public spaces where social and cultural activities are carried out, rather than just shopping places.

In conclusion, the improvement of the design concept and

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aesthetic appearance of shopping centers in Baku can make a significant contribution to the overall urban development, economic activity, and enhancement of the quality of life of the population. The application of complex and innovative approaches in this direction should serve as a main priority for future development.

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