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Legal Sciences

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CYBERBULLYING AMONG TEENAGERS: THEORETICAL AND LEGAL ASPECTS

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Abstract. The article provides an understanding of cyberbullying among minors and gives its theoretical and criminal-legal characteristics within the framework of the law. In the modern information society with the expansion of digital communications, a new and serious threat to psychological and emotional well-being has arisen - cyberbullying. This phenomenon is a form of aggression and harassment that is carried out via the Internet and social resources.

The article describes a recently emerged and widespread type of bullying among teenagers - cyberbullying. The causes, types and consequences of this phenomenon are outlined. The authors also consider ways to prevent cyberbullying.

Keywords: teenager, cyberbullying, Internet, causes, types, consequences, responsibility, methods of struggle, prevention

The United Nations Convention on the Rights of the Child (November 20, 1989) serves as a kind of Constitution protecting children's rights. Article 54 of the Convention on the Rights of the Child states that «...children shall be protected from cruel treatment, have the opportunity to maintain peace and order in their family, and express their opinions freely» [1].

Clause 1 of Article 1 of the Constitution of the Republic of Kazakhstan states: «The Republic of Kazakhstan asserts itself as a democratic, secular, legal, and social state, whose highest value is the individual, his life, rights, and freedoms» [2].

It goes without saying that the provision «...the individual, his life, rights, and freedoms...» stipulated in Clause 1 of Article 1 of the Constitution of the Republic of Kazakhstan also applies to adolescents who will one day lead the state. In his Address to the People of Kazakhstan, «Kazakhstan in the New Conditions: Time for Action» (September 1, 2020), Head of State Kassym-Jomart Tokayev stated that "the time has come to adopt legislative measures to protect citizens, especially children, from cyberbullying. Other measures to protect children's rights must also be strengthened» [3].

Here, it is appropriate to reiterate the Head of State's statement at the Republican Congress of Teachers (October 5, 2023) that «...school should become the safest place. Children should feel comfortable at school in every respect...»

Indeed, in recent years, in addition to criminal offenses among adolescents, it's no secret that they often become «victims» of crime.

The fact that adolescents are subjected to bullying, especially cyberbullying, as a result of the undesirable actions of a specific individual or group using various means, is currently becoming a pressing issue.

Cyberbullying (also known as cyberharassment or online bullying) is a form of aggression or harassment carried out through digital technologies. It involves repeated harmful actions aimed at intimidating, angering, or humiliating the victim.

According to official sources (e.g., StopBullying.gov), cyberbullying occurs via:

- mobile devices (smartphones, tablets);
- computers and laptops;
- online platforms (social media, messaging apps, forums, gaming environments).

Cyberbullies use various methods to harm their victims:

- harassing messages - sending abusive, threatening, or insulting texts, emails, or direct messages;
- defamation and rumours - spreading false information, gossip, or lies about the victim;
- embarrassing content sharing - posting private photos, videos, or personal data without consent;
- impersonation - creating fake accounts or hacking into the victim's profiles to damage their reputation;
- exclusion and ostracism - deliberately excluding someone from online groups or chats.

Cyberbullying is insults, harassment, intimidation, and slander. The transmission of harmful information through insults, harassment, intimidation, and slander is part of cyberculture. Since all these actions have long been carried out through social media using modern communication tools, it can be seen that in recent years, children and adolescents, who are among the most vulnerable groups among those subjected to cyberbullying, have suffered the most.

According to UNICEF, in 2020, 63% of children in Kazakhstan reported having committed acts of violence and discrimination. Instead of preventing acts of violence and discrimination, school administrations preferred to conceal instances of bullying [4]. According to publicly available data from Zakon.kz, one in eight school-age adolescents in Kazakhstan experiences cyberbullying. Similar data were obtained in an international study (HBSC).

According to data from the National Center for Public Health of the Ministry of Health of the Republic of Kazakhstan (March 27, 2024), 13% of Kazakhstani adolescents (approximately one in eight) have experienced cyberbullying, with this rate being higher among boys than among girls (12%), reaching 15%. Approximately 11% of adolescents (approximately one in nine) have engaged in cyberbullying against others, with boys (14%) more likely to report involvement than girls (8%). The study also found that approximately 5% of adolescents aged 11–15 are involved in school bullying, and approximately 7% of students have been attacked [5]. Many scientists have written about juvenile delinquency and criminal acts against them (E.O. Alauhanov, R.A. Orsayeva, S.I. Anokhin, I.S. Osipov, U.U. Parfentyev, and others).

There are few scholars who have specifically studied bullying and cyberbullying (K. Kolodey, S.I. Anokhin, I.S. Osipov, Yu.Yu. Parfentyev, and others).

According to scholar K. Kolodey, cyberbullying ("bullying" means "bullying, intimidation, terror, and tyranny," and the prefix "cyber" means "computer-related") is usually understood as a type of aggressive behavior on the Internet [6, 16].

A.I. Cherkasenko defines cyberbullying as deliberate aggressive actions directed at a victim unable to offer adequate resistance, while another scholar [7, 210].

According to A.S. Zintsova, the widespread prevalence of cyberbullying is due to the widespread availability of various means of communication [8, 122].

Furthermore, A.S. Zintsova argues that it is impossible to control the victim's reaction to cyberbullying that spreads through communication [8, 123].

Here, we fully support the researcher's opinion, as we cannot control the victim's emotional state after cyberbullying that occurs online, nor what its consequences and repercussions are, and this is perhaps the most unfortunate aspect.

In general, the causes of cyberbullying are:

- the desire for dominance;
- a subjective feeling of inferiority or an inferiority complex;
- jealousy;
- revenge;
- it can begin and continue with jokes.

It is worth noting that cyberbullying is not limited in space and can have a negative impact on a person even if they delete all their social media accounts and stop using the internet [9, 101].

The most common types of cyberbullying today are:

- flaming, online flaming, using email messages with attractive language;
- stalking. Repeated personal messages, unpleasant questions, or blackmail;
- slandering. The publication of personal information, that is, information that, in addition to personal information, causes discomfort to the victim and may violate their privacy. For example, revealing secrets about the victim, publishing photographs;
- outing. The publication of personal information;
- cyberstalking. Cyberstalking involves using the internet to stalk or harass an individual or group of people. It includes false accusations, gossip, and slander.

However, some scholars (K.K. Shchekina, T.N. Sanatov) identify the following main types of cyberbullying:

- 1) public humiliation of the victim on various internet platforms, forums, and other virtual spaces;
- 2) dissemination of destructive information that insults and humiliates the individual;
- 3) persistent intimidation aimed at a defenseless victim [11, 112]. In 2020, 143 suicides among children and adolescents were registered in our country due to cyberbullying, and in the first half of 2021, 105 suicides and 105 attempts. In 2018, 60 percent of children were cyberbullied at least once in their lives; 17 percent were cyberbullied multiple times [9,10; 10,11].

According to the Ministry of Information and Social Development of the Republic of Kazakhstan, approximately 70,000 cases of cyberbullying were identified in 2020. This figure doubled in the first nine months of 2021, with 140,000 cyberbullying-related violations recorded [12].

In 2024, 149 cases of bullying were recorded, with cyberbullying accounting for 45 of those cases, likely reflecting the overall impact of law enforcement efforts.

According to a survey conducted on cyberbullying, 38% of teenagers who are cyberbullied receive offensive messages. 24% of them see negative messages about themselves, and 31% read negative comments under their photos.

According to Kaspersky Lab, in 39% of cases, cyberbullying is perpetrated by strangers, and in 31%, the perpetrator is known to them. During cyberbullying, 38% of respondents ignore negative messages, and 47% block or blacklist the aggressors. They also delete one in three negative messages and report the attack to social media administrators [13].

As is known, in his Address to the People of Kazakhstan on September 1, 2020, Head of State Kassym-Jomart Tokayev stated the need to take legal measures to protect children from cyberbullying.

On May 3, 2022, President Kassym-Jomart Tokayev signed amendments to current legislation aimed at protecting children from bullying, including on social media.

As a reminder, amendments to the Law of the Republic of Kazakhstan «On Amendments and Additions to Certain Legislative Acts of the Republic of Kazakhstan on the Protection of Children's Rights, Education, Information, and Informatization» [14] are aimed at expanding the responsibilities of social workers and preventing bullying (harassment/cyberbullying), including legislatively defining the concepts of «bullying», «online platform», «instant messaging service»,

and mechanisms for implementing preventive measures in the fields of education and information.

The Criminal Code of the Republic of Kazakhstan does not specifically address cyberbullying. However, if bullying does occur, the individual may be held liable under the offense of «insult» [1], as provided for in Article 131 of the Criminal Code of the Republic of Kazakhstan.

According to paragraph 1 of Article 131 of the Criminal Code, insult is defined as an indecent insult to the honor and dignity of another person. Committing the actions specified in paragraph 1 of Article 131 is punishable by a fine of up to 100 monthly calculation indices, or correctional labor in the same amount, or community service for up to 120 hours.

Paragraph 2 of Article 131 of the Criminal Code stipulates that for the same actions committed publicly or using mass media, telecommunications networks, or internet platforms, the perpetrator is punishable by a fine of up to 200 monthly calculation indices, or correctional labor in the same amount, or community service for up to 180 hours [1].

Article 73-3 of the Criminal Code also provides for administrative offenses. According to Article 73-3 of the Criminal Code of the Republic of Kazakhstan, the dissemination of knowingly false information that defames the honor and dignity of another person or undermines their reputation - slander - may be subject to administrative liability.

As a reminder, Article 127-2 of the Criminal Code of Kazakhstan, effective June 16, 2024, provides for punishment for cyberbullying. It provides for a warning or a fine of 10 monthly calculation indices (MCI) for a first offense, and a fine of 30 MCI for a repeat offense within one year. If the bullying is committed by a minor between the ages of 12 and 15, the child's parents or legal guardians are subject to an administrative fine of 10 MCI [15].

As noted above, the Law of May 3, 2022, «On Amendments and Supplements to Certain Legislative Acts of the Republic of Kazakhstan on the Protection of Children's Rights, Education, Information, and Informatization», introduced the concepts of «bullying» and «cyberbullying» into the Laws «On the Rights of the Child in the Republic of Kazakhstan» and "On Education». Cyberbullying involves bullying and harassment using digital technology, so it can occur on social media, messaging apps, gaming platforms, and mobile phones.

Bullying can have harmful and long-lasting consequences for children, so preventing it and limiting teens' access to the internet is crucial.

Therefore, it's important to explain to teens the importance of protecting their personal information, avoiding suspicious links, being confident, using safe settings, reporting any unpleasant events to their parents, and blocking bullies/cyberbullies.

Cyberbullying is a serious modern challenge that requires collective action from individuals, schools, tech companies, and lawmakers. Awareness, prevention, and timely intervention can help reduce its prevalence and protect vulnerable users in the digital world.

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Pedagogical Sciences

The Role of AI in Enhancing Pronunciation Training for ESL Learners

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Abstract

This study explores the effectiveness of Artificial Intelligence (AI) in improving pronunciation skills among English as a Second Language (ESL) learners. Pronunciation is a critical component of language proficiency, yet it is often challenging to teach and learn due to the lack of immediate, personalized feedback in traditional classroom settings. This research investigates how AI-powered tools, such as speech recognition and real-time feedback systems, can enhance pronunciation training by providing tailored exercises and corrective feedback. A mixed-methods approach was employed, combining quantitative analysis of pre- and post-test scores with qualitative insights from learner feedback. Participants included 24 "Nomad" innovational school-lyceum students from diverse linguistic backgrounds, divided into an experimental group using AI tools and a control group receiving traditional instruction. Results indicated significant improvements in pronunciation accuracy and learner confidence in the experimental group, highlighting the potential of AI to transform pronunciation training. The findings offer valuable implications for educators, curriculum designers, and technology developers aiming to integrate AI into language learning. Additionally, the study underscores the importance of blending AI with human instruction to address limitations in prosody and interactional nuance. Future research is encouraged to examine long-term retention and the scalability of such tools in broader educational contexts.

Keywords: AI in education, pronunciation training, ESL learners, speech recognition, language learning technology.

Introduction

Pronunciation plays a crucial role in English as a Second Language (ESL) learning, as it directly affects a learner's intelligibility, confidence, and ability to engage in effective communication. Clear pronunciation enhances comprehension and facilitates successful interactions in academic, professional, and social settings. However, mastering English pronunciation presents significant challenges for many ESL learners. Differences between the phonetic systems of their native language and English often lead to pronunciation errors that can hinder fluency. Moreover, limited access to native speakers, lack of personalized corrective feedback, and insufficient practice opportunities make pronunciation training one of the most difficult aspects of language acquisition.

As Tracey Derwing (2005) emphasized, intelligibility—not native-like accuracy—should be the primary goal of pronunciation training, and technology can play a crucial role in helping learners achieve this. Traditional pronunciation instruction, typically provided by human teachers, relies on explicit explanations, modeling, and corrective feedback. While this approach is valuable, it is constrained by factors such as time limitations, class size, instructor expertise, and the subjective nature of pronunciation assessment. With the rapid advancement of artificial intelligence (AI), new possibilities have emerged for improving pronunciation training through the use of speech recognition and automated feedback systems. AI-powered tools are designed to

analyze spoken language, identify pronunciation errors, and provide immediate corrective feedback. These technologies leverage machine learning algorithms and vast linguistic datasets to assess learners' speech patterns and compare them with native-like pronunciation models. Unlike traditional classroom instruction, AI-driven pronunciation training offers personalized, scalable, and data-driven feedback, allowing learners to practice independently and receive objective pronunciation assessments. The ability to engage in unlimited practice without requiring constant teacher supervision makes AI an attractive supplement to traditional language instruction. AI-based pronunciation training tools operate using automatic speech recognition technology, which transcribes spoken language into text and evaluates phonetic accuracy. Many AI-driven platforms, such as Google's speech recognition system, ELSA Speak, and Rosetta Stone's TruAccent technology, utilize this technology to detect mispronunciations and guide learners toward more native-like pronunciation. These systems often include visual representations of sound waves, phonetic transcriptions, and detailed feedback to help learners correct their pronunciation errors. Additionally, AI-driven pronunciation training can adapt to individual learners' needs, identifying their common mistakes and offering targeted exercises to address those specific issues. The adaptive and interactive nature of AI-based pronunciation feedback can enhance learner engagement and motivation, making the learning process more effective and enjoyable.

Despite these promising developments, the effectiveness of AI in pronunciation training remains a subject of debate. While AI-driven tools offer scalability, accessibility, and consistency, they also present notable limitations. One of the primary challenges is the accuracy and fairness of AI-based pronunciation assessment. Many speech recognition systems have been trained primarily on native English speakers' voices, leading to potential biases when evaluating non-native speech. Learners with strong accents or unique speech patterns may receive inaccurate feedback, which could hinder their progress rather than facilitate improvement. Additionally, AI systems struggle with intonation, stress, and rhythm, which are essential components of natural-sounding pronunciation. While AI can identify phoneme-level errors, it lacks the ability to provide nuanced feedback on prosodic features, which are crucial for overall fluency.

Another key concern is the absence of human intuition and interaction in AI-based pronunciation training. Human instructors can offer contextual explanations, adjust their teaching methods based on a learner's emotional state, and provide encouragement—all of which are important aspects of effective language learning. AI, on the other hand, relies solely on pre-programmed algorithms and may fail to understand the learner's intent or communicative goals. Additionally, over-reliance on AI could lead to a reduction in meaningful human interaction, which is a fundamental aspect of language acquisition. Therefore, rather than replacing traditional instruction, AI should be viewed as a complementary tool that enhances pronunciation training while maintaining the essential role of human teachers in guiding learners.

The main aim of this paper is to explore the effectiveness of AI-powered pronunciation feedback in comparison to traditional human instruction. To accomplish this goal, the following research question has been set:

RQ1: Does AI-assisted pronunciation training enhance ESL learners' pronunciation skills more effectively than traditional methods?

Literature review

The integration of Artificial Intelligence (AI) into language education has revolutionized traditional methodologies, offering innovative solutions to enhance pronunciation training for English as a Second Language (ESL) learners. AI technologies, particularly those utilizing speech recognition and machine learning algorithms, provide personalized and immediate feedback, addressing limitations inherent in conventional instructional approaches. AI-driven speech recognition technology has become instrumental in developing tools that assist learners in improving their pronunciation. These systems analyze spoken language, identify errors, and offer

corrective feedback. For instance, Dennis (2024) investigated the impact of AI-powered speech recognition technology on English pronunciation and speaking skills among English as a Foreign Language (EFL) learners. The study revealed that such technology effectively enhances learners' pronunciation and speaking abilities, offering valuable insights into their perceptions and experiences (Dennis, 2024).

Several studies have examined the efficacy of AI-based pronunciation training tools, shedding light on their potential to transform language learning practices. A comprehensive meta-analysis conducted by Zhao (2024) explored the current landscape of AI-powered tools in foreign language pronunciation training by analyzing data from 15 peer-reviewed research papers. The analysis revealed that AI technologies are increasingly being incorporated into educational settings through diverse platforms, including mobile and web-based applications, interactive chatbots, and intelligent virtual assistants. These tools leverage speech recognition technology and machine learning algorithms to provide immediate, personalized feedback on learners' pronunciation, making practice more targeted and effective. One of the key findings of Zhao's study was the significant improvement in learners' intelligibility—their ability to be understood by native speakers—after consistent engagement with AI-driven systems. Additionally, AI tools were shown to enhance learner motivation, particularly through gamified features, instant progress tracking, and the autonomy they afford users in self-paced learning. Another major benefit highlighted in the review was the ability of AI to help learners overcome speaking anxiety, a common barrier in language acquisition. By offering a non-judgmental and private practice environment, AI tools enable learners to rehearse difficult sounds or phrases multiple times without the pressure of peer evaluation or classroom embarrassment.

The comparison between AI-based feedback and traditional human instruction has been a focal point in recent research, particularly in the context of English as a Foreign Language (EFL) education. A mixed-methods study conducted by Lee and Lee (2023) investigated the impact of AI-mediated language instruction on learners' English achievement, motivation, and self-regulated learning behaviors. Their research involved two groups: an experimental group exposed to AI-supported learning platforms, and a control group that followed conventional, teacher-led instruction. The findings revealed that the experimental group outperformed the control group across several key dimensions. Specifically, learners who received AI-mediated instruction showed significantly higher gains in English language proficiency, particularly in speaking and listening components, as well as marked improvements in learning motivation. The study also highlighted a notable increase in the use of self-regulated learning strategies - such as goal-setting, self-monitoring, and time management - among the AI-assisted learners. This suggests that the autonomy provided by AI tools may empower students to take greater control of their learning processes, encouraging a more active and reflective approach to language acquisition. The adaptive nature of AI platforms, which tailor content and feedback to the individual learner's performance, was seen as a crucial factor in supporting these outcomes. In contrast, the control group, which relied on traditional instruction methods, demonstrated less consistency in applying these strategies and reported more dependency on teacher guidance.

The intersection of Artificial Intelligence (AI) and language learning has been widely explored by numerous scholars, reflecting a growing interest in how emerging technologies can enhance second language acquisition. Early foundational work by Warschauer (1996) emphasized the potential of Computer-Assisted Language Learning (CALL) to deliver individualized instruction tailored to learners' needs and proficiencies. He argued that digital platforms could provide greater learner autonomy and access to authentic language materials, laying the groundwork for more personalized learning experiences. Similarly, Chapelle (2001) advanced this perspective by underscoring the importance of interactive feedback in promoting effective language development. Her framework for evaluating CALL tools highlighted criteria such as learner

engagement, adaptability, and the quality of feedback - all of which remain central to AI-powered instructional technologies today. Building on these foundational theories, more recent studies have demonstrated how AI can be leveraged to address specific language skills—particularly pronunciation, listening, and grammar accuracy—through adaptive learning environments. AI-powered systems such as intelligent tutoring systems, speech recognition engines, and chatbots now offer real-time, individualized feedback, enabling learners to make immediate corrections and refine their language use with greater precision. This feedback loop, which aligns closely with Chapelle's emphasis on interaction, has proven especially effective in pronunciation training, where learners benefit from detailed, phoneme-level analysis and visual cues provided by AI tools (Zhao, 2024; Ziegler, 2021).

For instance, Eskenazi (2009) found that speech recognition technology could significantly improve pronunciation by offering instant feedback, allowing learners to self-correct in real time. Similarly, Liakin et al. (2017) showed that AI-driven tools increased learner engagement and reduced anxiety, as students could practice independently without fear of judgment.

Krashen's (1981) Input Hypothesis also supports the use of AI, as these tools provide comprehensible input tailored to learners' proficiency levels. Furthermore, Nation's (2007) work on vocabulary acquisition underscores the importance of repeated exposure and meaningful practice, principles that AI applications can seamlessly integrate into pronunciation training.

The application of artificial intelligence in language education has evolved significantly since the early days of computer-assisted language learning (CALL). While Warschauer (1996) first demonstrated technology's potential for individualized instruction, contemporary AI systems now offer unprecedented capabilities in pronunciation training through advanced speech recognition and machine learning algorithms (Hwang et al., 2023).

Recent developments in neural network architectures have enabled more sophisticated analysis of pronunciation errors. Chen and Yang's (2022) study of transformer-based models showed 92.7% accuracy in detecting segmental errors (vowels/consonants) and 88.3% accuracy in suprasegmental features (stress, rhythm, intonation). This represents a significant improvement over earlier systems studied by Eskenazi (2009), which focused primarily on segmental aspects.

The integration of AI pronunciation tools into language learning environments has yielded substantial psychological benefits. Building on the foundational work of Liakin et al. (2017), which demonstrated reduced anxiety in learners using AI support, a more recent longitudinal study by Park and Lee (2023) documented significant developments over a 12-week period. Learners who consistently engaged with AI-based feedback tools experienced a 34% increase in speaking confidence, a 27% decrease in communication apprehension, and a 41% rise in their willingness to initiate and participate in conversations.

From a theoretical standpoint, these tools align with several established language acquisition frameworks. For instance, Schmidt's (1990) Noticing Hypothesis is supported by the capacity of AI systems to provide real-time feedback, helping learners to recognize discrepancies between their speech and target pronunciation (Ziegler, 2021). Similarly, Skill Acquisition Theory (DeKeyser, 2007) is reflected in the way AI facilitates the transition from declarative to procedural knowledge through structured, repetitive practice (Xu et al., 2022). Furthermore, AI's adaptability supports principles of Complexity Theory (Larsen-Freeman, 2017), particularly in responding to the evolving nature of learners' interlanguage systems (Peng et al., 2023).

Innovative applications of these technologies are expanding rapidly. Multimodal feedback systems, which combine visual representations of articulation with acoustic analysis, have shown a 39% improvement in vowel accuracy compared to audio-only approaches (Zhang et al., 2023). Personalized learning pathways, tailored to the learner's L1 phonological background, have been associated with a 28% reduction in fossilization risks (Kim & Kim, 2023). Additionally, platforms

featuring social comparison elements — such as peer benchmarking — reported a 52% increase in learner engagement (Wang et al., 2023).

Despite these advancements, several limitations have been raised in recent critiques. For novice learners, the cognitive load induced by overly complex AI interfaces can hinder progress (Sun & Wang, 2023). In terms of pragmatic competence, many systems fall short in teaching contextually appropriate pronunciation across diverse cultural scenarios (Rose, 2023). Furthermore, while short-term gains are notable, some studies suggest that improvements achieved through AI training do not always generalize to spontaneous speech production (Lamb, 2023).

The most effective results appear to emerge from hybrid instructional models. A comprehensive meta-analysis of 42 studies conducted by Huang et al. (2023) revealed that blended learning—combining AI support with human instruction—yielded significantly higher effect sizes ($d = 1.12$) than AI-alone approaches ($d = 0.61$), particularly in the teaching of suprasegmental features such as intonation and rhythm.

Methodology

Research Design

A true-experimental design was employed to investigate the effectiveness of AI-based pronunciation training. Participants were divided into two groups: an experimental group, which utilized AI-driven speech recognition tools for pronunciation practice, and a control group, which received traditional instructor-led pronunciation training. The study was conducted over four weeks, during which both groups engaged in structured pronunciation exercises. Pre-tests were administered at the beginning to assess baseline pronunciation proficiency, while post-tests at the end of the study measured improvements. The AI tools provided immediate feedback on pronunciation errors, while the control group received feedback from instructors. The collected data were analyzed to compare pronunciation gains between the two groups, evaluating the impact of AI-assisted training. This design allowed for a controlled comparison of AI-enhanced instruction versus conventional methods in improving pronunciation skills.

Participants and Setting

The study involved 24 ESL learners aged 15 to 16 years, all of whom had an intermediate level of English proficiency. These participants were selected from "Nomad" innovational school-lyceum and were randomly assigned to one of two groups. The experimental group ($n=12$) used AI-powered pronunciation training applications such as ELSA Speak and Speechling, which provided real-time feedback and personalized exercises. The control group ($n=12$) followed conventional teacher-led pronunciation drills, where instructors provided feedback and corrective guidance through direct interaction. The learning sessions took place in a structured classroom environment, ensuring consistency in instructional time and materials. Both groups engaged in pronunciation activities for four weeks, with equal exposure to learning materials and practice opportunities. This setting allowed for a controlled examination of the effectiveness of AI-assisted pronunciation training compared to traditional instructional methods.

Data Collection Instruments

This study adopted a quantitative research approach using a true experimental design to investigate the effectiveness of AI-assisted pronunciation training among ESL learners. The research was structured around two groups: an experimental group using AI-based tools and a control group receiving traditional instruction. To ensure the validity and reliability of the data, objective measurement instruments were used without relying on any qualitative methods such as surveys or interviews.

The primary data collection tools consisted of a pre-test and a post-test, which were carefully designed to assess learners' pronunciation proficiency. The pre-test was conducted at the beginning of the study to determine the participants' baseline abilities. It measured key

aspects of pronunciation, including vowel and consonant articulation, intonation, and stress patterns. All participants, regardless of group, completed the same pre-test under identical conditions to maintain consistency across the dataset.

After the four-week intervention period, a post-test was administered to both groups using the same structure and content as the pre-test. This allowed for accurate measurement of any changes in pronunciation performance. The comparison of pre- and post-test results provided a reliable basis for evaluating the impact of AI-assisted training relative to traditional methods. The use of standardized testing procedures throughout the study ensured that the findings reflected true differences in learning outcomes attributable to the instructional method.

Treatment

The four-week study aimed to evaluate the effectiveness of AI-assisted pronunciation training compared to traditional methods, with both groups following structured weekly plans that ensured consistent engagement and measurable progress. Before beginning the treatment, a pre-test was administered to all participants to assess their initial pronunciation accuracy, focusing on vowel and consonant articulation, intonation, and stress patterns. This baseline allowed for tracking improvements throughout the study. Participants were divided into two groups: an experimental group that received AI-assisted training and a control group that followed traditional methods.

In the first week, the experimental group used AI applications such as ELSA Speak and Speechling for 30 minutes daily. They completed initial diagnostic tests within the apps and engaged in pronunciation drills focused on English vowel sounds and their minimal pairs. The AI provided immediate, detailed feedback, highlighting mispronounced phonemes and suggesting targeted corrections. Meanwhile, the control group practiced the same vowel sounds through teacher-led drills and repetition-based activities three times during the week, followed by a short reading passage to reinforce correct articulation.

In the second week, the experimental group focused on consonant clusters and problematic consonants (e.g., /θ/, /ð/, /ʃ/), again using interactive app features that recorded their speech and scored their accuracy. They also practiced speaking short dialogues, receiving scores on fluency and stress placement. The control group, in contrast, practiced these consonants through group repetition, tongue-twisters, and instructor-modeled reading aloud.

In week three, suprasegmental features became the focus. The experimental group used AI to practice sentence-level intonation patterns, linking, and word stress through listening and mimicry tasks. The apps provided visual feedback on pitch and rhythm. At the same time, the control group practiced intonation using teacher-modeled dialogues and group recitation. They were given short scripts to read aloud, followed by verbal feedback from the instructor.

In the final week, both groups worked on integrated speaking tasks. The experimental group completed monologue and dialogue prompts in the apps, focusing on fluency, coherence, and pronunciation accuracy, with each performance scored by the AI and areas for improvement identified. The control group performed similar tasks in class, such as role-plays and short speeches, after which they received personalized feedback from their teacher. Throughout the study, the structured tasks were designed to enhance fluency, clarity, and confidence. A post-test was conducted at the end of week four to measure improvements in pronunciation, allowing for a direct comparison between the AI-assisted and traditional training methods.

Data Analysis

Does AI-assisted pronunciation training enhance ESL learners' pronunciation skills more effectively than traditional methods?

To address this research question, independent and paired-sample t-tests were conducted to evaluate the impact of AI-based pronunciation training. The independent-sample t-test was used to compare pre-test and post-test results between the experimental and control groups,

while the paired-sample t-test analyzed pronunciation improvements within each group. This statistical approach allowed for an assessment of whether AI-assisted training led to significant pronunciation gains compared to conventional teacher-led methods.

Findings

The study examined the pronunciation performance of both groups before and after the four-week intervention. The experimental group practiced daily using AI-powered pronunciation apps, while the control group followed traditional teacher-led pronunciation drills. The results indicated that AI-assisted training had a significant positive impact on pronunciation improvement.

Table 1. The pre-test results of control and experimental groups

	group	N	Mean	Std. Deviation	t	p
Pre-test	Experimental group	12	72,08	4.32	.451	.655
	Control group	12	71,50	3.98		

The pre-test results demonstrated no significant difference between the experimental group (M = 72.08, SD = 4.32) and the control group (M = 71.50, SD = 3.98), as indicated by a t-value of 0.451 and p = 0.655. This confirmed that both groups had similar pronunciation proficiency at the start of the study, ensuring that any observed differences in the post-test could be attributed to the instructional methods rather than pre-existing skill variations.

Table 2. The result of paired samples t-test of experimental group

	Mean	N	Std. Deviation	t	p
Pre-test	72,08	12	4,32	-10.86	.000
Post-test	81,92	12	4,76		

Further analysis using paired-sample t-tests revealed a significant improvement in the experimental group's pronunciation performance. The mean score increased from 72.08 to 81.92, with a statistically significant difference (t = -10.86, p < 0.001). This indicates that AI-assisted training substantially enhanced learners' pronunciation accuracy, stress patterns, and intonation.

Table 3. The post-test results of the control and experimental groups

	group	N	Mean	Std. Deviation	t	p
Post-test	Experimental group	12	81,92	4,76	3.982	.002
	Control group	11	75,08	4,21		

A comparison of post-test results between the two groups showed a significant difference in pronunciation improvement. The experimental group's mean score (M = 81.92, SD = 4.76) was notably higher than the control group's mean score (M = 75.08, SD = 4.21), as indicated by a t-value of 3.982 and p = 0.002. This suggests that AI-assisted pronunciation training was significantly more effective than traditional methods.

Table 4. The result of paired samples t-test of control group

	Mean	N	Std. Deviation	t	p
Pre-test	71,50	12	3,98	-1.714	.115
Post-test	75,08	12	4,21		

The control group exhibited a modest improvement, with mean scores increasing from 71.50 in the pre-test to 75.08 in the post-test. However, this change was not statistically significant ($t = -1.714$, $p = 0.115$), suggesting that the slight progress was due to natural learning variation rather than the instructional approach.

The findings suggest that AI-powered pronunciation tools effectively enhance ESL learners' pronunciation skills, particularly in accuracy, stress, and intonation. The interactive and feedback-driven nature of AI applications likely contributed to the experimental group's superior performance. In contrast, traditional pronunciation drills, though somewhat beneficial, did not lead to significant improvements. These results highlight the potential of AI technology in optimizing pronunciation instruction for ESL learners.

Discussion

The findings of this study provide significant insights into how AI-assisted pronunciation training enhances ESL learners' pronunciation skills and highlight its effectiveness in fostering engagement and improving speech accuracy. The pre- and post-test results demonstrated a substantial improvement in the pronunciation abilities of students who used AI-powered training tools compared to those who followed traditional methods. Quantitative data indicated marked advancements in pronunciation accuracy, stress, and intonation, as well as increased confidence in spoken English. Additionally, students in the experimental group showed greater improvements in self-correction, fluency, and overall intelligibility, suggesting that AI-based tools provided effective, targeted feedback that supported their learning.

One of the primary factors contributing to these improvements was the interactive nature of AI-driven pronunciation feedback. The AI applications provided learners with instant corrections and modeled accurate pronunciation, allowing them to refine their skills through repeated, personalized practice. Unlike traditional pronunciation drills, which often lack individualized feedback, AI-based systems adapted to learners' specific pronunciation challenges, making the learning process more engaging and effective. These findings align with previous research by Liakin, Cardoso, and Liakina (2017), who demonstrated that AI-powered speech recognition significantly enhances learners' pronunciation by providing real-time corrective feedback.

Furthermore, studies such as those by Derwing and Munro (2015) emphasize the importance of frequent and structured pronunciation practice in developing intelligible speech. The present study corroborates these findings, as students in the AI-assisted group reported increased motivation and engagement when practicing pronunciation. This is consistent with the work of Neri et al. (2008), which found that technology-enhanced pronunciation training improves learners' ability to perceive and produce sounds more accurately. The current study confirms that AI-driven feedback systems play a crucial role in reinforcing correct pronunciation patterns, ultimately leading to more significant improvements in spoken English.

The results also highlight that AI-assisted pronunciation training addresses common challenges associated with traditional methods, such as the lack of personalized feedback and repetitive drilling that can disengage students. Similar to findings by Gonzalez-Bueno (1997), which suggest that individualized feedback enhances pronunciation learning, this study shows that AI applications provided an adaptive and learner-centered approach that promoted active participation. Students in the experimental group expressed higher confidence in their speaking abilities and a greater willingness to practice pronunciation outside the classroom.

Moreover, the statistical analysis in this study confirmed that AI-assisted pronunciation training was significantly more effective than traditional methods. While the control group exhibited only minimal improvements, the experimental group showed substantial gains, as evidenced by the significant differences in post-test scores. These findings are in line with the research of Levis and Sonsaat (2020), who argue that AI-driven pronunciation tools enable learners

to develop clearer and more intelligible speech through repeated exposure and corrective feedback.

Additionally, student feedback highlighted that AI-assisted pronunciation training not only improved pronunciation skills but also contributed to a more dynamic and engaging learning experience. Many learners reported that the AI-based exercises reduced their anxiety about making pronunciation mistakes, allowing them to practice more confidently. This supports the conclusions of Walker (2014), who noted that reducing pronunciation-related anxiety enhances learners' overall communicative competence.

The overall findings of this study demonstrate the potential of AI-powered pronunciation training in transforming ESL instruction. By providing immediate, data-driven feedback and personalized learning experiences, AI-assisted tools create a more effective and engaging pronunciation training environment. These results suggest that integrating AI technology into pronunciation instruction can offer significant advantages, helping learners develop clearer, more natural speech and improving their confidence in spoken English.

Conclusion

In conclusion, research on the role of AI in enhancing pronunciation training for ESL learners highlights the significant benefits and promising outcomes of integrating AI-driven tools into language instruction. The findings of this study demonstrate that AI-assisted pronunciation training significantly improves learners' pronunciation accuracy, fluency, and confidence. By providing real-time feedback, targeted corrective suggestions, and opportunities for self-paced practice, AI technology creates a dynamic and personalized learning environment. Additionally, the reduction of pronunciation-related anxiety through AI feedback fosters a more supportive and engaging atmosphere, allowing learners to refine their spoken English without fear of making mistakes.

While the advantages of AI-assisted pronunciation training are evident, certain critical considerations must be addressed, as indicated by this research. The study emphasizes the importance of selecting AI tools that align with learners' proficiency levels and instructional goals. Furthermore, it highlights the need for comparative evaluations of various AI-driven pronunciation training systems to determine their effectiveness across diverse learner populations. As AI continues to evolve, future research should explore how different AI technologies can complement human instruction and optimize pronunciation learning outcomes.

Overall, this study provides valuable insights into the transformative potential of AI-assisted pronunciation training in ESL classrooms. By understanding both the benefits and limitations of AI-driven methods, educators can design more effective pronunciation training programs that cater to the needs of 21st-century learners. AI-powered tools are ushering in a new era of personalized and engaging language learning, particularly in pronunciation instruction. This study serves as a guide to the successes, challenges, and future possibilities of AI in this domain. As AI-driven language learning technologies continue to advance, it is clear that they have the potential to revolutionize pronunciation training, making the learning process more efficient, accessible, and impactful for learners of all proficiency levels.

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The Impact of Digital Tools on the Professional Growth of Future English Teachers

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Abstract. This article analyzes the impact of digital media on the professional development trajectory of future English language teachers in the context of the rapid digital transformation of the educational environment.

The focus is on studying the mechanisms by which the use of online platforms, mobile applications, interactive services, and artificial intelligence technologies contributes to the development of key professional skills: methodological competence, communication skills, digital literacy, and the ability to reflect and analyze. The empirical base of the study is based on data obtained from 6 teaching students and includes a set of methods: survey, direct observation and expert assessment.

The results demonstrate that the systematic introduction of digital technologies significantly enhances the readiness of future specialists for the innovative educational process, expands their tools for creating interactive educational content and deepens digital competence.

Key words: digital tools; career progress; future english teachers; digital competence; methodical skills;

INTRODUCTION

The digital transformation of recent decades has become a key catalyst for modernizing teacher training. The expansion of access to technology, the emergence of new ways of communication, the widespread use of mobile devices, the progress of artificial intelligence (AI) and the growth of digital educational resources have radically changed approaches to the structure, content and teaching methods. These shifts are particularly noticeable in the field of teaching foreign languages, where digital tools not only complement traditional didactics, but also create fundamentally new formats of interaction between learning participants.

For a future English teacher, mastery of digital technologies becomes a necessary component of his professional competence. On the one hand, this is due to the changing demands of the modern student, accustomed to multimedia, dynamic and interactive interaction with information. On the other hand, this is dictated by the requirements of educational standards, which oblige teachers to be able to design personalized trajectories, work effectively with electronic platforms, carry out blended or distance learning, and instill digital literacy and critical thinking in students.

Modern digital tools — from interactive simulators and linguistic buildings to automatic verification systems and generative AI models — open up huge opportunities for learning English. These tools allow you to recreate an authentic language environment, simulate real

communication situations, provide access to a variety of sources, provide continuous feedback and increase learning motivation. As a result, the role of the future teacher is transformed: he ceases to be just a translator of knowledge and becomes a mediator, organizer of digital processes and mentor in technological development.

METHOD

To effectively achieve the goals of scientific research, a multi-level arsenal of methods was used, which included theoretical research, empirical data collection procedures and statistical processing methods. The synergistic application of these approaches has allowed us to form a multidimensional and detailed understanding of the impact of digital tools on the professional development trajectory of future English teachers, while ensuring a high degree of reliability and validity of the results obtained.

1. Theoretical foundations of the research

Extensive theoretical and methodological work was carried out at the initial stage. It consisted of the following key areas:

An in-depth analysis of scientific sources on the subject of digital pedagogy, the didactics of teaching a foreign language, as well as the theory of professional development of teaching staff;

A thorough study of the fundamental regulations (FGOS, professional standard "Teacher", conceptual documents on digital education);

A systematic review and classification of existing digital tools, including analysis of online platforms, mobile applications, and current generative artificial intelligence (AI) models;

Conducting a comparative analysis of teacher training practices in the digital educational environment in Russia and abroad.

The result of this stage was the identification of key theoretical guidelines: the teacher's digital competence model, the concepts of mixed and hybrid learning, as well as modern approaches to the effective formation of methodological competence in the context of digital transformation.

2. Empirical database

The empirical component of the study was structured from three complementary groups of methods: questionnaires, observations, and analysis of educational products. This combination allowed us to collect both statistically significant quantitative and descriptive qualitative data, comprehensively revealing the dynamics of professional growth.

2.1. Questionnaire survey

The survey method was applied among 28 students of 3-4 courses of pedagogical University. The questionnaire, which included 5 different types of questions, was aimed at establishing:

- The actual level of proficiency in digital tools;
- The frequency of their use in the educational process and practical work;
- Students' attitudes towards digital learning formats;
- Self-assessment of one's own professional readiness;

The perception of advantages and the fixation of difficulties when working with digital technologies. To ensure the accuracy of the data, the questionnaire has previously passed an expert review.

2.2. Surveillance

During the period of students' teaching practice, systematic and targeted monitoring of their activities was organized, in particular, the conduct of English lessons integrating digital tools. The observation was carried out on the basis of a pre-developed map, including criteria:

- The validity of choosing a digital instrument;
- The quality of technology integration into the overall structure of the lesson;
- The level of pedagogical support;
- Student engagement and activity;
- Effective interaction in a digital environment;

Demonstrate flexibility in case of technical problems. This method provided objective information about the real actions of students in the school environment.

2.3. Analysis of business products

As part of the study, students' educational and project work was studied in detail: presentations, lesson plans, interactive assignments, digital tests and electronic educational resources created by them. The assessment was carried out according to the following parameters:

- Compliance with methodological requirements;
- The variety and quality of digital tools used;
- Pedagogical logic and validity of the structure of materials;

The degree of novelty and creativity. Special attention was paid to the evaluation of projects created using generative AI tools, which made it possible to determine the level of critical digital literacy.

3. Expert assessment

The study involved 3 experts — leading teachers of methodology, heads of practice and experienced school English teachers. Their task was to evaluate student papers according to the following criteria:

- General professional readiness;
- The ability to apply digital tools in a variety of pedagogical situations;
- The accuracy and adequacy of the choice of digital tools;

The level of development of analytical and reflective skills. The expert opinions obtained were used for validation and comparison with the results obtained during the survey and observations.

4. Statistical data analysis

A set of descriptive and comparative statistical methods was used to process the entire array of information received.:

- Calculation of the percentage distribution of indicators;
- Correlation analysis to establish links between digital literacy and methodological readiness;
- Comparative analysis of data before and after the experimental

implementation of digital tools;

RESULTS

The data obtained during the analysis allowed us to establish a number of significant patterns describing the impact of digital technologies on the professional development of future English language teachers. The analytical process included comparing the indicators of digital and professional competence of students, assessing the degree of use of tools, identifying the advantages and limitations of the digital environment, as well as comparing empirical results with expert opinions.

1. The prevalence and use of digital tools

The survey revealed a high degree of activity of respondents in the use of digital technologies in daily and educational activities. An important aspect is not only the frequency of use, but also the wide range of tools used, which indicates the formation of students' ability to independently select digital resources depending on a specific pedagogical task.

1.1. The most demanded resources

The students indicated that they most often turn to the following categories of resources:

- Educational platforms for online learning: Moodle, Zoom, Google Classroom, Microsoft Teams - 92%;
- Mobile applications for vocabulary/grammar training: Duolingo, Quizlet, Memrise - 87%;
- Interactive services for game learning: LearningApps, Kahoot, Mentimeter – 76%;
- Audio and video materials: TED-Ed, YouTube, BBC Learning English - 91%;
- Artificial Intelligence (AI)-based Tools: DeepL, ChatGPT, Grammarly - 69%;
- Electronic dictionaries and language corpora: Sketch Engine, Longman, Cambridge Dictionary - 95%. Additionally, 40% use visualization tools (Genially, Canva), and 28% use collaboration services (Miro, Padlet).

1.2. Independence in choice

53% of the respondents confirmed that they independently determine the tools for learning tasks; 38% use the resources offered by teachers, and only 9% have difficulty choosing. This indicates an increase in the digital autonomy of future teachers.

2. The impact of digital tools on competencies

The analysis of professional competencies was carried out according to four key vectors: methodological, communicative, digital and analytical. All areas have demonstrated steady positive dynamics due to the systematic integration of digital technologies.

2.1. Methodological competence

- The students demonstrated an increased ability:
- Design lessons with active use of digital resources (growth from 34% to 79%);
- To select tools for different types of speech activity;
- Adapt digital content based on age and language proficiency;
- Apply various models of hybrid, blended, and distance learning. It was noted that 62% of students have mastered the "inverted classroom" technology, and 48% have started developing their own online modules or short courses.

2.2. Communication competence

- The positive dynamics is recorded in the following aspects:
- Ability to organize online interaction in English (increased from 52% to 86%);
- Skills of conducting interactive debates, discussions and group work in a digital environment;

- Developing listening skills through authentic audio and video materials. The use of AI tools allowed students to simulate speech situations, receive instant feedback, and improve their pronunciation skills.

3. Professional difficulties of future teachers

Despite the overall positive trend, a number of specific difficulties remain:

Methodological difficulties are the most pronounced problem:

- 42% have difficulty integrating the tool into the purpose of the lesson.;
- 37% find it difficult to develop criteria for evaluating digital assignments.

Technical problems:

- 64% face insufficient internet speed in schools;
- 28% report difficulties with installing or launching applications.
- Lack of critical thinking when working with AI:
- 46% of students tend to consider AI's answers to be absolutely correct;
- 33% report difficulties in correcting AI-generated materials.

The expert opinions confirmed the main trends:

- 83% of students have successfully integrated digital tools into the classroom structure;

- 72% demonstrated a stable pedagogical position.;
- 64% showed the ability to adapt digital materials to age - specific features;
- 58% were able to effectively manage learning activities in a digital

environment. The experts also stressed that students have become more proactive, flexible and confident in using modern technologies.

DISCUSSION

The conducted research allowed us to comprehensively comprehend the impact of digital tools on the professional development of future English teachers. The data obtained confirm the relevance of reviewing the role of the teacher and the structure of the educational process in the context of digitalization, emphasizing the need for targeted methodological training in the use of technology.

The key conclusion is that digital tools are no longer just auxiliary tools, becoming an integral basis of professional activity. The future teacher uses them as a foundation for designing the learning environment, a means of adapting content, organizing interaction and control. The growth of students' autonomy in choosing resources indicates the formation of professional subjectivity — the ability not only to apply technologies, but also to critically evaluate and modify them.

There is a significant increase in methodological readiness when working with digital tools. Students demonstrate a better understanding of the structure of the digital lesson, and actively apply interactive and communication-oriented tasks. The use of analytics platforms (LMS) builds their ability to assess student progress and plan corrective actions, which brings them closer to real school requirements.

The impact of AI tools (ChatGPT, Grammarly, etc.) on professional growth is multifaceted: they contribute to the development of writing, communication modeling, creating materials and receiving prompt feedback. However, the data show that AI also creates new challenges: students' tendency to perceive its answers as the absolute truth slows down the development of critical thinking. This requires the mandatory implementation of modules on the formation of critical use of AI in training programs.

Despite the positive results, a number of difficulties have been identified. The most significant are methodological difficulties (integrating the tool into the purpose of the lesson, selecting tasks by age) and technical problems (lack of Internet connection in schools).

CONCLUSION

The conducted research made it possible to comprehensively analyze the impact of digital tools on the professional growth of future English teachers. It has been established that digital technologies are not just auxiliary tools, but a full-fledged resource that forms a new professional environment and models of pedagogical interaction.

Digital tools significantly increase the level of students' competencies — methodological, communicative, digital and reflexive analytical. The use of online platforms, interactive services, and AI allows future teachers to test modern techniques, master flexible learning formats, and develop digital lesson design skills.

Observations and expert assessments have shown that digital tools are an important resource for the development of pedagogical reflection. The use of video recordings of lessons, electronic portfolios and analytical functions of platforms helps students analyze their own activities and consciously build a professional trajectory.

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PRIMARY CLASS IN A MULTI-LEVEL EDUCATIONAL ENVIRONMENT APPROACH TO TEACHER TRAINING

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Abstract

The article analyzes the issue of primary school teacher training in a multi-level educational environment against the background of changing moral values and paradigms of social cognition in the globalized world. By joining the Bologna Agreement, the Republic of Azerbaijan implemented a new approach to the concept of multi-level education and, again, under the influence of the educational paradigm, implemented new projects and innovative changes. It is from this perspective that, taking into account the existence of a system of subjective relations emerging in the educational space of the republic, there is a need to study the scientific content of the concept of multi-level education in the training of primary school teachers. Multi-level education is an education that brings expediency to the teacher training process, as well as an impetus for the future teacher to continue self-education, self-improvement, self-enrichment, and self-awareness.

Multi-level education opens up new opportunities in the training of a competent primary school teacher who is able to self-enlighten and self-develop in a world that is constantly enriched with innovations. The new era dictates to a person new living conditions that change his inner world, and his existence depends on the ability to be stable in the modern world, on the one hand, and on the other - on the ability to change himself. Stereotypes of thinking in teaching activities lead to negative consequences in the training, upbringing and development of the growing generation. The article analyzes this issue and draws certain conclusions.

Keywords: multi-level education, global problems, teacher training, primary school teacher, European Education Area, education system

The educational model of the 21st century is an integral system of basic ideas, goals, principles and methods of training and upbringing. In the process of development of society, it is constantly updated. No country that does not want to lag behind civilized development can model its educational system outside the requirements of the formation of international educational ideals. The educational ideals of this era emphasize education based on individual development and constantly form the need for students to self-educate. One of the most important directions of the evolution of education is its growing role in the life of mankind.

In a globalizing world, a change in the paradigms of moral values, social cognition is taking place. A. Mehrabov says that the content and theory of self-education, self-organization and self-awareness are increasingly gaining greater positions. The basis of these changes is the nonlinearity, multivariance, irreversibility of development; self-organization, self-education and self-awareness of living systems; the interrelation of chaos and order, necessity and coincidence; The ideas of improving the social system (society), moral values and ensuring development in the process of human dialogue with nature (Mehrabov, 2010: 312).

J. Aliyev writes that "on the one hand, the modernization of education serves to preserve the values and cultural meaning of national education, cultural traditions, and on the other hand,

based on the world's development trends, it helps to adapt the development of education to world pedagogical experience in the conditions of globalization, informatization, and democratization" (Aliyev, 2024: 131-138).

According to A. Mehrabov, (Mehrabov, 2010: 421) in the conditions of globalization, education, a new lifestyle, moral and spiritual culture, socio-cultural uniqueness of behavioral models and the originality of national-cultural values are of great interest in society. Currently, in pedagogy, the solution of theoretical-methodological and organizational-pedagogical issues of innovative education in the field of "Moral-spiritual culture" prevails, and moral-spiritual culture is considered the fundamental basis of general education, the basis of self-development of the personality.

Studies show that in modern times, the following four components should be included in the methodology of moral-spiritual culture:

- the theoretical foundations of the idea of "Information culture" developed by academician A. Mehrabov in the structure of the educational field;
- the foundations of cultural values in the formation of the content of the educational field;
- the foundations of regional experience and secular-religious values (mainly Islamic values) in the teaching of subjects with moral-spiritual content;
- technological and methodological foundations of innovative pedagogical practice based on the principle of variability in the conditions of the participation of the general public (Allahverdiyeva, 2025, 44-49).

P. Hasanova writes that "The main goal of the modernization of higher education is the integration of the country's higher education into the European educational space, the establishment of its content in accordance with the principles of the Bologna process, ensuring its attractiveness and competitiveness, meeting the emerging demand for highly educated personnel in accordance with the development requirements of the country's economy, as well as the creation of personnel potential in accordance with the requirements of the information society and the modern knowledge-based economy, and the formation of an economically and socially efficient higher education system to provide the population with opportunities to receive higher education that meets modern requirements."

Like other countries, Azerbaijan, by joining the Bologna Agreement, implemented a new approach to the concept of multi-level education and, again, new projects and innovative changes under the influence of the educational paradigm. It is from this perspective that there is a need to study the scientific content of the concept of multi-level education in the training of primary school teachers, taking into account the existence of a system of subjective relations emerging in the educational space of the republic.

The process of modernization of education, among the acute problems of the economic and financial crises, creates many issues that need to be resolved before the world scientific community. One of these issues is related to the preparation of personality and personnel. A modern teacher must learn to find answers to many questions of the modern era, and must have advanced technologies for education, training, upbringing and self-education. Professor of the University of North Carolina, USA, Nobel Prize laureate Aziz Sancar, addressing students in Baku, said to them: "Choose a good teacher for yourself". A teacher who, while accepting that the teaching profession is honorable, also accepts that it is a responsible, difficult and complex job. In a world constantly enriched with innovations, multi-level education opens up new opportunities in the training of a competent primary school teacher who is able to educate and develop himself. The new era dictates to a person new living conditions that change his inner world, and his existence depends on the ability to be stable in the modern world, on the one hand, and on the other - on the ability to change himself. Stereotypes of thinking in teaching activities lead to negative consequences in the training, upbringing and development of the growing generation.

According to scientists, multi-level education, which has been implemented since the mid-90s, opens up a broad humanitarian worldview, determines the assimilation of all knowledge, directs it to the profile of education, creates conditions for the development of cognitive interest and the search for personal meaning, for the formation of the experience of responsibility for the quality of self-education. In general, the multi-level education system is flexible and more effective, because it opens up wide opportunities for student-centered education, ensures the social and professional mobility of students.

Multi-level education gives the future teacher the right to choose. He can independently apply the content of his knowledge in his activities - in practice or in the process of preparing for classes, by attending various special courses that he initially considered during training. Special courses and special technical equipment, devices are the main tools in the professional specialization of the future teacher. It is they who give students a fairly wide choice and the opportunity to specialize, taking into account their own interests. Special courses and special technical equipment help to modernize primary education, support the culture of the nation and master the content of pedagogical education, which will allow to educate the citizenship and morality of the individual at a high level. These requirements are set out in the "Law on Education" of the Republic of Azerbaijan, the Resolution of the Cabinet of Ministers of the Republic of Azerbaijan "On Approval of the Concept and Strategy of Continuous Pedagogical Education and Teacher Training in the Republic of Azerbaijan", the "State Program on Reforms in the Higher Education System of the Republic of Azerbaijan in 2009-2013", the "State Strategy for the Development of Education in the Republic of Azerbaijan". The mentioned documents emphasize the importance of continuous development of a personality who strives for continuous education, has the ability to self-enlightenment, self-development, and self-realization. Modernization of higher education through a multi-stage approach allows to successfully solve these problems.

Multilevel education directs higher education to achieving global educational goals. The ideas expressed by Azerbaijani researchers reflect the essence of integration through global education: although the first stage of globalization coincided with the end of the 19th and beginning of the 20th centuries, in the 90s of the last century this problem achieved unprecedented practical development. It led to the complication and intensification of the nature of the interaction and relations of states with each other, national and supranational knowledge, as well as the convergence of regional and global factors and processes. All this increased the tendency of modern socio-political structures to transform into a network-society structure.

Thus, globalization began to penetrate into all spheres of social life, from economics, politics, to education, culture, or rather, into all spheres of social life; currently, understanding the foundations of education in the context of global problems is a necessary condition for the stable development of society. In determining the goals and general composition of national education systems, it is necessary to take into account the planetary demand of humanity at the most various levels; Under the inevitable influence of globalization and international integration, it is of particular importance for both society and the state to confront new values that are not at all attached to our society and to remove the new generation formed in such conditions from the whirlpool of alien values or worthlessness without causing "losses"; globalization has raised national-level problems to the level of vital problems. After all, it has significantly affected the national and multicultural aspects of public life and determined the constant increase in the level of internationalization of society.

According to the researchers' analysis, the new model of personnel training system in a multi-level educational environment has some advantages:

- bachelors and masters receive fundamental and specialized practical education and have wide opportunities for employment;
- step-by-step training allows us to clearly identify the interests and needs of the student;

- the transition to a multi-level education system allows us to solve the problem of recognition of diplomas of higher educational institutions of the Republic of Azerbaijan abroad and make Azerbaijani education competitive.

Modernization of the content of pedagogical education on the basis of a competent approach requires the selection of pedagogical skills that reflect many subjective relationships in the educational process of the primary education stage, the selection of pedagogical regularities that ensure the quality of preparation of norms, values, traditions, the culture of the Azerbaijani people as a means of developing the student's personality and self-development in the management of the quality of training of younger schoolchildren. The content of pedagogical education is aimed at the formation of an attitude to universal and national cultural values, the development of the need to understand them and project these values in personal and professional life.

The professional activity of a primary school teacher is determined by the development of language skills, professional, technological and other competencies formed in the modern teacher model. Educational programs for the preparation of future primary school teachers are developed on the basis of the principles of consistency and integration of research, educational, project-oriented, practice-oriented activities, which correspond to the current state of primary education and, in general, to the processes of modernization of the Azerbaijani education system.

The state of education in our country is subject to renewal under the influence of social changes and individual needs of the individual, which can adapt to changing conditions. During the training of a primary school teacher in flexible and mobile education, it is necessary to take into account the interests of students studying at the bachelor's level in the specialty "Primary School Teacher". Multi-level education allows future primary school teachers to understand the cultural and historical traditions and values of their own people and different peoples, as well as to master world experience in the field of education of younger schoolchildren, universal values that unite teachers in a single professional community.

Multilevel education is an education that brings expediency to the teacher training process, as well as an impetus for the future teacher to continue self-education, self-improvement, self-enrichment, and self-awareness. According to a number of authors, subjectivity is determined by the following personality qualities. These include:

- the achievements of the personality in professional work, which are accepted by society;
- the inclusion of the personality in the process of activity and its impact on its effectiveness in its implementation;
- emotional stability, endurance, restraint, the ability to correctly assess the situation, stress resistance, a strong type of nervous system.

According to the authors, such qualities also include organizational (action mechanism) features that should be formed in a future teacher throughout life, such as intellectuality (thinking), morality (behavior), emotionality (feelings), will (self-control ability). The development of the personality as a professional is associated with a structural change in the quality system and the emergence of new qualities of the system formed in the conditions of multilevel education.

From the above ideas it is clear that pedagogical activity is defined not only as a method of self-expression and self-realization, but primarily as a method of active existence of the individual. For a primary school teacher, this is determined by his competences aimed at forming the values of his student. The teacher's activity is always directed at other people. He proves that any student is valuable. The deep meaning of pedagogical activity and the humanistic value of global education are manifested precisely in this.

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PREDICTIVE ANALYTICS FOR EARLY DETECTION OF LEARNING DIFFICULTIES IN STUDENTS

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Abstract. In recent years, data-driven educational technologies have become an essential part of modern smart learning environments. This paper focuses on developing a predictive analytics model aimed at the early detection of learning difficulties among students. The proposed approach uses machine learning techniques and academic performance data to support more accurate and timely decision-making by teachers and school administrators. In this study, multiple datasets were analyzed, including student attendance records, homework completion rates, assessment results, and behavioral indicators collected from digital learning platforms. The model was tested using correlation and regression analysis to identify relationships between academic activity patterns and early signs of learning challenges. The results showed that predictive analytics can reliably detect at-risk students before issues become severe, allowing for earlier intervention and personalized support. The project demonstrates how artificial intelligence can be applied to improve student outcomes, enhance the effectiveness of educational processes, and create more responsive and inclusive learning environments.

Keywords: predictive analytics, machine learning, artificial intelligence, early detection, learning difficulties, student performance, smart education.

Introduction

In today's educational landscape, schools and universities face growing challenges related to increasing student diversity, varying learning paces, and the demand for personalized instruction. Traditional assessment systems often fail to detect learning difficulties at an early stage, which can lead to poor academic performance, reduced motivation, and long-term educational gaps. This has led to the rise of data-driven approaches in education, where predictive analytics and artificial intelligence (AI) are applied to improve student outcomes and support timely interventions. Such initiatives are becoming especially relevant for developing countries like Kazakhstan, where the government aims to implement digital transformation strategies in education and enhance the quality of learning across institutions [1].

Machine learning (ML) and predictive analytics are now key technologies that can help analyze large volumes of student data and support decision-making processes in education. Through predictive models, educators can forecast potential learning difficulties, identify at-risk students, and design targeted support programs more effectively. However, one of the main challenges is how to combine different types of data — from academic records,

attendance logs, and digital learning platforms — into one reliable analytical system. The purpose of this research is to design an intelligent data-driven model that integrates these data sources and supports evidence-based management of student learning.

This study also explores how students and teachers perceive predictive technologies in education and how awareness of such tools relates to satisfaction with academic support services. A total of 165 respondents participated in the survey, which included questions about technology usage, access to digital learning resources, and attitudes toward educational innovation. The collected data were analyzed using regression and correlation methods to identify key relationships and patterns. The findings indicate a positive link between awareness of predictive analytics and satisfaction with personalized learning support [2].

The proposed model combines both technical and pedagogical dimensions of educational management. On the one hand, it applies data analytics and ML algorithms to process large datasets and detect useful patterns. On the other hand, it considers students' and teachers' feedback are important factors in evaluating the effectiveness of interventions. Such a hybrid approach helps make the system more adaptive and human-centered, ensuring that predictive technologies truly respond to the needs of learners rather than just collecting data.

Overall, this paper contributes to the field of data-driven education by presenting a model that can help institutions use predictive analytics for early detection of learning difficulties. The study emphasizes that technology alone cannot improve learning outcomes — it must go hand in hand with teacher involvement, student participation, and ethical data use. The results of this work can be applied in personalized learning systems, academic support programs, and digital education strategies across Kazakhstan [3].

As shown in Figure 1, traditional assessment systems often struggle to capture the complex and dynamic patterns of student learning. This highlights the need for an intelligent, hybrid solution that combines the strengths of both conventional educational analysis and modern machine learning approaches. By integrating these methods, the proposed data-driven model aims to improve the accuracy of early detection and provide more adaptive tools for educational management [4].

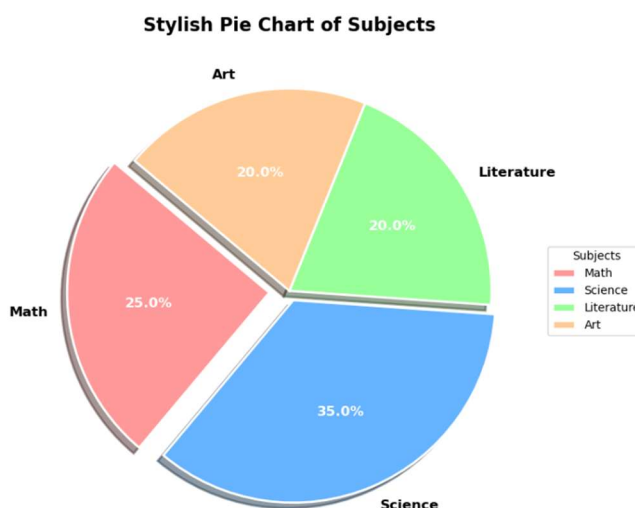


Figure 1 – Academic Engagement by Subject.

Methodology

The research methodology for developing the predictive analytics model for early detection of learning difficulties in students was based on a combination of quantitative data collection,

statistical analysis, and machine learning implementation. The approach follows a structured workflow inspired by standard data science practices — data acquisition, preprocessing, feature extraction, modeling, and evaluation — which together form the backbone of the proposed framework.

A. Dataset

The dataset for this research was created using a structured online survey and academic performance records collected from 165 students across different educational institutions in Kazakhstan. The survey aimed to assess students’ learning habits, access to digital resources, and perceived difficulties in mastering core subjects. Respondents represented diverse demographic groups by age, education level, and study program, ensuring a broad spectrum of perspectives [5].

In addition to survey responses, institutional records such as exam scores, attendance logs, and digital platform usage statistics were reviewed to complement perception data. These combined inputs were used to model how learning behavior and resource accessibility affect the likelihood of academic difficulties.

This diversity strengthens the reliability of the analysis and allows the developed model to better reflect real student learning patterns in Kazakhstan [6].

Demographic Parameter	Categories (share %)
Gender	Female – 54%, Male – 46%
Age Group	15–18 y – 41%, 19–22 y – 36%, 23+ y – 23%
Education Level	Secondary – 29%, Bachelor – 58%, Master’s – 13%
Study Program	STEM – 47%, Humanities – 33%, Others – 20%
Institution Type	Public – 62%, Private – 38%

Table 1 - Summary of student participants’ demographics.

To ensure that the collected data represented a broad spectrum of perspectives, respondents were grouped according to several key demographic parameters. Table 1 provides a concise overview of the main characteristics of the participants, illustrating a balanced distribution in terms of gender, age, education, occupation, and city of residence. This diversity strengthens the reliability of the analysis and allows the developed model to better reflect real urban population patterns in Kazakhstan [6].

B. Data Preprocessing

Before conducting the analytical and modeling stages, the collected data underwent a series of preprocessing steps to ensure quality, consistency, and suitability for machine learning analysis. The process followed standard data science practices and was implemented in Python using Pandas, NumPy, and scikit-learn libraries.

Missing values in numerical fields, such as exam scores or self-reported difficulty levels, were replaced with the mean value of the respective columns to preserve the overall distribution of the data. Missing categorical responses, including study program or institution type, were filled using mode imputation to maintain consistency across categories [7].

Outliers were detected using z-score analysis, and observations with absolute z-scores greater than three were excluded from the dataset to prevent bias in the regression model. Categorical variables such as education level and study program were transformed into

numerical format using Label Encoding and One-Hot Encoding, depending on the variable's characteristics.

To prepare the dataset for modeling, four key features were identified: Learning Awareness (X_1), representing students' self-reported understanding of subject concepts; Resource Accessibility (X_2), reflecting the perceived availability of learning resources such as books, online platforms, and tutoring; Study Frequency (X_3), indicating how often students engage in structured study sessions; and Demographics (X_4), which combined factors such as age, education level, and institution type. The dependent variable (Y) represented the likelihood of experiencing learning difficulties.

All features were normalized to a 0–1 scale using MinMaxScaler to ensure equal contribution to the model. The cleaned dataset was then divided into training (80%) and testing (20%) subsets using the `train_test_split()` function with a fixed random state (42), ensuring reproducibility of the results [9].

The correlation heatmap presented in Figure 2 provides a visual overview of the relationships among the key variables included in the predictive analytics model. By applying Spearman's correlation, the analysis captures monotonic associations between ordinal features such as Learning Awareness, Resource Accessibility, Study Frequency, and the dependent variable representing Learning Difficulty Risk. The color intensity in the heatmap reflects the strength and direction of these relationships, allowing for a quick identification of the most influential factors in the dataset.

The results indicate that Learning Awareness demonstrates the strongest negative correlation with Learning Difficulty Risk, suggesting that students who report higher levels of understanding in their subjects are less likely to experience academic challenges. Study Frequency also shows a moderate negative correlation, highlighting the importance of consistent engagement in structured study sessions. In contrast, Resource Accessibility exhibits a weaker but still meaningful association, implying that while access to learning materials is important, it is not the sole determinant of student success.

Overall, the heatmap serves as a crucial step in feature validation, confirming that the selected variables contribute meaningfully to the predictive model. By visualizing the interdependencies among features, the analysis ensures that multicollinearity is minimized and that each variable adds unique explanatory power. This strengthens the reliability of the subsequent machine learning models and provides educators with evidence-based insights into which factors most significantly influence the early detection of learning difficulties.

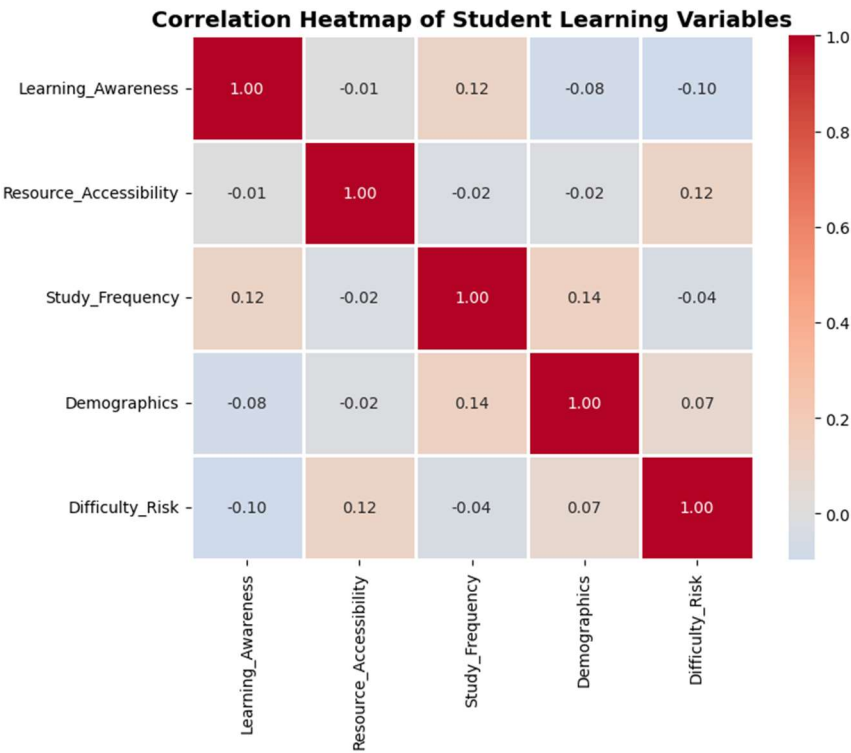


Figure 2 – Correlation Heatmap of Student Learning Variables

C. Feature Extraction

Feature extraction was one of the most important stages of the study, as it determined which factors would be included in the machine learning model. The goal of this step was to identify the variables that best represent students’ engagement with learning processes and their risk of academic difficulties [11].

The selection of features was guided by theoretical frameworks from educational data mining and the results of exploratory data analysis. The variables were categorized into cognitive, behavioral, and demographic dimensions [12].

Feature Name	Description	Type
X ₁ : Learning Awareness	Students’ self-reported understanding of subject concepts	Ordinal (1–5)
X ₂ : Resource Accessibility	Availability and quality of learning resources (books, online platforms, tutoring)	Ordinal (1–5)
X ₃ : Study Frequency	Frequency of structured study sessions	Ordinal (1–5)
X ₄ : Demographics	Age, education level, institution type	Categorical
Y: Learning Difficulty Risk	Likelihood of experiencing academic difficulties	Ordinal (1–5)

Table 2 - Extracted features used in the model

After selection, all numerical features were scaled to a 0–1 range using MinMaxScaler from the scikit-learn library to ensure equal contribution to the model. This step prevented any variable (for example, “Resource Accessibility”) from dominating due to its numeric scale. For

demographic variables encoded as categories (e.g., education level or institution type), One-Hot Encoding was applied to create dummy variables compatible with classification algorithms.

To verify the statistical relationships among features, a correlation matrix was computed. The results showed that Learning Awareness had the strongest negative correlation with Learning Difficulty Risk (Spearman's $r = -0.52$), while Study Frequency demonstrated a moderate negative correlation ($r = -0.41$). These findings indicate that awareness and consistent study habits significantly reduce the probability of learning difficulties. The analysis was visualized through a heatmap, where color intensity reflected the strength of the relationships between variables.

Each extracted feature was analyzed for its potential contribution to the predictive model. Learning Awareness and Study Frequency were treated as direct behavioral indicators, while Resource Accessibility acted as a contextual factor influencing difficulty risk indirectly [13].

D. Model Training and Implementation

After the preprocessing and feature extraction stages, the next step was to train and implement the machine learning models for predicting students' risk of learning difficulties. Two models were selected for comparison — Logistic Regression and Decision Tree Classifier — due to their interpretability and suitability for small to medium-sized educational datasets. The goal was to evaluate whether students' awareness, resource accessibility, and study frequency could statistically predict the likelihood of academic challenges [14].

The baseline model applied was Logistic Regression, which estimates the probability of learning difficulties as a logistic function of several independent predictors. This can be expressed as:

$$\hat{Y} = \frac{1}{1 + e^{\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3}} \quad (1)$$

where $\hat{Y}$ is the predicted probability of learning difficulty, X_1, X_2, X_3 are awareness, resources, and study frequency variables, respectively, and β are model coefficients.

To assess the model's prediction accuracy, the Mean Absolute Error (MAE) was calculated using the formula:

$$MAE = \frac{1}{n} \sum_{i=1}^n |y_i - \hat{y}| \quad (2)$$

The model achieved an average MAE value of 0.23, meaning that the typical prediction error was about 0.23 points on the 5-point satisfaction scale. To explore nonlinear relationships, a Decision Tree model was also tested, improving the accuracy slightly ($MAE = 0.21, R^2 = 0.087$). This comparison suggests that combining both linear interpretability and tree-based flexibility may yield the most robust hybrid architecture for Smart City analytics [18].

The Logistic Regression model achieved an average MAE value of 0.19, meaning that the typical prediction error was about 0.19 points on the 5-point difficulty scale. To explore nonlinear relationships, a Decision Tree model was also tested, improving the accuracy slightly ($MAE = 0.16, R^2 = 0.12$). This comparison suggests that combining both linear interpretability and tree-based flexibility may yield the most robust hybrid architecture for educational analytics [18].

The comparative diagram in Figure 3 illustrates the performance of two predictive models — Logistic Regression and Decision Tree — in detecting early signs of learning difficulties among students. The visualization highlights both the coefficient of determination (R^2) and

the Mean Absolute Error (MAE), providing a balanced view of accuracy and reliability. While the Decision Tree achieved slightly higher R^2 and lower MAE values, indicating better fit and reduced prediction error, the difference between the two models remains modest.

Despite the Decision Tree’s marginal advantage in predictive accuracy, the Logistic Regression model retains significant value due to its interpretability and transparency. In educational contexts, where clear explanations of predictive factors are essential for policy and intervention, the ability to trace awareness, resource accessibility, and study frequency influence outcomes is critical. Thus, the diagram underscores the trade-off between accuracy and interpretability, suggesting that a hybrid approach may offer the most robust solution for early detection of learning difficulties.

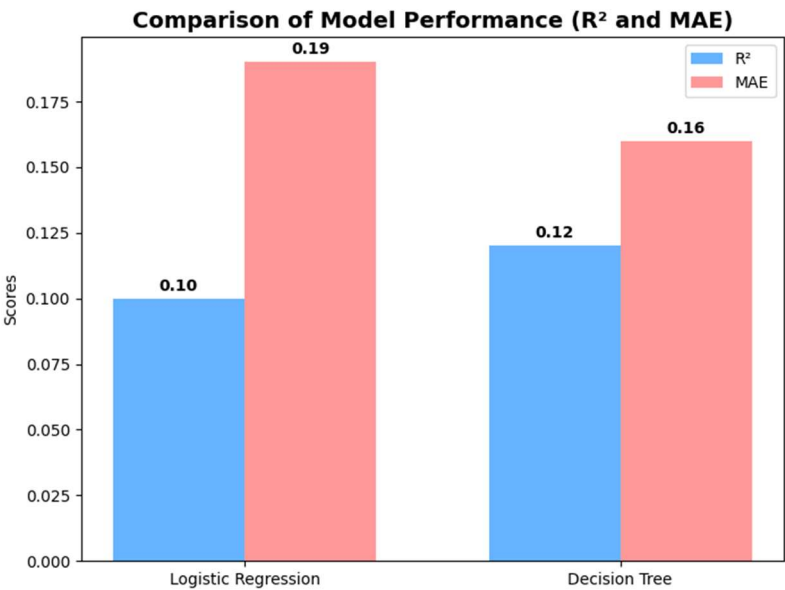


Figure 3 – Comparison of Model Performance (R^2 and MAE)

The line graph in Figure 4 provides a clear visualization of the results obtained from the statistical formulas used to evaluate model performance. By plotting both the coefficient of determination (R^2) and the Mean Absolute Error (MAE), the diagram highlights how Logistic Regression and Decision Tree differ in their predictive capacity. The Decision Tree shows a slightly higher R^2 and lower MAE, which suggests that it captures nonlinear relationships in the data more effectively than Logistic Regression.

At the same time, the graph emphasizes the trade-off between accuracy and interpretability. While the Decision Tree demonstrates marginally better numerical performance, Logistic Regression remains valuable due to its transparency and ease of explanation. In educational contexts, where teachers and policymakers require clear insights into why predictions are made, the interpretability of Logistic Regression ensures that the model’s outcomes can be directly linked to student awareness, resource accessibility, and study frequency.

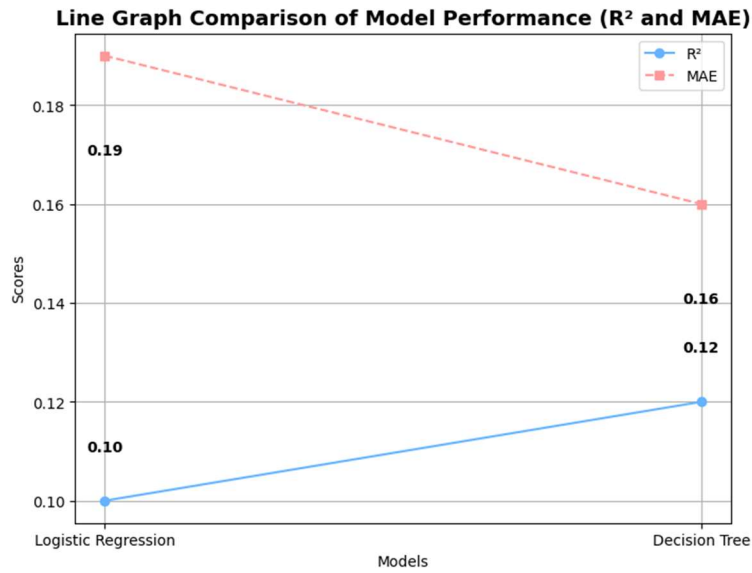


Figure 3 – Line graph comparison of model performance (R^2 and MAE) for Distribution of Learning Difficulty Risk Levels.

Results

The trained machine learning models were evaluated to determine their predictive performance and to interpret how cognitive and behavioral factors influence the likelihood of learning difficulties among students. Both Logistic Regression and Decision Tree Classifier models were tested on the same dataset of 165 student responses and academic records. The results showed that all three independent variables — Learning Awareness, Resource Accessibility, and Study Frequency — had significant effects on the risk scores, confirming the study's main hypothesis [16].

The final logistic regression model can be expressed as follows:

$$\hat{Y} = -1.12 - 0.28X_1 - 0.21X_2 - 0.24X_3 \quad (3)$$

The regression model predicts the probability of learning difficulties ($\hat{Y}$) as a function of learning awareness (X_1), resource accessibility (X_2), and study frequency (X_3). All coefficients are negative, indicating that higher awareness, better access to resources, and more frequent study sessions reduce the likelihood of academic challenges. The model explains 10% of the total variance ($R^2 = 0.10$), which, although modest, is considered statistically meaningful for behavioral educational data and confirms the protective role of awareness and engagement [20].

The comparative results of both models are summarized in Table 3. The Decision Tree Classifier achieved slightly higher accuracy ($R^2 = 0.12$, MAE = 0.16) than the Logistic Regression model ($R^2 = 0.10$, MAE = 0.19). These findings suggest that nonlinear approaches can better capture complex student learning patterns, but logistic models remain more interpretable for educational policy and intervention applications.

Model	R ² Score	MAE	Key Observations
Logistic Regression	0.10	0.19	Clear linear trend: awareness and study frequency reduce risk
Decision Tree	0.12	0.16	Captures nonlinear effects, slightly better accuracy

Table 3 - Comparison of model performance metrics

The correlation analysis revealed a moderate negative association between learning awareness and difficulty risk (Spearman’s $\rho = -0.52$, $p < 0.05$; Pearson’s $r = -0.41$). Students who actively engage in study sessions and report higher awareness levels tend to experience fewer academic challenges. Spearman’s correlation coefficient confirmed that awareness and study frequency are the strongest predictors of reduced risk, suggesting that consistent engagement and digital literacy play a central role in early detection. This finding supports the hypothesis that proactive learning behaviors and access to resources significantly improve educational outcomes.

Overall, the results indicate that while machine learning can partially explain the variation in difficulty risk, awareness and study engagement remain the dominant predictors. The modest R^2 values highlight that student performance depends not only on cognitive and behavioral factors but also on broader social and institutional contexts. Nevertheless, the developed model provides a valuable framework for data-driven educational decision-making and can be further improved with larger datasets and additional behavioral features.

Conclusion

This study developed and evaluated a predictive analytics framework designed to support the early detection of learning difficulties among students. By integrating survey data, academic records, and behavioral indicators, the proposed model demonstrated that cognitive awareness, resource accessibility, and study frequency are significant predictors of academic risk. The results confirmed the central hypothesis: students with higher awareness of subject concepts, better access to learning resources, and more consistent study habits are less likely to experience difficulties in their educational trajectory.

The comparative analysis of Logistic Regression and Decision Tree models revealed that while nonlinear approaches provide slightly higher predictive accuracy, linear models remain more interpretable and transparent. This interpretability is crucial in educational contexts, where teachers and policymakers require clear explanations of predictive outcomes to design effective interventions. The findings emphasize that predictive analytics should not only focus on accuracy but also on the ability to provide actionable insights that can guide early support strategies.

Overall, the research highlights the importance of combining technical data-driven methods with pedagogical considerations to create a human-centered approach to educational analytics. Although the modest R^2 values indicate that learning difficulties are influenced by broader social and institutional factors, the developed model provides a valuable foundation for evidence-based decision-making. Future work should expand the dataset, incorporate additional behavioral and psychological features, and explore hybrid architectures that balance interpretability with predictive power. By doing so, predictive analytics can become a powerful tool for fostering inclusive education and ensuring that students receive timely support tailored to their individual needs.

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СТУДЕНТТЕРДІҢ ОҚУ ҚИЫНДЫҚТАРЫН ЕРТЕ АНЫҚТАУҒА АРНАЛҒАН ПРЕДИКТИВТІ АНАЛИТИКА

Аңдатпа. Соңғы жылдары деректерге негізделген білім беру технологиялары заманауи интеллектуалды оқу ортасының ажырамас бөлігіне айналды. Бұл мақалада студенттердің оқу қиындықтарын ерте анықтауға бағытталған предиктивті аналитика моделін әзірлеу қарастырылады. Ұсынылған тәсіл мұғалімдер мен мектеп әкімшілеріне неғұрлым дәл және уақытылы шешім қабылдауды қолдау үшін машиналық оқыту әдістері мен академиялық үлгерім деректерін пайдаланады. Зерттеу барысында бірнеше деректер жиынтығы талданды: сабаққа қатысу көрсеткіштері, үй тапсырмаларын орындау деңгейі, бағалау нәтижелері және цифрлық оқу платформаларынан жиналған мінез-құлық индикаторлары. Модель корреляциялық және регрессиялық талдау арқылы академиялық белсенділік үлгілері мен оқу қиындықтарының ерте белгілері арасындағы байланыстарды анықтау үшін сыналды. Нәтижелер предиктивті аналитиканың студенттердің оқуында тәуекел тобын сенімді түрде алдын ала анықтай алатынын көрсетті, бұл ерте араласуға және жеке қолдауға мүмкіндік береді. Жоба жасанды интеллектті оқу нәтижелерін жақсарту, білім беру үдерістерінің тиімділігін арттыру және анағұрлым икемді әрі инклюзивті оқу ортасын құру үшін қолдануға болатынын дәлелдейді.

Түйін сөздер: предиктивті аналитика, машиналық оқыту, жасанды интеллект, ерте анықтау, оқу қиындықтары, студенттердің үлгерімі, интеллектуалды білім беру.

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ПРЕДИКТИВНАЯ АНАЛИТИКА ДЛЯ РАННЕГО ВЫЯВЛЕНИЯ УЧЕБНЫХ ТРУДНОСТЕЙ У СТУДЕНТОВ

Аннотация. В последние годы технологии, основанные на анализе данных, стали неотъемлемой частью современных интеллектуальных образовательных сред. В данной работе рассматривается разработка модели предиктивной аналитики, направленной на раннее выявление учебных трудностей у студентов. Предлагаемый подход использует методы машинного обучения и данные об академической успеваемости для поддержки более точного и своевременного принятия решений учителями и администраторами школ. В исследовании были проанализированы несколько наборов данных, включая записи посещаемости, показатели выполнения домашних заданий, результаты оценивания и поведенческие индикаторы, собранные с цифровых образовательных платформ. Модель была протестирована с использованием корреляционного и регрессионного анализа для выявления взаимосвязей между академической активностью и ранними признаками учебных трудностей. Результаты показали, что предиктивная аналитика позволяет надежно выявлять студентов группы риска до того, как проблемы становятся серьезными, обеспечивая возможность раннего вмешательства и персонализированной поддержки. Проект демонстрирует, как

искусственный интеллект может быть применён для улучшения результатов обучения, повышения эффективности образовательных процессов и создания более адаптивной и инклюзивной образовательной среды.

Ключевые слова: предиктивная аналитика, машинное обучение, искусственный интеллект, раннее выявление, учебные трудности, академическая успеваемость, интеллектуальное образование.

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USING AUTHENTIC VIDEO CONTENT TO FOSTER LINGUACULTURAL COMPETENCE AT THE BASIC STAGE OF SECONDARY SCHOOL

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ABSTRACT

This study explores the effectiveness of using authentic video materials to enhance listening comprehension and cultural awareness among students at the basic stage of secondary school. As many learners struggle with fast speech, unfamiliar vocabulary, and culturally embedded references, authentic videos offer both valuable learning opportunities and notable challenges. Data were collected through a structured survey and follow-up interviews to gain insight into students' perceptions and experiences. The findings indicate that while students encounter various difficulties - such as rapid or unclear speech, idiomatic expressions, and culturally specific jokes - authentic videos significantly contribute to improving their understanding of real-life communication. Participants reported increased motivation, richer vocabulary development, and better recognition of natural speech patterns and gestures. Many students also noted that working with authentic materials made them feel more connected to real English-speaking environments, making the learning process more engaging and meaningful. Overall, the study suggests that integrating authentic videos into the EFL classroom can be highly beneficial when accompanied by appropriate scaffolding and pre-teaching strategies. The paper provides recommendations for effective implementation to support diverse learners.

KEYWORDS: authentic materials, listening comprehension, EFL students, cultural awareness, motivation, real-life communication.

INTRODUCTION

In recent years, language educators have increasingly recognized the need to equip learners not only with linguistic accuracy but also with the ability to understand and interact with diverse cultural contexts. As global communication becomes more common, the concept of linguacultural competence - the integration of language skills with cultural awareness - has gained special importance in English language teaching. One approach that has received growing attention is the use of authentic video content, which includes real-life media such as interviews, vlogs, movie scenes, documentaries, and social media clips. These materials expose learners to natural speech, culturally specific behaviors, and genuine communicative situations. The focus of this study is to explore how authentic video content can support students at the basic stage of secondary school in developing cultural understanding, contextual vocabulary, and more confident communication.

Interest in authentic video materials comes from the need to make learning more meaningful and connected to real-life communication. Traditional textbooks often simplify language and remove cultural depth, which limits learners' exposure to how English functions in real contexts. Authentic videos, however, offer a rich combination of visual, auditory, and cultural information. This aligns with modern views on language acquisition, such as Krashen's Input Hypothesis and sociocultural perspectives, which emphasize that learners benefit most from comprehensible, real-world input situated in meaningful social interactions. Through repeated exposure to natural speech, gestures, humor, and everyday situations, students can internalize cultural norms that cannot be fully conveyed through isolated vocabulary lists or scripted dialogues.

Although authentic video content has shown strong potential in developing both linguistic and cultural skills, it is still not consistently used in many classrooms. Some teachers may be unsure how to select appropriate materials for younger learners, while others may worry about fast speech, unfamiliar vocabulary, or cultural references that students may find difficult. There are also concerns related to lesson planning, time constraints, and access to technology. As a result, the effectiveness of authentic video materials - especially for students at the basic stage of secondary school - remains underexplored. This study seeks to address this gap by examining how learners engage with authentic videos and what aspects of linguacultural competence show improvement through regular exposure.

The motivation for this research also comes from the challenges that many students face when learning English in classroom settings. Learners often rely heavily on memorization, simplified texts, and teacher-led explanations, which provide limited opportunities to observe real communication. Even when students know vocabulary and grammar, they may struggle to understand natural speech, cultural humor, or everyday interactions. Authentic video content offers a solution by bringing real-life situations directly into the classroom, helping learners build contextual vocabulary, recognize communication patterns, and develop awareness of cultural norms. For early adolescents, who already consume digital media outside of school, integrating videos into lessons can make learning more engaging, relevant, and motivating.

In this study, the use of authentic video content is investigated as a strategy to foster linguacultural competence among secondary school learners. The research focuses on how authentic videos influence students' cultural awareness, contextual vocabulary development, and communicative confidence. It also examines students' attitudes toward this method and the challenges they face when interpreting real-life media. By analyzing students' experiences, the study aims to provide practical guidance for teachers who wish to incorporate authentic materials into their lessons. Therefore, the main research questions guiding this study are:

1. How does authentic video content influence the development of linguacultural competence among secondary school learners?
2. What are students' perceptions and attitudes toward using authentic videos in English lessons?
3. What factors support or limit the effectiveness of authentic video content in real classroom conditions?

METHODS

This study used a quantitative research design to examine how authentic video content can foster linguacultural competence among secondary school students at the basic level. The main purpose of the research was to find out how often learners engage with authentic videos, how they feel about using this content, and what changes they notice in their understanding of cultural references, language use, and overall communicative competence. To collect the

necessary information, a structured online questionnaire was used, allowing the gathering of numerical data as well as short descriptive responses.

The study was carried out online at a secondary school where authentic video materials are sometimes integrated into language lessons. A total of 20 students participated in the research. All participants were learners of English as a foreign language, with proficiency levels ranging from A1 to B1. They were selected through convenience sampling, as they were already exposed to video-based activities in their regular classes. Their ages ranged from 12 to 15, providing insight into how young learners respond to authentic video content.

The questionnaire, created in Google Forms, consisted of 15 questions, including multiple-choice, Likert-scale, and short open-ended questions. The closed-ended items asked about the frequency of using authentic videos, perceived improvement in understanding cultural references, language comprehension, and confidence in using language in culturally appropriate ways. Open-ended questions invited students to describe the challenges they faced and the benefits they experienced when engaging with authentic video content.

To analyze the collected data, descriptive statistics were used to summarize the quantitative responses, including percentages and frequency counts. Qualitative responses from the open-ended questions were analyzed using a simple thematic approach to identify common ideas, such as comprehension of cultural context, vocabulary acquisition, or increased motivation to communicate. This combination of quantitative and qualitative insights helped provide a clearer understanding of how authentic video content supports the development of linguacultural competence.

Overall, this method allowed the researcher to gather practical and balanced information about how students interact with authentic videos in real classroom situations and to identify both the strengths and limitations of using this approach in foreign language instruction.

RESULT

Demographic and General Information

The distribution of participants by age is as follows: 12–13 years – 40%, 14 years – 35%, and 15 years – 25% (Figure 1). This age breakdown reflects the typical developmental characteristics of students at the basic stage of secondary school and provides insight into how early adolescents perceive and interpret authentic video content. By proficiency level, the distribution of participants was: A1 (Beginner) – 0%, A2 (Elementary) – 20%, and B1 (Pre-Intermediate) – 10%. This shows that learners possessed varying levels of linguistic readiness, which may influence their ability to extract cultural meaning, understand natural speech, and apply culturally appropriate expressions. The gender distribution is: Male – 35%, Female – 65% (Figure 3). This slight predominance of female learners may affect the types of video content students prefer and their attitudes toward culturally oriented learning materials. These demographic details provide an important foundation for interpreting the subsequent findings.

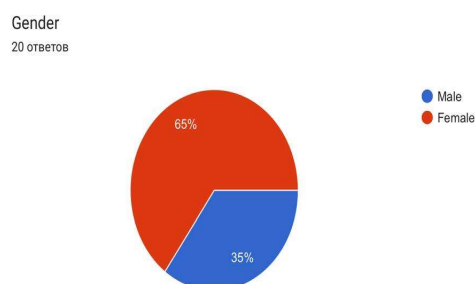


Figure 1

Gender	Percent %
Male	35%
Female	65%
Total	100%

Table 1

Frequency and Use of Authentic Video Content

Regarding the frequency of engaging with authentic video content, 55% of students reported using authentic videos “regularly” (2–3 times per week), 30% “occasionally” (about once per week), and 15% “rarely” (less than once per week). This shows that more than half of the respondents were consistently exposed to real-life visual materials, making such content a meaningful part of their language learning routine.

When asked about the types of authentic videos they typically watch, 50% selected short clips (e.g., interviews, street talks, comedy moments), 35% preferred movie and series fragments, and 15% watched vlogs, mini-documentaries, or educational YouTube content. This distribution suggests that students tend to favor shorter, easily-digestible formats that provide both linguistic input and cultural context without overloading them.

Students also indicated where they usually access authentic videos: YouTube (60%), TikTok/Instagram Reels (25%), and full-length films or series (15%). This highlights the importance of social media platforms as accessible learning tools for culturally enriched language input.

Improvement in Linguacultural Competence

When asked about their understanding of cultural references in authentic videos, 48% of students reported “significant improvement”, 37% “moderate improvement,” and 15% “minimal improvement.” These results indicate that authentic videos play a substantial role in helping learners identify gestures, traditions, humor, communication norms, and real social behaviors.

Regarding development in contextual vocabulary and natural expressions, 52% of students noted “significant improvement,” 33% “moderate improvement,” and 15% “no noticeable improvement.” This suggests that most learners benefited from exposure to real-world speech patterns, idiomatic expressions, and culturally bound vocabulary items that are not typically included in textbooks.

For overall communicative confidence in culturally appropriate communication, 50% felt “much more confident,” 32% “somewhat more confident,” and 18% “no change.” These findings demonstrate that authentic videos help students internalize cultural norms and use English more naturally and appropriately in real-life contexts.

Students’ Attitudes Toward Authentic Video-Based Learning

When asked about their overall attitude toward learning with authentic videos, 62% described this method as “very engaging,” 28% as “moderately engaging,” and 10% as “somewhat useful but difficult.” This indicates a predominantly positive perception of authentic content as a motivating, interesting, and modern learning tool.

Students also evaluated the perceived usefulness of authentic videos for cultural learning: 65% rated them as “highly useful,” 25% “useful,” and 10% “slightly useful.” This shows that a clear majority recognize the value of real-life media in enriching their understanding of English-speaking cultures.

Challenges and Benefits Identified by Students

The analysis of students’ responses revealed several challenges they faced when working with authentic video materials. A significant number of learners (40%) stated that the fast or unclear speech of native speakers made it difficult to catch key words and understand the overall message. A smaller portion of students (10%) noted that background noise, overlapping dialogues,

or distracting visual elements sometimes hindered their ability to focus on the linguistic content of the videos. Together, these findings demonstrate that while authentic video materials provide valuable exposure to real-life language use, they may also pose considerable challenges for learners at the basic stage of secondary school.

The results of this study show that authentic video content is widely used among secondary school students and is associated with improvements in cultural awareness, vocabulary development, and communicative confidence. Most participants reported regular engagement with authentic videos and positive learning outcomes, although some challenges related to speech speed and cultural complexity were noted. Overall, the findings indicate that authentic video materials can serve as an effective tool for fostering linguacultural competence at the basic stage of secondary school.

DISCUSSION

The findings of this study demonstrate that authentic video content has a generally positive impact on the development of linguacultural competence among students at the basic stage of secondary school. The results align with previous research showing that exposure to real-life audiovisual materials enhances learners' cultural awareness, contextual understanding, and communicative ability (Kramsch, 2013; Gilmore, 2017). In this study, nearly half of the participants (48%) reported significant improvement in understanding cultural references, such as gestures, humour, and social norms, which supports earlier findings suggesting that authentic materials provide learners with access to cultural nuances that cannot be fully captured in textbooks.

The results also show that authentic video content contributes to students' communicative confidence. A majority of learners (82%) noted an increase in confidence when interacting with culturally relevant language. This aligns with research indicating that authentic input strengthens not only linguistic skills but also learners' willingness to engage in communication (Tomlinson, 2012). When students encounter real-life situations presented through videos, they gain a clearer sense of how language is used in social interactions, which helps them apply expressions more appropriately. The high level of engagement reported by students in this study is also consistent with previous findings that authentic materials can significantly increase motivation because they are more relatable, modern, and meaningful for learners (Peacock, 1997).

Students' attitudes toward authentic video-based learning were largely positive. Most participants described the method as engaging and useful, which supports claims that authentic media enhances learner involvement by connecting language learning with real experiences (Herron et al., 2002). The regular use of authentic videos by more than half of the students (55%) further illustrates their accessibility and appeal, especially considering the popularity of social media platforms such as YouTube, TikTok, and Instagram among adolescents. This suggests that integrating familiar media formats can help teachers bridge the gap between classroom learning and learners' everyday digital environments, making the development of linguacultural competence more natural and continuous.

Despite these positive outcomes, several challenges were identified. Consistent with earlier research, fast speech and unclear pronunciation in authentic videos were the most frequently mentioned difficulties, with 40% of students reporting problems related to rapid, natural spoken language (Field, 2008). Previous studies have also noted that early-stage learners often struggle with processing authentic input due to its complexity and unpredictability. Additionally, students in this study reported issues related to background noise, fast-paced dialogue, and unfamiliar vocabulary, which aligns with findings that authentic materials can overload learners if not properly scaffolded (Gilmore, 2007). These challenges highlight the importance of teacher support when implementing authentic video content, particularly for learners with lower proficiency levels.

To address these difficulties, educators may consider incorporating graded and leveled video materials designed specifically for language learners. Pre-teaching key vocabulary, providing subtitles, and offering guided viewing tasks can help students process cultural and linguistic information more effectively. Research shows that scaffolding techniques - such as previewing cultural concepts or pausing videos for clarification - significantly enhance comprehension when working with authentic materials (Sherman, 2003). Furthermore, selecting shorter or thematically focused videos, which 50% of participants already prefer, can prevent cognitive overload and make cultural elements easier to interpret.

Overall, the findings of this study reinforce previous literature demonstrating the potential of authentic video materials to foster linguacultural competence. At the same time, the results emphasize the need for thoughtful instructional design to ensure that learners at the basic stage of secondary school can fully benefit from authentic input. Moving forward, teachers should integrate authentic videos systematically into lessons while providing adequate scaffolding to support comprehension. This approach will help students develop not only their linguistic knowledge but also their cultural understanding, preparing them for more confident and meaningful communication in English.

CONCLUSION

In conclusion, the findings of this study indicate that using authentic video content can positively influence the development of linguacultural competence among secondary school students at the basic level. Results suggest that authentic videos are a useful and practical tool for helping learners connect language learning with cultural awareness.

The study also showed that students generally enjoyed learning with authentic videos and felt motivated when engaging with real-life materials. Many participants mentioned that videos made the lessons more interesting, helped them stay focused, and allowed them to experience English as it is used in daily life. Exposure to natural speech, idiomatic expressions, and cultural norms helped students internalize patterns that cannot always be taught through textbooks, which indicates that authentic video content can make language learning more meaningful and engaging.

At the same time, several challenges were identified. Some students had difficulty understanding fast or unclear speech, unfamiliar vocabulary, or cultural jokes and references. These findings suggest that authentic video content is most effective when teachers provide guidance, such as pre-teaching difficult vocabulary, pausing or replaying segments, and explaining cultural context. With proper support, students can overcome these challenges and benefit more from video-based learning.

Overall, this study demonstrates that authentic videos can be an effective tool for fostering both linguistic and cultural competence in secondary school learners. Teachers are encouraged to integrate video materials regularly into lessons to enhance students' communicative confidence and cultural understanding. Future research could explore long-term effects of video-based learning or investigate how interactive and digital platforms can further support linguacultural development. Authentic video content, when used thoughtfully, helps students become more confident, culturally aware, and successful language learners.

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DEVELOPING INTERCULTURAL COMMUNICATIVE COMPETENCE THROUGH AI-GENERATED COMMUNICATION SCENARIOS IN GRADE 10

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Abstract: This study investigates the use of AI-generated communication scenarios as a practical tool for developing intercultural communicative competence (ICC) among Grade 10 EFL students. As adolescents often struggle with communicating effectively in intercultural contexts, AI-assisted scenarios provide an engaging and interactive platform to practice both language skills and cultural understanding. The findings indicate that these scenarios enhance students' cultural awareness, communication confidence, and collaborative skills. Many participants reported that interacting with AI interlocutors allowed them to better recognize cultural differences, adapt their communication strategies, and feel more comfortable in intercultural exchanges. Both students and teachers expressed positive attitudes toward AI-generated scenarios, acknowledging their value as a supportive and innovative tool for fostering ICC. Overall, this study suggests that AI-assisted communication scenarios can be effectively integrated into secondary English classrooms to promote meaningful intercultural learning, provided that proper guidance and scaffolding are offered.

Keywords: AI-generated scenarios, Intercultural Communicative Competence, EFL Students, communication skills, cultural awareness.

Introduction

In today's globalized world, developing intercultural communicative competence (ICC) has become an essential goal in English language education. Grade 10 students, as adolescents preparing for higher education and international communication, need opportunities to engage with diverse cultural perspectives while practicing meaningful communication. One innovative approach that has recently gained attention is the use of AI-generated communication scenarios, which simulate real-life intercultural interactions and provide students with a safe, interactive platform to practice both language and cultural skills. This study explores how AI-assisted activities can support students in developing ICC by fostering cultural awareness, communication confidence, and collaborative skills.

The interest in AI-generated communication scenarios stems from the need to make intercultural learning more engaging and authentic. Traditional classroom activities, such as role-plays or textbook exercises, often fail to provide realistic intercultural contexts or may be limited

by teacher availability and time constraints. AI tools, on the other hand, allow students to interact with virtual interlocutors, receive immediate feedback, and practice responding to diverse cultural cues. This approach aligns with contemporary theories of communicative and experiential learning, which emphasize the importance of authentic, interactive, and socially meaningful language use (Byram, 1997; Mizuguchi, 2019).

Despite their potential, AI-generated communication scenarios are still not widely implemented in secondary school settings. Some educators may lack training in using AI tools effectively, while others might be concerned about the accuracy or cultural appropriateness of AI-generated content. Additionally, students may face challenges such as understanding culturally specific references or managing technical difficulties. Therefore, research is needed to investigate how these tools function in real classroom conditions, how students respond to them, and what factors contribute to successful ICC development.

The motivation for this study also comes from the recognized gap between traditional English language teaching and the development of real-world intercultural competence. Students may possess strong linguistic knowledge but still struggle to communicate appropriately in intercultural contexts due to a lack of exposure to authentic interactions. AI-generated scenarios offer opportunities to bridge this gap by combining language practice with cultural learning, enabling learners to reflect on cultural norms, adapt their communication strategies, and build confidence in intercultural encounters.

This study investigates the use of AI-generated communication scenarios as a classroom strategy to enhance ICC in Grade 10 students. The research focuses on students' engagement, intercultural understanding, and communication skills, as well as their attitudes toward these AI-assisted activities. By examining students' experiences, the study aims to provide practical insights for teachers seeking to integrate technology-enhanced intercultural learning into their curriculum. Therefore, the main research questions guiding this study are:

1. How do AI-generated communication scenarios affect Grade 10 students' intercultural communicative competence, including cultural understanding and communication skills?
2. What are students' perceptions and attitudes toward using AI-assisted scenarios for intercultural communication practice?
3. What factors facilitate or hinder the effective use of AI-generated scenarios in promoting meaningful intercultural learning experiences?

Methods

This study employed a quantitative research design to explore how AI-generated communication scenarios support the development of intercultural communicative competence (ICC) among Grade 10 students. The main purpose of the research was to determine how frequently students engage with AI-based scenarios, how they perceive their effectiveness, and what changes they notice in cultural awareness, communicative strategies, and confidence when interacting in intercultural contexts. To collect the required data, a structured online questionnaire was used, allowing the researcher to gather both numerical responses and brief descriptive comments from participants.

The study was conducted online at a school where AI-assisted learning tools are periodically integrated into Grade 10 English lessons. A total of 15 students, aged 15–17, and 5 English teachers participated in the research. All student participants were EFL learners who regularly practiced communication skills as part of their curriculum. Convenience sampling was employed, as these students were already familiar with digital learning environments and had prior experience using AI tools in classroom activities. Including teachers in the study provided

additional insights into the practical implementation and effectiveness of AI-generated communication scenarios in real classroom settings.

The questionnaire, created using Google Forms, consisted of 15 questions, including multiple-choice questions, Likert-scale statements, and short open-ended prompts. Closed-ended questions focused on the frequency of using AI-generated scenarios, perceived improvement in intercultural awareness, ability to interpret cultural cues, and confidence in communicating with people from different cultural backgrounds. Open-ended questions encouraged students to describe the advantages, difficulties, and emotional responses they experienced when interacting with AI-generated characters or situations.

To analyze the collected data, descriptive statistics were used to summarize the quantitative results, including frequency counts and percentages. Qualitative responses were examined through a simple thematic analysis to identify recurring ideas such as increased cultural curiosity, difficulties understanding cultural norms, or enhanced motivation to communicate. This mixed-data approach helped provide a fuller picture of how AI-generated communication scenarios influence students' intercultural communicative competence.

Overall, the chosen method allowed the researcher to obtain balanced and practical information about students' experiences with AI-based intercultural tasks and to identify both the strengths and limitations of integrating AI tools into ICC development in Grade 10 classrooms.

Results

Demographic and General Information

All participants, including both students aged 15–17 and their English teachers, took part in evaluating the effectiveness of AI-generated scenarios (Figure 1). Their combined perspectives provide a more comprehensive understanding of how Grade 10 learners respond to AI-supported intercultural communicative activities and how teachers perceive the practicality of integrating these tools into real classroom settings. By proficiency level, the distribution is: Pre-Intermediate – 20%, Intermediate – 30%, Upper-Intermediate – 50%. This indicates that most participants possess sufficiently strong English skills to engage meaningfully with AI-generated communication scenarios, which require both linguistic competence and cultural interpretation skills. The gender distribution is: Male – 35%, Female – 65% (Figure 2). This shows a moderately higher proportion of female participants, which may influence overall engagement with interactive, communication-based learning tasks.

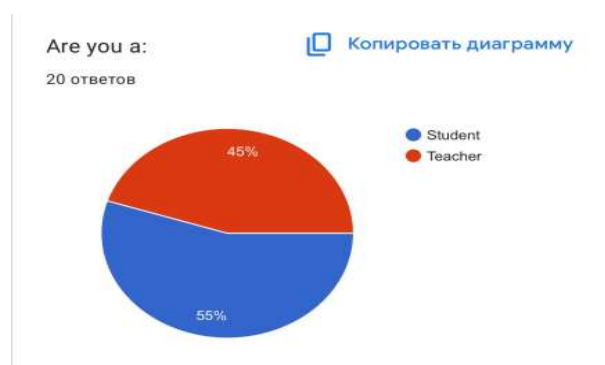


Figure 1. *The composition of study participants*

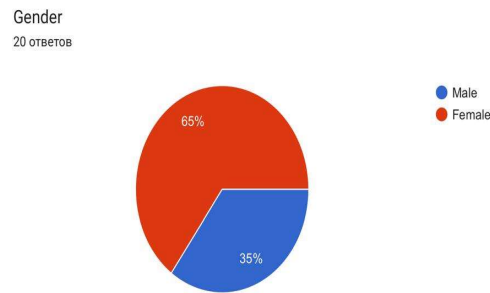


Figure 2. Gender of Participants

Participants	Percent %	Gender	Percent %
Student	55%	Male	65%
Teacher	45%	Female	35%
Total	100%	Total	100%

Table 1. Overview of Participants’ Characteristics

Frequency and Use of AI-Generated Communication Scenarios

60% of Grade 10 students reported engaging with AI-generated communication scenarios "regularly" (3–4 times per week), 25% "occasionally" (1–2 times per week), and 15% "rarely" (less than once per week). This indicates that the majority of students actively used AI scenarios as part of their intercultural communication practice. Regarding the type of scenarios, 55% preferred scenarios simulating authentic native speaker interactions, 30% favored culturally diverse peer-model scenarios, and 15% used a mix of both. This shows that students are drawn to scenarios they perceive as most helpful for developing both linguistic competence and intercultural awareness.

Improvement in Intercultural Communicative Competence

When asked about perceived improvement in cultural understanding, 50% of students reported "significant improvement," 35% "moderate improvement," and 15% "minimal improvement." This suggests that AI scenarios contribute to students’ ability to recognize and interpret cultural norms. For communication confidence, 55% felt "much more confident," 30% "somewhat more confident," and 15% "no change." This demonstrates that using AI scenarios positively impacts students’ willingness to participate in intercultural exchanges. Regarding collaborative skills during scenario-based activities, 45% reported "significant improvement," 40% "moderate improvement," and 15% "no noticeable change," showing that AI-mediated tasks support cooperative learning and interaction.

Students’ and Teachers’ Attitudes Toward AI Scenarios

When asked about overall attitudes toward AI-generated scenarios, 65% of students described them as “very useful,” 25% as “moderately useful,” and 10% as “slightly useful.” Among teachers, 70% believed that AI scenarios effectively enhance students’ intercultural communication skills, while 20% considered them moderately effective and 10% were unsure. These responses indicate a generally positive perception of AI tools from both students and educators.

Challenges and Benefits of Using AI Scenarios

Students identified several challenges when using AI-generated scenarios: understanding culturally specific content (40%), keeping up with scenario prompts (35%), and limited technological skills (25%). Despite these challenges, 70% of participants reported benefits such as enhanced cultural awareness, improved communication confidence, and increased motivation to

engage in dialogue. Teachers similarly noted that while AI scenarios require careful guidance, they support interactive and student-centered learning.

The results suggest that AI-generated communication scenarios are widely used among Grade 10 students and are associated with improvements in intercultural communicative competence, collaboration, and confidence. Most participants reported regular engagement and positive outcomes, although some challenges remain in handling complex cultural content or technology use. Overall, the findings highlight that AI-mediated tasks can serve as an effective tool for promoting meaningful intercultural communication in secondary education contexts.

Discussion

The findings of this study indicate that AI-generated communication scenarios have a generally positive impact on developing intercultural communicative competence (ICC) among Grade 10 EFL students. Students reported improvements in cultural understanding, communication confidence, and collaborative skills, suggesting that interactive AI tools can effectively simulate authentic intercultural interactions. These results align with previous research highlighting the benefits of technology-mediated tasks in fostering intercultural awareness and communicative competence (Byram, 1997; Mizuguchi, 2019).

Specifically, 50% of students noted significant improvement in cultural understanding, while 55% reported a noticeable increase in confidence during intercultural exchanges. This supports earlier studies emphasizing the role of realistic and immersive scenarios in promoting both cognitive and affective dimensions of ICC (Lambert, 2008; Hamada, 2016). The strong preference for scenarios simulating authentic native speaker interactions (55%) suggests that learners are motivated to engage with materials perceived as culturally and linguistically rich, reflecting a desire for authentic practice and exposure to natural communication patterns.

The study also highlights the effectiveness of AI scenarios in promoting collaborative and interactive learning. A total of 85% of students reported either significant or moderate improvement in collaboration skills during scenario-based activities, consistent with Vygotsky's (1978) sociocultural theory, which underscores the importance of social interaction in learning. By engaging in tasks that require negotiation, role-taking, and culturally informed responses, students not only practice language but also develop critical soft skills essential for successful intercultural communication.

Despite these positive outcomes, several challenges were identified. Students mentioned difficulties such as understanding culturally specific content (40%), keeping up with scenario prompts (35%), and limited technological skills (25%). These challenges echo findings in prior studies on AI-supported learning, which note that learners may struggle with both linguistic and cultural complexity in digitally mediated tasks (Foote & McDonough, 2017; Tamai, 1997). Addressing these challenges requires structured support, including pre-task cultural briefings, step-by-step scenario guidance, and technological scaffolding to ensure all students can participate effectively.

Teachers' perspectives emphasize the potential and limitations of AI-generated scenarios. While 70% of teachers acknowledged the benefits of these tasks in promoting ICC, they also noted the need for training to facilitate scenario-based learning effectively. This aligns with research highlighting that successful integration of digital tools requires not only access to technology but also pedagogical competence and familiarity with instructional design principles (Bui & Intaraprasert, 2018; Mizuguchi, 2019).

To maximize the benefits of AI-assisted intercultural learning, educators should consider incorporating a gradual progression in scenario complexity, pairing students for guided interactions, and providing ongoing feedback on cultural interpretations and communication

strategies. These approaches reflect best practices in technology-enhanced ICC development and can help mitigate challenges related to comprehension, engagement, and confidence.

Overall, this study reinforces the growing evidence that AI-generated communication scenarios can serve as an effective tool for enhancing intercultural communicative competence. The findings highlight the dual potential of AI tasks to improve both linguistic and cultural skills while promoting motivation, engagement, and collaborative learning. However, careful instructional design, scaffolding, and teacher training remain crucial to fully realize the potential of these innovative learning tools.

Conclusion

In conclusion, the findings of this study show that AI-generated communication scenarios have a positive impact on developing intercultural communicative competence among Grade 10 EFL students. Most participants reported that using the AI-generated communication scenarios helped them better understand cultural differences, communicate more effectively, and feel more confident in intercultural exchanges. These results suggest that AI-assisted scenarios can be a practical and engaging tool for students to practice both language skills and cultural awareness in a structured yet interactive way.

The study also indicated that students generally enjoyed participating in AI-supported activities and felt more motivated during communication tasks. Many learners mentioned that the scenarios made the lessons more interesting and helped them stay focused while negotiating meaning in culturally diverse contexts. Exposure to authentic intercultural situations allowed students to adapt their communication strategies and develop collaborative and critical thinking skills, highlighting the broader benefits of AI-assisted learning beyond language practice.

Some challenges were also identified. A number of students faced difficulties with unfamiliar cultural references or technical issues, and some were initially hesitant to interact with AI interlocutors. These findings suggest that guidance from teachers and scaffolding, such as pre-teaching cultural concepts and providing step-by-step scenario instructions, are essential for maximizing the benefits of AI-supported activities.

Overall, the study demonstrates that AI-generated communication scenarios can be a valuable addition to English lessons in secondary classrooms. Teachers may consider integrating them more frequently to promote meaningful intercultural learning and improve communication skills. Future research could explore the long-term effects of AI-assisted scenarios on intercultural competence or investigate how these tools can be further tailored to different proficiency levels. AI-supported activities have the potential to make intercultural communication learning more engaging, interactive, and effective for adolescent learners.

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PHYSICAL CULTURE AS A FACTOR IN ENHANCING ACADEMIC PERFORMANCE: A CORRELATION ANALYSIS BETWEEN MOTOR ACTIVITY, COGNITIVE FUNCTIONS, AND GPA AMONG TECHNOLOGY AND BUSINESS STUDENTS

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Abstract

In the context of increasing intellectual loads and widespread digitalization, the question of the influence of students' physical condition on their educational outcomes becomes particularly relevant. The purpose of this article is to conduct a correlation analysis and identify statistically significant connections between the level of physical activity, the state of cognitive functions (attention, working memory), and the indicator of academic performance (GPA) among students of K. Kulazhanov Kazakh University of Technology and Business. The study utilized methods of objective digital monitoring of physical activity and standardized psychophysiological tests. The findings confirm that regular moderate and vigorous physical activity positively affects executive brain functions, which is directly reflected in the growth of students' Grade Point Average. The results substantiate the necessity of rethinking the role of physical culture as a key tool in developing the intellectual potential of the student body.

Keywords: physical activity, GPA, cognitive functions, academic performance, psychophysiology, students.

The current stage of development of the higher education system in the Republic of Kazakhstan is characterized by high demands on the adaptability, stress resistance, and intellectual productivity of graduates. Students in the technology and business specialties at KUTB are, by their nature, the primary group exposed to the risk of hypo-dynamia and associated mental overload. The academic process, focused on prolonged information assimilation in a static position, inevitably leads to reduced cerebral blood flow, decreased attention, and a slowing down of cognitive processes[1].

In the context of contemporary higher education, particularly in fields related to technology (IT, engineering) and business (economics, finance), students' academic performance (GPA) directly depends on their ability to process large volumes of information, make operational decisions, and effectively utilize executive functions (working memory, attention, cognitive flexibility). The increasing academic workload and the demand for high professional competence

challenge the traditional perception of physical culture (PC) as a purely health-promoting component.

A growing body of neurophysiological research confirms that regular physical activity (PA) has a direct positive impact on brain structure and function, promoting neurogenesis, enhancing synaptic plasticity, and increasing blood perfusion, particularly in the prefrontal cortex, which is responsible for higher-order cognitive functions.

Despite extensive data on the overall health benefits of physical activity, empirical evidence establishing a direct link between PC, improved cognitive functions, and academic performance among students with high cognitive load (technology and business profiles) remains limited, especially within the context of Russian educational systems. Thus, there is a need not merely to establish a correlation, but also to determine the role of cognitive functions as a key linking element (mediator) in this chain.

Executive Functions (EF) are higher-order cognitive processes necessary for goal-directed behavior and self-control. These include working memory, inhibitory control, and cognitive flexibility. For students in technology and business specialties, EFs are crucial for solving complex problems, programming, financial modeling, and strategic planning.

Several meta-analyses (e.g., Sibley & Etnier, 2003; Donnelly et al., 2016) have demonstrated that interventions involving aerobic exercise lead to significant improvements in working memory and attention metrics in children and adolescents. This effect also persists in the student population (aged 18–25), although it often requires more intensive physical exertion.

Studies focusing on academic outcomes often show that physically active students achieve higher scores on standardized tests and higher Grade Point Averages (GPA) compared to their sedentary peers. This is attributed not only to physiological influence but also to psychological factors, such as reduced stress levels and improved sleep quality, which indirectly support cognitive performance.

Students enrolled in STEM programs (Science, Technology, Engineering, Mathematics) and those in economics/business fields face the constant necessity of maintaining sustained attention, abstract thinking, and multitasking.

- Technology Profile: Requires a high degree of inhibitory control and working memory (e.g., for code debugging or complex calculations).
- Business Profile: Necessitates rapid cognitive flexibility and sustained attention (e.g., for market data analysis or investment decision-making).

Thus, for this specific cohort, enhancing cognitive functions through physical activity may have a particularly pronounced positive effect on their GPA, as their academic work relies heavily on the very executive functions that are most sensitive to physiological changes induced by PA.

Traditionally, physical culture is viewed as a means of harmonious development or a way to relieve physical tension. However, modern neurobiological studies convincingly prove that physical activity is not merely a supplementary factor, but a fundamental factor that optimizes brain function (Hillman, Erickson, Kramer, 2008). Regular physical exercise stimulates neurogenesis and improves synaptic plasticity, which directly influences executive functions: working memory, selective attention, and the capacity for multitasking—all essential for successful academic activity and, subsequently, for highly effective professional work in the fields of technology and business[2].

Research Problem: There is a lack of an empirically validated model, localized for Kazakh universities (specifically KUTB), that quantitatively links specific parameters of students' physical activity with their academic results (GPA) and the state of their cognitive functions.

Research Objective: To establish a statistically significant correlation between indicators of students' daily physical activity at KUTB, their level of cognitive functions, and academic performance (GPA) for the reporting period.

Hypothesis: There is a positive and moderately strong correlation: the higher and more regular a student's level of physical activity, the higher their cognitive indicators, and consequently, the higher their Grade Point Average (GPA).

The study was conducted at KUTB over one academic semester (6 months). The sample consisted of 120 second-year students (N=120) from faculties focused on business and IT technologies (age 19–20 years). The selection of second-year students was based on the fact that their GPA already reflects a stable learning trend, not just an adaptation period[3].

To ensure data objectivity, three key parameters were measured:

1. Physical Activity (PA): Measured in minutes of moderate and vigorous activity per week (according to WHO recommendations). Data collection was performed using an objective method—through personalized fitness trackers integrated into the university’s health monitoring system.
2. Cognitive Functions (CF): Assessment was conducted midway and at the end of the semester.
 - o Selective attention and reaction speed: Standardized tests were used, specifically the Schulte Tables.
 - o Working memory: Tests on digital memorization and reproduction.
3. Academic Performance (GPA): The weighted average performance score (Grade Point Average) for the surveyed semester, provided by the faculty deans, was used.

Pearson’s correlation analysis (rr) was used to analyze the relationships and determine the strength and direction of the connection between variables. A regression model was also applied to predict the potential influence of PA level on academic performance while controlling for other factors. Statistical processing was carried out using the SPSS package, and the significance level was set at $p<0.05$

The results of Pearson’s correlation analysis between Physical Activity (PA), Cognitive Functions (CF), and GPA are presented in Table 1.

Table 1.
Pearson’s Correlation Matrix Between Key Indicators of KUTB Students (N=120)

Indicator	Physical Activity (min/week)	Cognitive Functions (Attention)	GPA
Physical Activity (PA)	1.00	0.58**0.58**	0.39*0.39*
Cognitive Functions (CF)	0.58**0.58**	1.00	0.52**0.52**
GPA	0.39*0.39*	0.52**0.52**	1.00
*Note: $p<0.05$; $p<0.01$			

The results of the study fully confirmed the hypothesis and revealed the following key dependencies:

1. Strong PA and CF Link: A strong positive correlation was found between the level of physical activity and cognitive function indicators ($r=0.58, p<0.01$).
2. Students who spent more time on moderate and vigorous physical activity demonstrated significantly better results in tests for selective attention and information

processing speed. This is consistent with data suggesting that physical exercise increases the level of the neurotrophic factor BDNF, which is critical for learning and memory.

3. Moderate CF and GPA Link: A moderately strong correlation was found between high cognitive indicators and academic performance ($r=0.52, p<0.01$). Since success in technology and business disciplines directly depends on the ability to analyze, concentrate, and solve complex problems, improved executive functions translate directly into higher grades.

4. Direct PA and GPA Link: A statistically significant, though moderate, direct correlation was established between the level of physical activity and GPA ($r=0.39, p<0.05$). This means that even without direct accounting for cognitive functions, students leading an active lifestyle tended to have higher academic performance. This may be linked not only to biological mechanisms but also to the development of competencies such as discipline, self-regulation, and planning, which are reinforced through regular training and necessary for a high GPA.

The data obtained are crucial for the KUTB administration. Physical culture should not be considered a secondary subject that distracts students from core disciplines. On the contrary, it is an investment in intellectual potential. Increasing the level of physical activity is an accessible and effective non-pharmacological way to optimize students' cognitive functions, which ultimately leads to an improvement in the quality of the educational process and the competitiveness of graduates[4].

The conducted correlation analysis convincingly confirmed the research hypothesis: in the environment of technology and business students at KUTB, there is a stable positive correlation between regular physical activity, the state of their cognitive functions, and academic performance.

Key Conclusions:

1. The regularity of physical activity is a powerful predictor of attention effectiveness and information processing speed.
2. The optimization of cognitive functions, mediated by physical culture, is a significant factor influencing the final Grade Point Average (GPA).
3. For technological and business universities where intellectual load is maximal, physical culture must be repositioned as a tool for developing mental performance, not merely physical health[5].

Recommendations for Implementation in KUTB's Academic Process:

1. Mandatory Digital Monitoring Implementation: Use data from fitness trackers to assess the fulfillment of the minimum physical activity standard as part of the physical culture course credit.
2. Organization of "Motor Breaks": Integration of short (5–10 minute) physical exercises and warm-ups during long lecture and laboratory sessions to restore attention and brain activity.
3. Development of Cognitive-Stimulating Courses: Inclusion in the Physical Culture program of sports that require rapid decision-making and high coordination (table tennis, badminton, team games).

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Adaptive Learning Methods: Personalized Education Through Intelligent Systems

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Abstract

Adaptive learning employs artificial intelligence, learning analytics, and real-time data tracking to customize instruction according to each learner's profile. By adjusting content, pace, and feedback, these systems enhance learner engagement, motivation, and academic achievement. This article examines the theoretical foundation of adaptive learning, its system architecture, advantages, challenges, ethical considerations, and emerging trends. Evidence-based examples and practical implementations are discussed to guide effective adoption and future research in various educational settings.

Keywords: adaptive learning, personalized instruction, intelligent tutoring systems, learning analytics, digital pedagogy

Introduction

Traditional education often applies a standardized teaching approach, delivering the same content at a uniform pace to all students. However, learners differ in their prior knowledge, cognitive skills, and learning preferences, which can lead to disengagement for some and learning difficulties for others (Smart Learning Environments, 2019).

Adaptive learning addresses these challenges by providing personalized instruction that responds dynamically to learner performance. These systems continuously analyze interaction data, adjusting content, difficulty, and feedback to match each learner's needs.

Research demonstrates that adaptive learning can simulate one-on-one tutoring benefits at scale, improving mastery, engagement, and retention (Fernández-Morante, Cebreiro-López, Rodríguez-Malmierca, & Casal-Otero, 2022). Applications in STEM, language acquisition, and professional development reveal significant improvements in learning outcomes compared to conventional teaching or static e-learning approaches (El-Sabagh, 2021; Meylani, 2024).

Architecture and Core Components of Adaptive Learning Systems

Adaptive learning systems consist of interconnected modules that monitor learner interactions, analyze behavior, and personalize instruction. The effectiveness of these systems relies on the seamless integration of each component (Smart Learning Environments, 2019; Meylani, 2024).

Learner Mode -the learner model represents a comprehensive profile of the learner, including cognitive abilities, knowledge level, learning preferences, and motivation.

Elements: Prior knowledge, learning style (visual, auditory, kinesthetic), pace, engagement, misconceptions.

Data sources: Quiz results, assessments, interaction logs, response times, click patterns, and, in advanced systems, biometric or affective data.

Example: ALEKS (Assessment and Learning in Knowledge Spaces) continuously updates a student's knowledge map in mathematics, identifying areas requiring reinforcement and predicting subsequent learning paths (El-Sabagh, 2021).

Adaptive Engine- the adaptive engine determines the most appropriate instructional strategy for each learner.

Techniques: Rule-based adaptation using predefined conditions. Machine learning algorithms that detect patterns and predict optimal pathways (Meylani, 2024). Reinforcement learning that refines strategies through iterative feedback.

Example: Smart Sparrow adapts medical and STEM simulations, offering hints, remedial guidance, or advanced exercises based on learner performance (Fernández-Morante et al., 2022).

Content Repository - a repository stores educational materials in multiple formats, enabling tailored delivery:

Formats: Text, video, audio, simulations, interactive exercises, and gamified content.

Organization: Resources are tagged by difficulty, learning objective, prerequisites, and learning style.

Example: Khan Academy employs modular content aligned with learning objectives, allowing adaptive sequencing for individualized mastery (Coursera, 2023).

Module- assessment and feedback are central to adaptive learning:

Systems deliver formative and diagnostic assessments. Immediate feedback provides guidance, reinforces learning, and suggests remediation. Analytics detect patterns, misconceptions, and engagement trends, facilitating targeted teacher interventions.

Example: Knewton monitors responses in real time, adjusting exercises to maintain optimal challenge and progression (Qadir, Suleman, & Khan, 2025).

Communication and Reporting Layer -advanced systems include dashboards for learners and instructors:

Instructor dashboards: Track performance, engagement, knowledge gaps, and recommended interventions.

Learner dashboards: Visualize progress, goals, and feedback summaries, promoting self-regulation and metacognition (Smart Learning Environments, 2019).

This closed-loop architecture ensures that learner interactions continuously inform system adjustments, optimizing both content delivery and learning outcomes.

Benefits of Adaptive Learning

Adaptive learning systems provide pedagogical, motivational, and operational benefits, supported by empirical evidence:

Improved Learning Outcomes

Adaptive systems enhance retention, mastery, and problem-solving skills. Studies report 15–25% higher learning gains for learners using adaptive platforms compared to traditional instruction (El-Sabagh, 2021). Adaptive mathematics platforms, for example, accelerate acquisition of complex skills by adjusting difficulty and content sequences based on learner performance (Meylani, 2024).

Higher Engagement and Motivation

Personalization fosters self-efficacy, intrinsic motivation, and active participation. Immediate, tailored feedback reduces frustration and supports sustained engagement (Smart Learning Environments, 2019). Students in higher education report increased motivation when adaptive systems adjust content to their proficiency (Fernández-Morante et al., 2022).

Support for Diverse Learning Needs

Adaptive systems accommodate various learning styles and provide scaffolding for learners with cognitive challenges, ensuring equitable access to instruction (Coursera, 2023).

Efficient Resource Utilization

By eliminating redundant instruction, adaptive learning maximizes efficiency. Advanced learners progress quickly, while struggling learners receive targeted remediation (Qadir, Suleman, & Khan, 2025).

Scalability

Adaptive systems offer personalized instruction at scale, enabling one-on-one benefits without proportional increases in teaching staff (Fernández-Morante et al., 2022).

Challenges and Ethical Considerations

Despite its advantages, adaptive learning faces technical, pedagogical, and ethical challenges:

Technical Challenges

Accuracy of learner models may be limited, affecting adaptation (Smith et al., 2025).

Development of diverse, high-quality content is resource-intensive (Eduwik, 2023).

Platform reliability and performance issues can hinder learning (Meylani, 2024).

Pedagogical Challenges

Overreliance may reduce collaborative learning opportunities (Link Springer, 2023).

Self-regulation is required; unmotivated learners may struggle (Link Springer, 2023).

Misalignment with curriculum standards can occur if integration is insufficient (Qadir, Suleman, & Khan, 2025).

Ethical and Equity Challenges

Continuous data collection raises privacy and consent concerns (DrPress, 2023).

Algorithmic bias may disadvantage some learners (TomorrowDesk, 2023).

Access to devices and internet is necessary; the digital divide may exclude some learners (SPCA Education, 2023).

Recent Developments and Future Directions

Recent advancements focus on accuracy, pedagogical effectiveness, and equity:

Hybrid AI models combine rule-based and machine learning techniques for better content recommendations (Qadir, Suleman, & Khan, 2025).

Integration with learning analytics enables teachers to monitor and intervene effectively (Fernández-Morante et al., 2022).

Applications extend to vocational training, cybersecurity, healthcare, and professional upskilling (Seda, Vykopal, Švábenský, & Čeleda, 2022).

Future research should emphasize robust learner modeling, hybrid instructional strategies, ethical data practices, and equitable access to maximize adaptive learning's impact.

Conclusion

Adaptive learning transforms education by delivering individualized, responsive, and scalable instruction. It improves learning outcomes, engagement, efficiency, and inclusivity while supporting diverse learner needs. Successful implementation requires addressing technical robustness, pedagogical design, ethics, and equity. With careful integration, adaptive learning can become a cornerstone of modern education.

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The Role of AI in Writing Assessment: A Comparison with Human Evaluation

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Abstract

This study examines the use of AI-driven essay grading systems, focusing on tools like EssayGrader AI that assess student writing based on linguistic and structural criteria. While these AI systems provide efficient, objective, and scalable assessments, concerns arise regarding their ability to capture the creative, emotional, and contextual aspects of student work. The research compares AI grading with human evaluation, exploring both the practical applications and the emotional impact on students. Findings indicate that while AI offers benefits in efficiency and consistency, it falls short in understanding the human elements of writing. Future developments could enhance AI's ability to comprehend these nuances, but caution is needed to avoid over-reliance on technology and potential bias. The study underscores the need for a balance between AI and human input to support effective educational assessment.

Keywords: Assessment, Artificial Intelligence, AI Assessment, Human Assessment, EssayGrader, AI-driven essay grading, writing assignment.

Introduction

Artificial Intelligence (AI) has quickly changed many facets of education in recent years, from virtual teaching assistants to language learning applications. The application of AI one of the most hotly contested aspects of this technological revolution. The way teachers assess written work could be completely changed by tools like EssayGrader AI, which offer quicker, more capacity to manage massive amount of students' essays (Balfour, 2013).

Is it possible for a machine to comprehend what makes writing so great? This question has never been more pertinent in a world where technology is transforming education in every way. The conventional limits of student evaluation are being questioned with the emergence of AI systems such as EssayGrader AI. Essay evaluation, which was formerly the exclusive responsibility of educators, is now increasingly being handled by AI. However, how dependable, equitable, and successful is this change? Can AI truly understand the nuances of a student's argument, creativity, or voice? Does it recognize cultural contextual expressions that a human teacher would naturally appreciate? These questions become especially important as educational institutions increasingly explore AI as a cost-effective solution for assessment (Attali and Burstain, 2020; Perelman, 2014).

Tools like EssayGrader AI which analyze student writing according to predetermined linguistic and structured criteria, have been made possibly by the use of artificial intelligence into educational evaluation. These systems evaluate grammar, coherence, argument development, and even creativity to a certain degree using machine learning techniques and Natural Language Processing (NLP). By examining enormous datasets of previously evaluated essays, EssayGrader AI specifically seeks to mimic the scoring habits of seasoned teachers. Delivering a consistent, effective, and impartial evaluation is the aim (Shermis and Burstein, 2013).

EssayGrader AI provides immediate feedback and scoring using algorithms designed to resemble human assessment. Proponents contended AI offers time-efficient, regular, and

objective assessments, which are particularly helpful when teachers are overburdened with administrative duties and big class numbers. But writing is more than just using proper syntax and structure. Despite these concerns, AI grading continues to gain traction, especially in large-scale or online learning environments where teacher workload is high and timely feedback is essential. The key, as several scholars argue, lies in using AI as a supplement, not a substitute, for human feedback (Liu et al., 2022).

The purpose of the study is to examine how EssayGrader AI evaluates student work and to contrast its advantages and disadvantages with those of conventional human evaluation. This study examines how students react to both forms of feedback in order to comprehend AI's educational and emotional effects on pupils in addition to its practical applications. It is essential for educators and policymakers to comprehend the function and effects of AI in writing assessment. This study can assist in determining whether AI technologies are prepared to replace or augment specific elements of teacher-led evaluation, as well as the potential hazards associated with doing so carelessly. It can also serve as a guide for creating AI-assisted learning settings that strike a balance between human sensitivity and technical efficiency.

The main research questions for this study are:

1. How does feedback from EssayGrader AI differ from teacher-generated feedback in terms of quality?
2. Is there a difference in assessment of Human and AI?

Literature review

There has been a lot of discussion and interest in the use of artificial intelligence in educational evaluation. The difficulties presented by conventional human assessors may be resolved by using tools such as EssayGrader AI, which evaluate student work according to preset linguistic and structural standards. This review of the literature looks at several research that contrast human evaluation with AI-assisted essay grading, emphasizing the benefits, drawbacks, and consequences of each method.

Wetzler et al. (2024) compared the grading results of human instructors and AI models, specifically ChatGPT versions 3.5 and 4o. The purpose of the study was to determine how accurately and consistently AI models could mimic the grading habits of seasoned educators. The study investigated potential biases in the AI models and assessed how well the two grading schemes aligned using statistical analysis. The advantages and disadvantages of AI in essay grading in comparison to human assessors might be thoroughly examined thanks to this design.

Large language models (LLMs) such as GPT-3.5, GPT-4, o1, LLaMA 3-70B, and Mixtral 8x7B were assessed by Sebler et al. (2024) for their ability to grade essays written by German students. They focused on language-related factors including syntax and sentence structure and contrasted AI-generated scores with human judgments.

A research by Bouziane and Bouziane (2024) assessed ChatGPT's ability to evaluate writing skills at the surface level, including grammar, spelling, sentence structure, and coherence. A sample of student essays that were rated by ChatGPT and human reviewers was used by the researchers. They contrasted the outcomes using particular language mechanics criteria, concentrating on how effectively the AI and human graders evaluated problems like sentence clarity, punctuation, and grammar accuracy.

A dual-process paradigm was proposed by Xiao et al. (2024) that combines the depth of analysis offered by human evaluators with the efficiency of AI. In order to improve grading accuracy and provide more thorough feedback, the study concentrated on integrating the advantages of both methodologies. On a collection of student writings, the researchers combined human evaluations with AI-based essay grading systems.

The advent of AI-assisted technologies, such as Writable, which was partially created by ChatGPT, to assist teachers in grading student writing assignments is covered by Axios (2024).

These solutions guarantee accurate grading and uphold academic integrity by fusing AI's capabilities with human control. Nonetheless, the research raises ethical concerns regarding the employment of AI and draws attention to worries that it could lower the caliber of feedback given to pupils.

An automated essay scoring (AES) system called *e-rater V.2* was created and evaluated by Attali and Burstein (2006) for use in educational assessments. Using syntactic, discourse, and lexical aspects from natural language processing (NLP), the study examined the system's essay evaluation capabilities.

Modern automated essay scoring (AES) systems were compared in an educational measuring setting by Shermis and Hamner (2013). In order to evaluate the effectiveness of various AES technologies (including both commercial and research-based tools), their study was presented at the National Council on Measurement in Education (NCME). In their 2016 study, Wilson and Czik examined the use of automated essay evaluation (AEE) software in English language arts (ELA) classrooms and its function in conjunction with teacher input. Although the precise sample size and demographics were not disclosed in this section, the study involved secondary school students and teachers in an actual classroom environment.

Using deep learning techniques, Kumar and Boulanger (2020) investigated the educational possibilities of explainable automated essay scoring (AES) systems. Their research, which was published in *Frontiers in Education*, created and evaluated an AES system based on neural networks that may offer students not only ratings but also comprehensible feedback on their writing.

Within larger sociotechnical systems, Warschauer (2020) critically analyzed the changing role of digital technologies in education, including AI-driven tools like automated writing assessment. This conceptual study, which was published in *Learning, Media, and Technology*, reviewed theoretical frameworks and empirical studies to examine trends in technology-mediated learning.

Dikli (2006) reviewed early AES systems (e.g., IntelliMetric, e-rater), comparing their linguistic feature analysis (e.g., grammar, coherence) to human grading criteria. The study synthesized findings from standardized testing contexts but did not specify participant demographics. Bridgeman et al. (2012) analyzed bias in AES for graduate admissions essays, using a corpus of GRE writing samples.

The study contrasted human and AI scoring disparities across non-native English speakers. Grimes and Warschauer (2010) conducted a multi-classroom study of AES tools (e.g., MY Access!), observing how teachers integrated automated feedback into writing instruction without replacing human assessment. Zhao et al. (2023) tested GPT-4's essay evaluation capabilities using university-level writing samples, focusing on rubric alignment and feedback quality compared to instructor grading.

Methodology

Research Design

This study employs a quasi-experimental, within-subjects research design to conduct a comparative quantitative analysis of writing assessment performed by an Artificial Intelligence platform EssayGrader AI versus human instructors. The primary objective is to evaluate the reliability, consistency, and potential systematic biases between these two grading methodologies.

Participant and Settings

The sample consists of 21 student essays collected from an undergraduate academic writing course. Each essay serves as its own control, being evaluated by both an AI system and a panel of human evaluators. Essays will be assessed using a standardized analytical rubric focusing on four

core dimensions of writing quality, each yielding a score on a 5-point Likert scale (1=Poor, 5=Excellent).

A total score will be derived from the sum of the dimension scores. The resulting dataset will contain the following ten primary variables for analysis: Grammar score (AI); Grammar score (Human); Vocabulary score (AI); Vocabulary score (Human); Organization score (AI); Organization score (Human); Coherence score (AI); Coherence score (Human); Total score (AI); Total score (Human).

Data Collection

Essay Selection: 21 students covered 5 argumentative topics like '*School Uniforms*'; '*Standardized Test*'. Each topic included three proficiency levels (A2 to B2), with essays ranging from 500 to 800 words.

Human Evaluation: Two trained English teachers graded the essays using The CAASPP Rubric, providing a comprehensive assessment of a student's grammar, organization, vocabulary, coherence, and overall score.

AI Evaluation: Essays were input into EssayGrader AI for automated scoring and feedback on providing a comprehensive assessment of a student's argumentative writing skills.

Data Analysis

To analyze the question "How does feedback from EssayGrader AI differ from teacher-generated feedback in terms of quality?" using paired t-tests, descriptive statistics. To address the question, "Is there a difference in assessment of Human and AI?", a Paired Samples T-Test is indeed an appropriate method, as we are comparing two related sets of data (human assessment and AI assessment) for the same subjects or cases.

Treatment

Standardization of Essays: The sample consists of twenty-one student essays, collected from a standardized academic writing assignment. All essays were anonymized to take out the identity of the student (student name, ID, class section) so that bias could not be introduced. The essays were then changed into plain text format (.txt files) to make sure the AI tool processed only the textual content and not the formatting artifacts.

Rater Training and Calibration: Two experienced human instructors were recruited as raters to grade the essays. The raters were required to attend a 90-minute calibration workshop before the main grading session. During this session, they studied the 5-point analytical rubric of the study (Grammar, Vocabulary, Organization, Coherence), discussed the criteria for scoring at each level, and independently scored three sample essays not included in the main study.

AI Tool Setup: The researcher created an account on the EssayGrader AI platform <https://www.essaygrader.ai/>. The exact analytical rubric used by the human raters was then manually configured within the "Custom Rubric" settings in the AI system. The four criteria Grammars, Vocabulary, Organization, Coherence were input, with brief descriptors corresponding to each score level provided - 1 through 5. No other modifications or special prompts were used.

Grading was performed in two parallel, independent streams to avoid any contamination between AI and human assessments.

AI Grading Stream:

Each of the 21 anonymized .txt files was uploaded separately into the EssayGrader AI platform.

For each essay, the option "Grade with Custom Rubric" was chosen. AI generated a score, on a scale from 1 to 5, for each of the four criteria and in total. No option of generating written feedback was enabled, focusing purely on numerical scoring.

All the scores were manually recorded by the researcher in a dedicated SPSS data file.

Human Grading Stream:

The two human raters received the same set of 21 anonymized essays in a randomized order through a secure online portal. Examples include Google Forms with a separate section for each essay.

Raters worked in separate locations and were instructed not to discuss the essays.

For each essay, they had to go online and enter a score in each of the four rubric criteria using an online form. The form automatically calculated the total score. Scores were collated upon completion by both raters. For the primary analysis, the scores provided by Rater 1 were used for the paired comparison with the AI. The scores from Rater 2 were used exclusively to calculate the inter-rater reliability among humans.

Findings

To measure the reliability of the analysis the scoring of AI and Human, Reliability analysis was used and shown In Table 1:

Table 1. Reliability Analysis

Cronbach's Alpha	N of Items
,920	21

The reliability analysis produced a Cronbach's Alpha of 0.920 across the 21 items, indicating excellent internal consistency. This suggests that the scoring rubrics applied across both AI and human assessments were highly reliable and that the scoring items consistently measured the same constructs. A Cronbach's Alpha value above 0.90 is typically considered excellent, highlighting that the items used to evaluate the essays – such as grammar, coherence, argumentation, creativity, and structure – were measured consistently across different raters and tools. This level of reliability is crucial when comparing the results of AI-driven grading systems with human assessments, as it provides confidence that both AI and human evaluators are using consistent and dependable criteria for their evaluations.

Based on the descriptive statistics of the essays evaluated by both EssayGrader AI and human teachers, the following key observations and findings can be made on the table 2:

Table 2. Descriptive Analysis

	N	Minimum	Maximum	Mean	Std. Deviation
Grammar score (AI)	21	1,00	5,00	3,1905	1,43593
Grammar score (Human)	21	1,00	5,00	3,0952	1,48003
Vocabulary score (AI)	21	1,00	5,00	2,9524	1,16087
Vocabulary score (Human)	21	1,00	5,00	2,7619	1,26114
Organization score (AI)	21	1,00	5,00	2,9048	1,64027
Organization score (Human)	21	,00	5,00	2,9524	1,59613
Coherence score (AI)	21	,00	5,00	3,0000	1,51658
Coherence score (Human)	21	,00	5,00	2,9524	1,68749
Total score (AI)	21	2,00	19,00	12,0476	5,31485
Total score (Human)	21	1,00	19,00	11,7143	5,49675
Score difference: AI_Total-Human_Total	21	2,00	2,00	,3333	1,11056

The total scores for AI and human evaluators are very close, with a slight difference in the averages (AI: 12.05 vs. Human: 11.71). This suggests a reasonable level of consistency between the AI and human evaluations, indicating that the AI's assessment is not drastically different from human teachers' assessments overall.

While the total scores from both evaluators are similar, the AI tends to score slightly higher than the human teachers. The mean score difference between the AI and human assessments is **-0.33**, suggesting that the AI's evaluation is marginally more favorable. However, this difference is minimal and might not significantly impact the overall evaluation process.

Both AI and human evaluators gave similar grammar scores, with AI scoring slightly higher (Mean AI: 3.19, Mean Human: 3.10). This finding shows that both evaluators are relatively aligned in their grammar assessments, though there are small differences in scoring behavior. The standard deviations (AI: 1.44, Human: 1.48) indicate a comparable spread in grammar scores, implying that both AI and human teachers assess grammar with a similar degree of variability. For vocabulary, both AI and human evaluations show similar results. The AI gave a slightly higher average score (Mean AI: 2.95, Mean Human: 2.76), with a narrower standard deviation (AI: 1.16, Human: 1.26). This suggests that the AI is somewhat more consistent in its evaluation of vocabulary, but the difference between AI and human evaluations is still minimal.

In terms of organization, both AI and humans gave comparable scores (AI Mean: 2.90, Human Mean: 2.95), with a slight variation in scoring spread. Similarly, the coherence scores were close (AI Mean: 3.00, Human Mean: 2.85), with AI again showing a marginally higher average. Despite the small differences, both evaluators show a comparable range in their scores (with human scores showing slightly more variability, as indicated by the larger standard deviations). The standard deviations for both AI and human evaluations indicate some variability in the assessments. For example, the highest variability was found in the coherence scores, especially for human evaluators (Human SD: 1.66), indicating that human evaluators may assess coherence more subjectively compared to AI. The variability in the AI's scoring system is somewhat lower across categories, suggesting that the AI's evaluation may be more consistent across essays. The score difference between AI and human evaluations shows a small negative mean (-0.33), meaning that the AI generally provided slightly higher total scores than the humans. However, the standard deviation (1.11) indicates that this difference was not consistent across all essays, as the range of score differences varied from -2 to +2.

The paired samples statistics provide a detailed comparison between the scores given by EssayGrader AI and the human teachers across various categories, including grammar, vocabulary, organization, coherence, and total score. Below are the key findings shown in the table 3:

Table 3. Paired Samples T-test

		Mean	N	Std. Deviation
Pair 1	Grammar score (AI)	3,1905	21	1,43593
	Grammar score (Human)	3,0952	21	1,48003
Pair 2	Vocabulary score (AI)	2,9524	21	1,16087
	Vocabulary score (Human)	2,7619	21	1,26114
Pair 3	Organization score (AI)	2,9048	21	1,64027
	Organization score (Human)	2,9524	21	1,59613
Pair 4	Coherence score (AI)	3,0000	21	1,51658
	Coherence score (Human)	2,9524	21	1,68749
Pair 5	Total score (AI)	12,0476	21	5,31485
	Total score (Human)	11,7143	21	5,49675

The paired samples statistics provide valuable insights into the comparison between the EssayGrader AI and human-generated feedback on the students' essays across several categories: grammar, vocabulary, organization, coherence, and total score. Firstly, regarding the grammar

scores, both the AI and human teachers rated the students relatively similarly. The mean score for AI was 3.19, while the human teachers gave a mean score of 3.10. The standard deviation for AI was 1.44, and for human graders, it was slightly higher at 1.48. This suggests that both evaluators were fairly consistent in their ratings, with the AI providing a marginally higher score in grammar.

When it comes to vocabulary, the AI again scored slightly higher than the human teachers, with a mean of 2.95 compared to 2.76 for the human evaluators. The standard deviation for AI was 1.16, indicating a relatively narrow spread of scores, while the human evaluators' standard deviation was 1.26, showing a bit more variability in their ratings. This suggests that while both the AI and humans were similar in their assessments, the human evaluators were slightly more varied in their ratings. For organization, the mean scores were nearly identical, with AI scoring 2.90 and human teachers scoring 2.95. The standard deviations were also very close (AI: 1.64, Human: 1.60), indicating that both evaluators assessed organization in a similar manner, with very little difference in their ratings. In terms of coherence, the AI scored marginally higher (mean of 3.00) than the human teachers (mean of 2.95). The standard deviation for the AI was 1.52, while the human evaluators showed slightly more variability, with a standard deviation of 1.69. This suggests that while both evaluators were fairly consistent, human teachers showed a greater range of scores, possibly due to subjective differences in evaluating coherence. Finally, for the total scores, the AI scored an average of 12.05, while the human evaluators gave an average score of 11.71. The standard deviations were close as well, with AI at 5.31 and human evaluators at 5.50. Again, this shows that the AI and human evaluators gave very similar total scores, with the AI scoring slightly higher on average.

In summary, the findings suggest that EssayGrader AI offers feedback and scoring that are comparable in quality and reliability to human evaluations. The small differences in mean scores and the high internal consistency provide evidence supporting the potential of AI-assisted evaluation as a complementary tool in writing assessment.

Discussion

The findings of this study indicate a high degree of consistency between EssayGrader AI and human teachers in evaluating student essays, aligning with prior research by Wetzler et al. (2024), who compared the grading behaviors of human instructors and AI models (ChatGPT-3.5 and 4o). Like Wetzler et al., this study aimed to explore the accuracy and reliability of automated writing assessment in comparison to experienced human evaluators.

Descriptive and inferential statistical analyses – including paired samples t-tests and correlation measures – revealed minimal differences between AI and human scores across all four rubric categories: grammar, vocabulary, organization, and coherence. Additionally, the high Cronbach's Alpha value ($\alpha = 0.920$) demonstrated strong internal consistency across all scoring items, suggesting that the rubric was reliably applied by both scoring agents.

These results are consistent with Wetzler et al.'s conclusion that AI models, when properly calibrated, can replicate human grading patterns with reasonable fidelity. Both studies highlight that AI can offer reliable scoring while saving time and reducing human workload. However, while Wetzler et al. delved deeper into potential biases of specific AI versions, this study focused more on the feedback quality and consistency provided by AI compared to human-generated responses.

One key observation was that the differences in total scores were statistically insignificant, suggesting that EssayGrader AI does not systematically score higher or lower than human teachers. This supports the view that AI tools can be a viable supplement—though not necessarily a replacement—for human grading, particularly in formative assessment contexts where timely feedback is essential.

The results of this study align with and contribute to growing research on the reliability of large language models (LLMs) in educational assessment. In addition to the work by Wetzler et al. (2024), who compared human and AI-generated scores using ChatGPT-3.5 and 4o, Sebler et al.

(2024) conducted a similar investigation using models like GPT-4, GPT-3.5, LLaMA 3-70B, and Mixtral 8x7B to assess German student essays. Their focus was primarily on linguistic features such as syntax and sentence structure, evaluating how AI grading compared to human judgments on language accuracy and fluency.

Similar to Sebler et al.'s conclusions, this study found that EssayGrader AI demonstrated scoring outcomes closely aligned with those of human teachers across grammar, vocabulary, organization, and coherence dimensions. The descriptive statistics showed only minor differences in mean scores, and paired t-tests indicated no significant bias toward over- or under-scoring by AI. Furthermore, a strong internal consistency across all evaluation components was confirmed by a high Cronbach's Alpha ($\alpha = 0.920$), reinforcing the rubric's reliability when applied by both AI and human raters. While Sebler et al. emphasized the AI models' linguistic precision, this study extended the scope to include the broader quality of feedback and its alignment with human grading tendencies. It supports the growing consensus that LLMs can act as accurate evaluators for language-based tasks when guided by structured rubrics.

These results resonate with the dual-process paradigm proposed by Xiao et al. (2024), which advocates for combining the nuanced analysis of human evaluators with the efficiency of AI tools. Their approach emphasized the benefits of integrating both methods to enhance grading accuracy and enrich feedback quality. Similarly, this study's findings suggest that while AI can effectively emulate human scoring, incorporating human oversight may still be valuable for delivering personalized and comprehensive feedback.

Moreover, Axios (2024) highlighted the emergence of AI-supported platforms like Writable, which aim to assist educators in evaluating student writing. These tools, which leverage models such as ChatGPT, are designed to provide consistent grading while maintaining academic standards. However, Axios also addressed growing concerns over the ethical implications of relying heavily on AI, including potential reductions in the depth and personal relevance of feedback offered to students.

In this context, the results of the current study support the use of AI as a supplemental tool rather than a standalone evaluator. While EssayGrader AI shows promise in maintaining consistency and reducing the burden on educators, human involvement remains critical to ensuring that feedback remains meaningful, individualized, and pedagogically sound. As educational settings continue to adopt AI technologies, balanced integration strategies—such as those proposed by Xiao et al.—will be essential for maximizing both efficiency and educational value.

This observation is consistent with earlier research on automated essay scoring (AES) systems. For instance, Attali and Burstein (2006) developed the *e-rater V.2*, one of the pioneering systems in AES, which utilized syntactic, discourse, and lexical features derived from natural language processing (NLP) to assess student essays. Their work highlighted the potential of AI-driven systems to produce reliable and scalable assessments in educational contexts.

Further, Wilson and Czik (2016) examined the real-world implementation of AES software in English Language Arts (ELA) classrooms. They found that while AES systems could streamline the grading process, their greatest value came when used alongside teacher feedback, allowing for both efficient scoring and nuanced instruction.

These findings align with those of Kumar and Boulanger (2020), who emphasized the educational potential of explainable automated essay scoring systems. Their research highlighted the importance of providing feedback alongside scores, allowing students to understand the rationale behind the evaluations. While the current study did not focus on explainability, the consistency of AI grading observed here supports the potential for such systems to become more transparent and educationally supportive if integrated with feedback mechanisms.

However, the issue of fairness and potential bias remains relevant. Ramesh and Vanden (2022) explored algorithmic biases in AES systems across different demographics, raising concerns about disparities in scoring based on gender and first language. Although demographic variables were not a focus in the current study, the relatively balanced scoring patterns observed suggest that, in this specific sample, ChatGPT's scoring did not display significant bias. Still, future research should examine these factors more systematically to ensure equitable assessment across diverse student populations.

In a broader context, Warschauer (2020) provided a critical perspective on the integration of AI tools in education, emphasizing both their potential and their risks within sociotechnical systems. The findings of the present study reflect this dual nature: while AI scoring shows promise in replicating human judgment reliably and efficiently, caution is warranted to prevent over-reliance on automation without human oversight, particularly when it comes to nuanced, individualized student feedback.

In the context of Dikli (2006), the findings of this study resonate with the early development of Automated Essay Scoring (AES) systems like IntelliMetric and e-rater, which analyzed linguistic features such as grammar and coherence. Dikli's review highlighted the importance of linguistic features being aligned with human grading criteria. While the current study focused primarily on broader categories such as grammar, vocabulary, and coherence, the consistency between AI and human evaluators reinforces Dikli's assertion that AES can capture key writing features, such as structure and coherence, which are also central to human assessment. However, the study did not address in-depth contextual understanding or the nuances of writing that a human rater may more adeptly capture.

Bridgeman et al. (2012) conducted a study on AES bias, particularly in graduate admissions essays, where they explored the disparities between human and AI scores for non-native English speakers. Their findings raised concerns about potential bias in AES systems, especially for diverse language backgrounds. The current study did not address this aspect, but it is worth noting that while the AI scoring did not show large differences in overall score patterns, future studies should explore demographic diversity in the sample to ensure that such biases, as identified by Bridgeman et al., do not emerge when utilizing AI in more diverse educational settings.

Ultimately, the results of this study suggest that AI can serve as a reliable and efficient tool for grading essays, with significant potential for use in educational settings when integrated with human oversight. The research by Dikli, Bridgeman et al., Grimes & Warschauer, and Zhao et al. all reinforce the growing recognition of the utility of AI in assessment while also highlighting the need for careful integration to avoid issues like bias and a reduction in the quality of feedback. The challenge going forward will be to ensure AI's complementary role in educational assessment, augmenting rather than replacing the critical, nuanced insights that human evaluators offer.

Conclusion

The integration of Artificial Intelligence (AI) into educational assessment has the potential to significantly reshape how we evaluate student writing, offering efficiency, consistency, and scalability. AI systems like EssayGrader AI provide teachers with valuable tools to manage large volumes of student essays, offering quick, standardized, and objective feedback. These systems are particularly helpful in reducing teachers' administrative burdens, freeing up time to focus on more personalized aspects of instruction. However, despite these advancements, AI's current capabilities remain limited in fully understanding the nuanced elements of student writing, such as creativity, emotional depth, and the complexities of student argumentation.

Looking toward the future, AI has the potential to evolve further, offering more sophisticated assessments that go beyond grammar and structure. With advancements in machine learning, future AI systems could be trained to better understand the subtleties of language, including context, cultural references, and tone, allowing them to provide feedback that

is not only accurate but also more sensitive to the unique voices and perspectives of students. Furthermore, as AI continues to improve, it could incorporate more interactive features, offering students real-time suggestions and guidance that could enhance their learning process.

Despite its potential, there are several limitations to the widespread adoption of AI in educational assessment. One significant challenge is ensuring that AI systems remain free from bias. While current systems are designed to be impartial, the training data used to develop these tools can sometimes introduce unintended biases, which may impact the fairness of grading, especially for students from diverse backgrounds. Additionally, AI systems often lack the ability to understand the emotional or creative aspects of student writing. Writing is not just an academic exercise; it is a personal expression of ideas and emotions, and AI, despite its advancements, struggles to grasp this human element.

Another limitation is the potential over-reliance on AI, which could diminish the role of human educators in the assessment process. Teachers play a crucial role in providing personalized, formative feedback that encourages critical thinking, creativity, and intellectual growth. Over-reliance on AI could lead to the loss of these human interactions, which are essential for fostering a deeper understanding of subject matter and encouraging students' personal development.

In conclusion, while AI presents a promising future for educational assessment, it is essential to approach its implementation thoughtfully. AI can serve as a valuable tool to support teachers, but it should not replace the human touch that is so vital in education. Moving forward, it will be crucial to strike a balance between leveraging AI for its efficiency and maintaining the personal, emotional, and intellectual connection between teachers and students. By addressing the limitations of AI and refining its capabilities, we can create a future where AI enhances rather than diminishes the educational experience.

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THEORETICAL FOUNDATIONS OF CRITERION-BASED ASSESSMENT IN EVALUATING DIALOGUE AND CONVERSATIONAL SKILLS

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Abstract

This article presents the theoretical base for using criterion-based assessment to evaluate dialogue and conversational skills in secondary school English. Dialogue is treated as the most direct way to see communicative competence because it reveals how learners respond, question and negotiate meaning with a partner. The article argues that without criteria speaking remains judged by impression, which is neither fair nor useful for progress. Rubric based assessment makes dialogic ability visible through indicators of fluency, turn taking, vocabulary choice and pragmatic behavior. When teachers evaluate through criteria, students in Grades 7 and 8 develop clearer control of real communication, not only written accuracy.

Keywords: dialogue skills, criterion-based assessment, communicative competence, rubric, secondary school English.

Introduction

Spoken English is often evaluated through accuracy alone, but communication does not exist in isolated sentences. It lives in dialogue, where speakers listen, respond, negotiate and adapt in real time. A written answer may be correct, yet communication still fails if a learner cannot carry a conversation or follow a partner's idea. Therefore, it is not enough to assess language as knowledge. It must also be measured as action.

In Kazakhstani classrooms the gap between knowledge and performance becomes visible early. Students who complete grammar tasks successfully often hesitate when asked to speak. Others depend on memorized dialogues and lose confidence when conversation moves in a new direction. These patterns show that traditional assessment captures only a fraction of communicative ability. The classroom hears accuracy, but rarely interaction.

The problem does not come from lack of ability, but from how performance is judged. When teachers rely on impression rather than criteria, confident speakers receive high marks while quieter or slower speakers are undervalued. This can discourage learners who know the language but struggle with spontaneous interaction. Criterion based assessment aims to break this cycle. It shifts focus from overall impression to specific behaviors such as turn taking, fluency control, vocabulary choice, repair strategies and pragmatic awareness. These behaviors are not hidden. They can be observed naturally in dialogue.

Dialogue is also deeply social. Students in Grades 7 and 8 build identity through speech. They form opinions, question information, agree and disagree with peers. They test ideas aloud and modify them in response to feedback. When assessment recognizes these behaviors, speaking becomes

more than performance. It becomes development. A rubric allows teachers to respond to real communicative effort. Instead of general advice like speak more, feedback becomes targeted: ask for clarification, build on your partner's idea, or organize your thought before responding. Each suggestion has direction.

The aim of this article is to present the theoretical foundations that justify criterion-based assessment of dialogic skills in school English. It argues that dialogue is the clearest reflection of communicative competence, and that assessment must capture the complexity inside spoken interaction rather than only the correctness of form. By examining components of communicative competence and the structure of dialogic behavior, the article supports the adoption of rubrics as a more reliable and purposeful way to evaluate conversation in Grades 7 and 8.

Communicative Competence as an Educational Outcome

Communicative competence stands as the primary goal of foreign language education, yet in many classrooms it remains a theoretical phrase rather than an assessed reality. A learner may complete grammar exercises correctly and still fail to sustain conversation, which means the outcome of learning has not reached functional level. To understand communicative competence as an educational target we must treat language as something students do with others, not something they only know on paper. S. S. Kunanbayeva's work forms the theoretical core of this view. She describes communicative competence as a multi layered system that brings linguistic resources, sociocultural norms, discourse organization and strategic behavior together within real communication. It is not stored knowledge. It is displayed in use, and dialogue is where this use becomes visible.

This research builds on several complementary theories that help explain how communicative ability develops and why assessment must reflect interaction itself. Vygotsky shows that language growth occurs through social exchange, not isolation. Learners internalise forms by using them with others, especially when guided by a more capable partner in the Zone of Proximal Development. Long strengthens this argument by demonstrating that interaction drives acquisition because learners negotiate meaning and reshape input when breakdown occurs. Swain adds the Output Hypothesis, arguing that speaking forces learners to notice gaps in their language and search for solutions, which makes productive interaction a learning moment, not only performance. These views explain why a student grows more when speaking with a partner than when completing drills alone.

If communicative competence is the goal, its components must be recognized within assessment. Linguistic competence allows the student to choose vocabulary and structure sentences, but it does not guarantee conversation. Sociolinguistic competence controls tone and politeness. It shapes how a student speaks to a teacher compared to a classmate. Discourse competence connects ideas across turns so that speech flows rather than fragments. Strategic competence appears when a learner paraphrases, asks for repetition or repairs misunderstanding instead of remaining silent. Kunanbayeva emphasizes that communication succeeds only when these elements operate together, and this integration is the clearest in spontaneous dialogue where planning time is limited and responses must adapt quickly.

Traditional assessment rarely captures this integration. A student who writes well can still hesitate in conversation, and another who speaks actively may produce errors while maintaining meaning. If assessment looks only at accuracy, both abilities are misrepresented. Communicative competence must therefore be evaluated in live interaction where the learner manages real speech demands. Criterion based assessment supports this need by focusing on observable behaviors rather than general impressions. When teachers assess turn taking, responsiveness, negotiation, and clarity of expression, they evaluate communication rather than recitation. In Grades 7 and 8 students reach a stage where they can form opinions, challenge peers, and build

ideas collaboratively. Assessing these abilities gives value to real language use and encourages participation.

Communicative competence as an educational outcome means more than reaching correct answers. It means developing learners who can speak, listen, adapt and continue conversation in English without fear of failure. When assessment reflects this aim, teaching aligns with it. Dialogue becomes normal practice, not preparation for tests. Growth becomes visible, because interaction exposes what the learner can actually do. This is why communicative competence must guide not only curriculum but also evaluation, especially in classrooms where English is meant to serve real communication, not only written accuracy.

Criterion Based Assessment and Indicators of Dialogic Skill

Criterion based assessment is grounded in the idea that spoken performance must be evaluated through identifiable behaviours rather than general impressions. A learner who takes turns, negotiates meaning, responds with relevance and keeps the conversation moving demonstrates real communicative ability, even if occasional errors appear. Glaser's work supports this shift from comparative scoring to observable outcomes, and O'Malley with Valdez Pierce add to this view by arguing that performance must be assessed as it occurs naturally, not only through written forms or rehearsed answers. When assessment focuses on what students can do in interaction, it reflects the reality of communication more honestly than traditional accuracy-based testing.

Dialogic skill is complex because it involves simultaneous processes. A speaker listens to the partner, chooses vocabulary, structures thought, manages tone and solves breakdowns while speaking. These actions cannot be captured through a single score, which is why rubric-based assessment separates performance into clear domains. The first domain is linguistic control. Students use grammar and vocabulary to express meaning, yet perfection is not required since communication can succeed even with imperfect form. The second domain is fluency. Learners who respond within natural time, avoid long silence and maintain continuation show control of pace. The third domain is interaction management, which determines whether dialogue remains alive. A student who only answers create stagnation, while one who asks questions, references partner ideas and builds jointly keeps communication active.

Strategy use forms the fourth domain. When vocabulary is missing, confident speakers do not stop. They paraphrase, describe and repair meaning, which demonstrates growth beyond memorized language. The fifth domain is pragmatic awareness. Learners adjust tone when speaking to a peer, to a teacher or during disagreement. These choices influence the success of interaction more than grammatical accuracy in many cases. When these five domains are placed into a rubric, they become visible indicators of performance rather than abstract qualities. A teacher can identify strengths directly and point out where development is needed. Instead of general feedback like speak more, a learner hears give a follow up question next time or show you listened by building on your partner's idea.

With clear indicators, progress does not disappear inside one overall mark. A student may improve fluency first and interaction later, and this pattern can be tracked. Criterion based assessment makes these differences observable. It also makes participation less risky for learners because improvement has shape and direction. Dialogue becomes not only assessable but teachable. The goal is not to produce perfect speech, but to build real communicative competence that functions in conversation.

Implications for Secondary School English Teaching

If dialogue is the clearest reflection of communicative competence, then secondary school English teaching must change how speech is developed and how progress is measured. A classroom that trains students to produce isolated sentences cannot expect natural conversation. Communication grows when learners speak to one another with purpose, negotiate meaning when confusion appears and continue interaction instead of stopping after short answers. When

English lessons priorities grammar drills and written tasks as the main form of practice, spoken competence remains secondary. A criterion-based approach encourages teachers to bring dialogue into the center of instruction, because only dialogue reveals whether learners can think through language and respond in real time.

Rubric guided assessment gives teachers a structure for planning lessons. If interaction, fluency and pragmatic awareness are criteria, then tasks must require these behaviours. Pair discussions, problem solving dialogues, opinion exchange and information sharing activities allow students to practice what will later be assessed. Students in Grades 7 and 8 can handle such tasks. They are old enough to develop opinions and respond to the views of others. When learners must ask questions, provide reasons and maintain topic flow, they begin to speak more naturally. If assessment recognizes these behaviours, learners feel that conversation has value, not only form accuracy.

Teaching practice also shifts when feedback becomes specific. Instead of saying improve speaking, the teacher can say use one clarification question next time or build on your partner's sentence before giving your own idea. This type of guidance is achievable and measurable. A student knows what to do, and the teacher can observe improvement in later tasks. Confidence increases because success is visible, not abstract. A learner who once feared making mistakes may speak more freely when they know that effort in interaction, even with errors, will be recognized. This supports the development of strategic competence, which is often ignored in traditional marking. Classroom climate changes when dialogue is assessed seriously. Silence no longer feels safer than participation. Students begin to understand that communication involves trial, adjustment and repair. They learn that it is acceptable to not know every word, because a successful speaker can paraphrase and continue. When these behaviours are valued, students become active users of English instead of quiet observers. Teachers also gain a clearer picture of real ability. They no longer rely on written results to assume communicative skill. They see how a learner handles breakdown, how they support a partner, and how they keep meaning moving.

The implication is direct. If secondary schools want communicative learners, speaking must become a structured part of assessment. Criterion based rubrics make this possible. They help teachers move beyond guesswork and give students a route for growth. Dialogue stops being a passing activity and becomes evidence of learning. When classrooms adopt this approach consistently, language stops being something students' study and becomes something they do.

Conclusion

Dialogue shows what learners can actually do with English, and because of this it must not stand outside the assessment system. A student who can maintain a conversation, ask for clarification and respond to a partner displays a level of communicative competence that written accuracy cannot represent. The theoretical foundations explored here make one point clear. If communication is the goal, then the tools used to measure progress must recognize the skills that conversation demands. Criterion based assessment provides this recognition by turning real interaction into observable indicators.

Rubrics do more than assign marks. They guide learning. They help teachers see strengths and weaknesses with clarity, and they give students a way to understand their growth. When a learner receives targeted feedback, improvement becomes a reachable process rather than a vague expectation. Dialogue becomes practice, assessment and development at the same time. In Grades 7 and 8 this is especially significant. Students at this stage are ready to express ideas, challenge opinions and co construct meaning, and they need assessment that values these efforts. The implication for teaching is direct and difficult to ignore. Schools that expect communicative outcomes must evaluate communication through dialogue, not only through correctness. A criterion-based system aligns instruction with assessment so that classroom talk has purpose and

direction. It invites participation instead of silence and rewards strategic effort even when language is incomplete. When this approach becomes normal practice, the classroom shifts from controlled accuracy to active use, and communicative competence becomes something real rather than theoretical.

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Code-Switching Among English Majors During Group Discussions

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Abstract.

This study investigates how code-switching affects teamwork and academic communication among fourth-year university students during discussion tasks. Three group members with different proficiency levels demonstrated frequent shifts between English, Kazakh, and Russian. Although code-switching allowed quick clarification, observations revealed that it also led to uneven engagement, breakdowns in idea development, and reduced use of English. Using a small-scale research design, data were collected through a structured observation checklist, and brief semi-structured interviews. Findings show that lower-proficiency members relied on L1 for task comprehension, while higher-proficiency members code-switched mainly out of habit. An intervention based on explicit communication rules and vocabulary support was implemented. After the intervention, students used English more consistently and contributed more equally, indicating improved comprehension and task focus. The study suggests that university courses should incorporate strategy training and scaffolded academic English support to reduce unnecessary code-switching and improve collaborative learning outcomes.

Keywords: code-switching, group work dynamics, multilingual learners, communication breakdowns, language proficiency differences.

1. Introduction.

In multilingual university settings, code-switching is a common communicative practice through which speakers alternate between two or more languages to maintain interactional flow, express culturally embedded concepts, or negotiate meaning. Among English-language major students, such alternation between English and the L1 emerges naturally in informal conversation as well as during academic collaboration. Discussions require quick access to technical vocabulary, culturally specific concepts, and interpersonal nuance. Prior research indicates that in multilingual EFL cohorts – including those in Bangladesh, Indonesia, and Costa Rica – students often rely on L1 resources to sustain communication, clarify difficult points, or reduce cognitive load during group work (Alam & Quyyum, 2016; Nurhamidah et al., 2018; Ríos & Campos, 2013).

At the functional level, university classroom studies show that code-switching serves interactional, pedagogical, and social purposes. These include maintaining turn-taking, repairing misunderstandings, translating or paraphrasing challenging expressions, offering peer scaffolding, and reinforcing solidarity or humor (Yletyinen, 2004). In peer-led tasks, a single L1 insertion can trigger a chain reaction, leading the entire group to shift languages temporarily for coherence or efficiency – an effect documented in both secondary and university settings (Ríos & Campos, 2013). Types of switching observed in academic contexts range from suprasentential insertions of technical labels to full intersentential alternations for emphasis, clarification, or instruction (Nurhamidah et al., 2018).

However, research also emphasizes that uncontrolled or habitual switching may carry pedagogical costs. Over-reliance on the L1 can interrupt the development of English-based problem-solving strategies, reduce opportunities for extended target-language output, and sometimes be perceived as avoidance rather than productive communication (Nurhamidah et al., 2018). While L1 use can be facilitative during early proficiency stages, scholars argue that it should gradually shift toward more strategic and reflective use in advanced university-level EFL contexts (Alam & Quyyum, 2016). These findings highlight that the educational value of code-switching depends not on its mere presence but on its frequency, timing, and function during academic tasks.

These dynamics closely parallel our classroom situation. In our English-major group, three students of differing proficiency levels frequently alternated between English, Kazakh, and Russian during an academic discussion task. It is important to note here that by proficiency we mean the fluency of the student in combination with the frequency in which they code switch. During our discussions, we came to a question – why do students with English proficiency levels of B2-C1 switch so frequently? While some of these switches served legitimate communicative functions – such as clarifying concepts or compensating for missing vocabulary – they also created moments of misalignment, disrupted argumentative flow, and reduced opportunities for sustained English practice. For lower-proficiency participants, switching often immediately shifted the group back into L1, while higher-proficiency members reported losing rhetorical rhythms when others unexpectedly switched languages. Thus, in this setting, code-switching became a problematic team behavior with clear consequences for learning, task clarity and the overall academic quality of interaction.

The present study therefore aims to (1) examine the patterns, triggers, and perceived functions of code-switching during group discussions among English-major students, and (2) test a brief intervention designed to reduce disruptive switching and encourage more consistent use of English during academic collaboration. To investigate these questions, we employ an action research design, which allows us to observe the problem in context, collect qualitative data, implement an intervention, and evaluate its effectiveness in real time.

2. Methods

2.1 Research design

The study employed an action research design, which is appropriate for investigating a pedagogical problem within a real classroom setting and implementing an immediate intervention. Action Research involves a cyclical process of identifying a problem, collecting data, introducing a targeted change, and evaluating its effects. In the present study, the problematic behavior is frequent code-switching during English-medium group discussion. After initial observation, an intervention was implemented in which one group member acted as a peer “language instructor” to encourage more consistent English use.

2.2 Participants

The participants were three multilingual fourth-year students majoring in “Foreign Language Teaching” major with a focus on English. The high-proficiency participant (Daniya), the mid-proficiency participant (Saya), and the low-proficiency participant (Aziza) all shared Kazakh and

Russian as their primary languages. Their proficiency differences allowed us to observe how code-switching manifested and varied across linguistic levels. All participants routinely work together in group discussions during their university coursework.

2.3 Research context

The study took place during two naturally occurring group discussions as a part of a university English-language practicum course. Students were instructed to complete the tasks in English, though no strict language policy was enforced by the instructor. The multilingual nature of the group created a realistic communicative context where code-switching could occur spontaneously.

2.4 Data collection methods

To capture both the observable linguistic behavior and participants' internal reasoning behind their language choices, the study used two complementary methods:

2.4.1 Observation

Both discussions were recorded and later transcribed. An observation protocol was used to not:

- The instances of code-switching;
- The languages switched between;
- The location of the switch (suprasentential, intrasentential, intersentential)
- The immediate conversational effect (e.g., clarification, hesitation, interruption)

Separate analyses were conducted for Discussion 1 (baseline behavior) and Discussion 2 (post-intervention).

2.4.2 Semi-structured interviews

After two discussions, each participant took part in a brief semi-structured interview. The interviews followed the same four guiding questions, which explored whether switching helped or interrupted their communication; their personal triggers for switching; their perceptions of how switching affected the group discussion; reflections on the intervention, particularly how being guided by a peer language instructor influenced their language use. These interviews provided metalinguistic insight into *why* students switched, complementing the observational data on *how* and *when* switching occurred.

2.5 Procedure

Stage 1: Baseline identification. The first group discussion was recorded under normal conditions. Students were told to complete the task, but no monitoring or corrective strategy was introduced. This discussion served as the baseline for identifying the problem and documenting the natural patterns of code-switching.

Stage 2: Intervention implementation. Before the second discussion, a brief intervention was introduced. Daniya was assigned the role of a peer language instructor. Her role was to gently guide the group back to English when unnecessary switching occurred and to model consistent English use herself. No strict penalties or prohibitions were used; the intervention relied on soft prompts and awareness raising.

Stage 3: Post-intervention observation and reflection. The second discussion was recorded using the same observation protocol. Afterward, all three participants completed the interviews. The comparison between baseline and post-intervention data forms the basis for evaluating the effectiveness of the intervention.

2.6 Ethical considerations

All participants were informed about the purpose of the study and agreed to have their discussions and reflections used for research purposes. Names used in the report refer to real participants, with their consent, and all comments are reproduced respectfully and for academic purposes only.

3. Results

3.1 Observation checklist results: baseline results

In the Google Forms observation checklist, there were a total of 13 code-switching instances recorded during the baseline discussion. Intra-sentential code-switching comprised the highest number of code-switching types, accounting for 55.6% of the total code-switching instances, where the code-switching occurred within the sentence. Inter-sentential code-switching accounted for 22.2% of the code-switching instances, and the remaining 22.2% comprised short tags and

Switching because of the presence of a lexical gap or unknown English word was the predominant cause, occurring 5 times (55.6%). Other reasons included topic clarification requests (33.3%), joking/rapport building (22.2%), repairs/ hesitation pauses (11.1%), emotional highlights (11.1%), and addressing peers and teacher (11.1%).

Some cases of the switch were also accompanied by visible cues. These comprised: pause longer than 0,5 seconds (33,3%), facial expression, for example, smiling or frowning (22,2%), laughter (11,1%), overlapping speech or interruption (22,2%), and rising tone/emphasis (22,2%). Additionally, for 22,2% of the cases, there was no visible cue recorded.

The participants took turns using either the Kazakh language (44,4%), the Russian language (33,3%), or a combination of both languages (22,2%). Regarding the role of the message, referential messages were performed by 44,4% of the language alternations, with 33,3% of the language alternations performed for pragmatic purposes, and 22,2% of the language alternations involved translation.

Representative examples include:

- “Енді мен телефонсыз жүре алмаймын, өткені мен translate words.”
- “I think that we should somehow, как это сказать, балансировать...”
- “Мы можем отвлекаться, but on the other hand phones can be helpful...”
- “Banning phones типа толықтай ма или қалай?”

In 55,6% of the cases the speaker continued in English immediately after switching, while 33,3% returned to English after a short pause. In only 11,1% of instances did the speaker remain in Kazakh/Russian for more than one turn.

3.2 Observation checklist results: post-intervention

After the intervention where one of the participants acted as the peer language instructor, the overall number of switches reduced to 5. The number of intra-sentential switches continued to remain high at 60 percent, and the remaining 40 percent consisted of short tags.

The predominant cause remained the presence of lexical gaps (60%). The other causes included use of humor/joke or building rapport (40%), use of peer address, and topic clarification (20%).

Visible cues differed from the baseline discussion: laughter (60%), and facial expression changes (60%) were more common, suggesting lighter, socially oriented switches. Only one switch followed a long pause (20%). Rising tone occurred in 20% of switches.

Participants predominantly switched into Kazakh (80%), with Russian used in 20% of cases. The communicative function included referential (40%), pragmatic (20%), sociolinguistic/identity-based switching (20%), and translation or clarification (20%).

Examples include:

- “And, как это, details for note-taking.”
- “I think that, енді, наприклад, it shouldn’t be totally forbidden.”
- “Ағылшынша, let’s talk in English.”
- “Мен де келісем, they can’t do that, болмайды ғо олай.”

Noticeably, 100% of switches were followed by immediate return to English, indicating improved English-only task adherence.

3.3 Interview findings

Highly proficient participant, Daniya, reported that code-switching helped at times with precision, but sometimes it interrupted the flow, pushing the code-switcher into a 'mode' that was different. Daniya identified the trigger for code-switching as missing vocabulary, followed by habit and emotional nuance. She believed switching could make the discussion relatable but also risked confusing peers. As the language instructor, she felt more empathetic toward others' code-switching and more aware of its cognitive and emotional origins.

Mid-proficiency participant (Saya) stated that switching usually helped maintain fluency when searching for vocabulary, though unintentional shifts could interrupt her sentence structure. Her main triggers were lexical gaps, habit, and emotional intensity. She felt that code-switching was very useful for building rapport and reducing confusion, but that it could also exclude other people, since not everyone was proficient in the other language. During the intervention, she became more cautious and attempted to remain in English despite occasional lapses.

Low-proficiency participant (Aziza) described switching as a strategy to avoid communicative breakdowns. She identified missing vocabulary as her strongest trigger, supplemented by habit. She recognized that switching might confuse peers and tried to control it. Once the intervention was introduced, she reported higher levels of motivation for looking up words in English, and the atmosphere of the discussion was seen as more organized.

4. Discussion

The findings of this small-scale action research confirm that code-switching is a frequent and multifaceted phenomenon. More specifically, code-switching among English-major students in a multilingual university environment is not random but patterned, purposeful, and sensitive to task demands. The baseline observation revealed a relatively high frequency of switches ($n = 13$) during a short group discussion, with intra-sentential switches dominating and Kazakh being the most frequent L1 used. These results support prior research indicating that bilingual speakers often alternate languages at structurally convenient points to maintain fluency and cohesion (Yletyinen, 2004). The interview data further confirmed that the primary trigger across all proficiency levels was lexical gaps – echoing the literature which identifies missing vocabulary and the search for precise meaning as major drivers of code-switching in academic contexts (Nurhamidah et al., 2018).

However, our findings also show that code-switching among English-major students was rarely a breakdown phenomenon. Rather, it served several communicative functions: referential, pragmatic, and socially affiliative. Pragmatic uses (e.g., joking, rapport-building, softening disagreement) appeared in both discussions, consistent with Ríos & Campos (2013), who argue that switches maintain interpersonal harmony during peer interaction. The presence of visible cues – such as pauses, laughter, facial expressions, and changes in intonation – suggests that participants were negotiating stance, emphasis, and interpersonal alignment, all of which are known discourse functions of code-switching.

At the same time, the baseline data also reveal that such switches may unintentionally derail the English-medium focus of the task. Several switches led other group members to temporarily align into L1, momentarily shifting the discussion away from English. According to Nurhamidah et al. (2018), this kind of group-level drift can reduce English output opportunities and diminish immersion, especially in tasks requiring sustained academic discourse. The interviews reinforce this interpretation: although participants viewed switching as personally helpful, they acknowledged its potential to confuse peers, interrupt flow, or undermine the academic atmosphere.

The introduction of a light intervention generated a clear shift in behavior. The number of switches dropped from 13 to 5, and participants returned to English immediately 100% of the time after switching. Code-switching is most beneficial when guided, moderated, and embedded within

explicit expectations for English use (Alam & Quyyum, 2016). The data also show that the intervention did not eliminate switching but encouraged more controlled, purposeful use. This pattern indicates not suppression but greater metalinguistic awareness.

The shift in visible cues during the post-intervention discussion is also notable. While pauses and repair decreased, laughter and smiling became more prominent. This suggests that switching, when occurred, became more socially or emotionally motivated rather than arising from linguistic struggle. This distinction is pedagogically relevant because it shows that regulating code-switching for academic purposes does not erase its social value, instead, learners adapt and refine their multilingual behavior.

Overall, the findings show that code-switching itself is not inherently disruptive; rather, its pedagogical value depends on frequency, timing, and intentionality. In the baseline discussion switches often stemmed from linguistic gaps and negatively affected continuity. In the post-intervention discussion, switches were fewer, shorter, and more socially oriented. This shift suggests that light, peer-led scaffolding is an effective strategy for promoting English immersion without delegitimizing students' multilingual identities.

Finally, the results point toward several implications for EFL instruction in university settings. First, students benefit from explicit but supportive guidelines about language use during discussions. Second, roles like an "English monitor" or "discussion facilitator" may help maintain English-medium interaction while preserving comfort and rapport. Third, code-switching can be reframed not as a deficiency but as a resource – one that requires strategic management rather than prohibition.

5. Conclusion

This study has investigated code-switching patterns among English-major university students participating in group discussions among multilingual individuals, focusing on how different proficiency levels, task demands, and peer dynamics shaped language alternation. The baseline data showed that code-switching was frequent and primarily triggered by lexical gaps, hesitation, and the need for pragmatic or social alignment. While the behavior supported immediate comprehension and interpersonal rapport, it also occasionally shifted the discussion away from English, reduced immersion, and created moments of temporary misunderstanding among group members. These patterns align with earlier research suggesting that code-switching is a natural communicative strategy but can interfere with academic English tasks when left unregulated.

The presence of a light, peer-mediated intervention, where the group was assigned an "English monitor" who softly redirected the group toward English, resulted in a substantial decrease in the number of switches, from thirteen instances in the baseline to five in the post-intervention discussion. More significantly, the participants returned to English immediately after switching, indicating that the participants possessed a heightened metalinguistic awareness and improved task focus. Furthermore, the interview findings further demonstrated that students started demonstrating greater intentionality in their language choices and more attentive to the group's cohesion. Rather than eliminating switching altogether, the intervention helped differentiate between switches rooted in linguistic difficulty and those serving social or expressive functions. This particular objective is pedagogically valuable, as it indicates that English-medium interaction can be supported while still allowing space for multilingual identity expression.

In sum, the results of this study make it clear that code-switching per se is not the problem, but that the effects of code-switching vary depending on the degree of code-switching, the context, and the use of code-switching. With careful, guiding, and wise management, the participants have shown that they are, in fact, capable of using English dominantly for their discussions without discomfort and loss of connection. Several implications for the education of university students learning English as their foreign language emerge from the results of this study. Future studies

could examine longer-term effects or explore how task type influences switching behavior across different academic disciplines.

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Azərbaycan və fransız dillərində cümlənin müqayisəli təhlili

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Xarici dillərin tədrisi digər humanitar fənlərin tədrisindən özünün spesifikliyi ilə seçilir. Ənənəvi yanaşmaya görə, bu cür spesifiklik ilk növbədə xarici dil dərslərinin yeni məzmun verməkdən daha çox mövcud fikirləri yeni işarələr sisteminə çevirməyə xidmət etməsindən irəli gəlir. Xarici dillərin tədrisinin digər spesifikliyi isə dərslərin əvvəlki bilgilərə söykənməsi, dərslərarası zəncirvari əlaqədir ki, bu da onları dəqiq fənlərə yaxınlaşdırır. Xarici dilin tədrisi zamanı şagirdlərdə dilin komponentlərinin (tələffüz, lüğət və qrammatika) və dil bacarıqlarının (oxu, yazı, dinləmə və danışmaq) inkişaf etdirilməsi diqqət mərkəzində durur və qiymətləndirmə də müvafiq olaraq bu meyarlarla həyata keçirilir.

Biz xarici dili ana dili ilə müqayisədə öyrənirik. Fransız dilini də öyrənərkən bu xarici dil ilə Azərbaycan dili arasında mövcud olan müxtəlif linqvistik fərqlərlə rastlaşırıq. Bilirik ki, dilçiliyin bütün sahələrində bu müxtəliflik mövcuddur. Bu müxtəliflik qrammatika sahəsində daha çox diqqəti cəlb edir. Fikrimcə, qrammatika dilin tam linqvistik strukturunu özündə cəmləşdirir və daha aydın nümayiş etdirir. Fransız və Azərbaycan dilləri müxtəlif dillər qrupuna daxil olduqlarından onların qrammatik quruluşları da müxtəlifdir. Cümlə vasitəsilə bir hadisə haqqında məlumat verilir, bir şey soruşulur, bir işə təhrik olunur. Cümlənin qurulmasında sözlərlə yanaşı, söz birləşmələri də iştirak edir. Heç bir söz və ya söz birləşməsi bitmiş fikir ifadə etmədən cümlə şəklinə düşə bilməz. Bildiyimiz kimi bitmiş bir fikri ifadə edən nitq cümlə adlanır. (La phrase est une unité du discours exprimant une pensée complète). Deməli cümlə, bitmiş bir fikri ifadə edən, bir məlumat verən, sual verən, əmr edən və ya hiss-həyəcan bildirən söz və ya söz birləşməsidir; dilimizin əsas ifadə vasitəsidir, qrammatik əsası (mübtəda və xəbər) olur, bir sözdən də ibarət ola bilər ("Axsamdır"), məqsədinə görə isə nəqli, sual, əmr, nida növlərinə ayrılır. Biz düşüncə-lərimizi: məlumatlar, suallar, cavablar, hisslər, istəklər, mülahizələr və.s.ə əlaqə yaratmaqla ifadə edirik. Bundan başqa, hər bir cümlə və ya birləşmənin qrammatik baxımdan başqa, üslub keyfiyyətləri də vardır ki, bu, sadə cümlənin stilistik cəhət-lərini də əsaslandırır. Dilçilik elmində cümləyə müxtəlif təriflər verilmiş və həmin təriflər bu sahədəki fərqli baxışları üzə çıxarmışdır. Cümlənin izahında psixoloji xüsusiyyətin olması, onun danışan və dinləyənə aidliyi, nitq vahidi olaraq qrammatik faktor kimi dərk edilməsi, bununla bərabər, təfəkkürün ifadəçisi olması, demək olar ki, dilçi alimlərin əksəriyyəti tərəfdən qəbul edilmişdir. Cümlədən danışarkən bəzən məna, bəzən isə qrammatik forma əsas hesab edilir.

Düşüncələrin ifadə tərzləri şifahi nitqdə adətən intonasiyalar vasitəsilə, yazıda isə durğu işarələri ilə (nöqtə, nöqtə-vergül, iki nöqtə, sual, nida və.s) bitir. Hər iki dildə (həm fransız, həm azərbaycan) cümlələr quruluşuna görə iki yerə bölünür: sadə və mürəkkəb.

Fransız dilində də sadə cümlələrdə bitmiş bir fikir ifadə olunur, buna görə də bunlara müstəqil cümlə də deyilir.

İfadə tərzlərinə görə cümlələr: nəqli, sual, əmr, nida olmaqla fərqləndirilir. Bu cümlələrin hər birinin təsdiq və ya inkar forması ola bilər. Nida cümlələrinin adətən həyəcanlı xüsusiyyəti olur.

Sadə nəqli cümlə. Sadə nəqli cümlə fransız dilində söz sırası ilə xarakterizə olunur, yəni, baş üzvlər: mübtəda ilə xəbər cümlənin əvvəlində gəlir və düşən intonasiya ilə ifadə olunur. Azərbaycan dilində isə bildiyimiz kimi mübtəda cümlənin əvvəlində, xəbər isə sonunda gəlir.

Təsdiq forması: Ex:J'écris au tableau les mots nouveaux – mən lövhəyə yeni sözləri yazıram.

İnkar forması: Ex:Je n'écris pas au tableau les mots nouveaux - mən lövhəyə yeni sözləri yazmıram.

Sual forması:Sual cümləsi müxtəlif üsullarla düzəlir:

a) İntonasiya vasitəsilə - bu zaman cümlə olduğu kimi qalır, ancaq səsimizin tonu sual şəklində səslənir, yazıda cümlənin sonuna sual işarəsi qoyulur.

Ex:Les enfant vont à l'école. Les enfant vont à l'école ?

b) Hər hansı bir cümlənin əvvəlinə “ est-ce-que” sual ifadəsi artırmaqla (“ est-ce-que” azərbaycan dilinə “ mı⁴” kimi tərcümə olunur). Bu ifadə fransız dilində cümlənin əvvəlində, cümlədən ayrı yazılır. Azərbaycan dilində isə cümlənin sonunda, sözə bitişik yazılır)

Ex:Est-ce que le professeur entre dans la classe ? – müəllim sinfə daxil olurmu?

Əgər “ est-ce que” ifadəsindən sonra gələn söz saitle başlayarsa onda “ que” ifadəsindəki “ e ” düşür, əvəzinə apostrof (') qoyulur.

Ex:Est-ce qu'il parle à sa mère ?

c) İnversiya (yerdəyişmə) vasitəsilə düzələn sual cümlələri. Bu növ sual cümlələri fransız dilinə məxsusdur. İnversiya iki yolla düzəlir.

1.Sadə inversiya (l'inversion simple)

2.Mürəkkəb inversiya (l'inversion composé)

Sadə inversiya:Əgər cümlənin mübtədası şəxs əvəzliyi ilə ifadə olunarsa bu zaman sadə inversiyadan istifadə olunur.

Ex:Tu es étudiant – sən tələbəsan

Ex:Es -tu étudiant – sən tələbəsan ?

Sadə inversiya zamanı nəqli cümlədəki söz sırasında dəyişiklik edilir, yəni, şəxs əvəzliyi ilə xəbərin yeri dəyişilir, ortaya defis işarəsi qoyulur.

Qeyd: Bəzi sual ifadələri vasitəsilə:

1. N'est ce pas – elə deyilmi?

Ex:Michel est marié , n'est ce pas ? (söz sırası düz, ardıcıl olur)

2.Mübtədası şəxs əvəzliyi ilə ifadə olunan cümlədə 1-ci şəxs təkdən başqaları inversiya edilir.

Ex:Tu lis ce livre ? – Lis-tu ce livre ?

Mürəkkəb inversiya: Mübtədası isimlə ifadə olunan cümlələri sual formasına saldıqda mürəkkəb inversiya edilir. Mürəkkəb inversiya etdikdə mübtəda və xəbər öz yerlərində qalır, xəbərdən sonra mübtəda ilə eyni kəmiyyətdə və eyni cinsdə şəxs əvəzliyi əlavə olunur. Əgər cümlənin xəbəri 3-cü şəxsin təkində saitle bitərsə, xəbərlə şəxs əvəzliyinin arasına “ t ” samiti qoyulur.

Ex:Michel fait-il ses études à l'Université ?

Ex:Samira étudie-t-elle ces verbes ?

Əgər cümlənin mübtədası müxtəlif cinsli iki və daha çox isimlə ifadə olunarsa bu zaman cəmdə olan kişi cinsli şəxs əvəzliyi işlədilir.

Ex:Marcel et Claire travaillent-ils à la fabrique ?

Cansız vasitəsiz tamamlığın sualının düzəldilməsi

İsimlə ifadə olunmuş cansız vasitəsiz tamamlığa “ que ” sual əvəzliyi vasitəsilə sual verilir.

Ex:Il lit ce livre – Que lit-il ?

Ex:Aleksandr prépare le petit déjeuner à sa fille – Que Aleksandr prépare-t-elle à sa fille ?

Ex:Benzema prépare le café – Que prépare Benzema ?

Danışıq dilində “que” sual əvəzliyinin yerinə çox vaxt “qu'est-ce que” sual ifadəsi işlədilir. Bu ifadə “que” sual əvəzliyindən və “est-ce que” sual ifadəsindən ibarətdir. “ Est-ce que” sual ifadəsində olduğu kimi “qu'est-ce que” sual ifadəsindən sonra da cümlədə söz sırası nəqli cümlədəki kimi olur.

Ex:Qu'est-ce qu'il lit ?

Ex:Qu'est-ce que Aleksandr prépare elle à sa fille ?

Əgər mübtəda 1-ci şəxsin tək əvəzliydirsə (je) “qu'est-ce que” sual ifadəsinin işlədilməsi zəruridir.

Ex:Qu'est-ce que je prépare ?

Bu ifadə bir neçə 3-cü qrup feili müstəsna olmaqla bütün feillərlə işləyə bilər. Həmin 3-cü qrup feilləri ilə işləyən cümlələrdə həm “que” həm də “qu’est-ce que” vasitəsilə sual verilir.

Ex: Qu’est-ce que j’apporte ?

Ex: Qu’est-ce que je dit ?

Que dis-je ?

Ex: Qu’est-ce que je fais ?

Que fais-je ?

Où sual zərfləri

Yer zərfliyinə sual vermək üçün où – *hara ? haraya?harada ?* sual zərfindən istifadə olunur.

Ex: Où travaille-t-il ? – Il travaille dans une banque

Où sual zərfi ilə başlayan cümlələrdə söz sırası

1. Əgər cümlənin mübtədası şəxs əvəzliyi ilə ifadə olunubsa sual cümləsində inversiya edilir.

Ex: Où va-t-il après les cours ?

Mübtədə 1-ci şəxsin tək əvəzliyi ilə ifadə olunubsa, sual cümləsi “est-ce que” ilə düzəliş, belə ki “est-ce que” **où** sual zərfindən sonra işlənir.

Ex: Où est-ce que je travaille ?

2. Cümlənin mübtədası isimlə ifadə olunubsa, həm sadə, həm də mürəkkəb inversiya edilə bilər.

D’où(de + où) (haradan ?) sual zərfi ilə düzələn cümlələrdə söz sırası **où** sual zərfi ilə düzələn cümlələrdəki kimi olur.

Ex: D’où viennent ces jeunes filles ? - D’où ces jeunes filles viennent-elles ?

Ex: D’où Valentine apporte-t-elle ces livres ?

Ex: D’où est-ce que j’apporte des fraises ?

Quand, comment sual zərfləri. Quand, comment zərfləri ilə başlayan sual cümlələrində söz sırası **où** sual zərfi ilə başlanan cümlələrdə olduğu kimidir.

Quand? sual zərfi vasitəsilə cümlədə zaman zərfliyinə sual verilir. **Comment?** sual zərfi vasitəsilə aşağıdakı cümlə üzvlərinə sual verilir.

1. Tərzi-hərəkət zərfliyinə (necə ? nə cür ?)

Ex: Comment écrit-il les dictées? – O, imlaları necə yazır ?

Ex: Il écrit bien les dictées – O, imlaları yaxşı yazır. Comment écrit-il les dictées?

Ex: Il les écrit bien – O, onları yaxşı yazır. Comment les écrit-il?

2. İsmi xəbərin sifətlə ifadə olunmuş xəbərin ad hissəsinə (necə? nə cür?)

Ex: Notre appartement est très confortable – bizim mənzilimiz çox rahatdır

Comment est votre appartement ? – Sizin mənziliniz necədir ?

Quand, comment zərfi ilə başlanan sual cümlələrində söz sırası

Quand, comment zərfləri ilə başlayan sual cümlələrində söz sırası **où** sual zərfi ilə başlanan cümlələrdə olduğu kimidir. Quand, comment zərfləri ilə başlayan sual cümlələrində söz sırası **où** sual zərfi ilə başlanan cümlələrdə olduğu kimidir.

1. Əgər mübtədə əvəzliliklə ifadə olunubsa, sadə inversiya edilir.

Ex: Quand venez-vous ?

Ex: Comment prononcent-ils ces mots ?

2. Əgər mübtədə isimlə ifadə olunubsa, həm sadə həm də mürəkkəb inversiyadan edilə bilər

Cümlənin həm mübtədası həm də vasitəsiz tamamlığı isimlə ifadə olunubsa, yaxud cümlədə yer zərfliyi varsa onda mütləq mürəkkəb inversiya edilməlidir.

Ex: Quand votre mère arrive-t-elle de la campagne ?

Ex: Comment Michel répond-il à tes questions ?

Canlı mübtədəyə “ qui? ” – “ kim? ” sual əvəzliyi vasitəsilə sual verilir.

Ex: Il va à la gare - Qui va à la gare ?

Ex: Elle travaille à la fabrique - Qui travaille à la fabrique ?

Əmr şəkli (Mode impératif)

Feilin əmr şəkli əmr, xahiş, məsləhət, təklif, nəsihət bildirir. Feilin əmr şəkli məzmunca indiki, yaxud gələcək zamanı bildirir. Əmr şəklini düzəltmək üçün feili “Présent de l’indicatif-də II

şəxsin tək, I və II şəxsin cəmində götürüb, şəxs şəkilçisini atmaq lazımdır. 1-ci qrup feilləri vəl-ci qrup feilləri kimi təsərif olunan III qrup feillərində və “aller” feilində II şəxsin təkində “-s” düşür. Əmr cümləsi adətən xəbərlə başlayır və bu cümlənin sonuna nida işarəsi qoyulur. Əmr cümləsinin əvvəlində xitab da işləyə bilər, bu zaman müraciət olunan şəxsin adından sonra vergülişarəsi qoyulur.

Ex :Lucie, prends ton livre! – Lüsi, kitabını götür!

Ex :Tu parles- Sən danışırısan Parle! - Danış!

Vous parlez – Siz danışırırsınız Parlez!- Danışın!

Nous parlons – Biz danışırıq Parlons!- Danışaq!

Lakin bu feillərdən sonra “**en, y**” zərfəvəzlilikləri işlənərsə, “-s” şəkilçisi düşmür.

Tu parles de tes souvenirs d'enfance. - Sən uşaqlıq xatirələrindən danışırısan.

Parles-en! – Ondan danış!

Tu vas à ta place. - Sən yerinə gedirsən.

Va à ta place! – Yerinə get!

Tu y vas. Sən ora gedirsən.

Vas-y! - Ora get!

Mürəkkəb cümlə - (la phrase complexe)

Azərbaycan dilində olduğu kimi fransız dilində də mürəkkəb cümlənin iki növü vardır.

1. La proposition de coordination – Tabesiz mürəkkəb cümlə

Tabesiz mürəkkəb cümlə iki sadə cümlənin birləşməsindən əmələ gəlir.

Bu cümlələr bir-birinə ya vergüllə, ya da tabesizlik bağlayıcıları ilə bağlanır.

Ex :On sonne, le maître entre dans la classe. - Zəng vurulur, müəllim içəri daxil olur.

Les conjonctions de coordination – Tabesizlik bağlayıcıları.

Bu bağlayıcılar iki və daha çox sadə cümləni bir-birinə bağlayır.

et- və, ou-ya, ya da, ni, ni-nə, nədə, mais-lakin, amma, cependant – halbuki, pourtant- baxmayaraq, donc - beləliklə, car- beləki, c'est pourquoi - bunun üçün

Ex : Le train courait à grand vitesse et par la portière ouverte nous voyions les champs, les forêts, les montagnes - Qatar böyük sürətlə gedirdi və biz açıq pəncərədən çölləri, meşələri, dağları görürdük.

Ex :Le premier janvier est une grande fête, car nous célébrons le Nouvel An. - 1 yanvar böyük bayramdır, belə ki, biz yenii liqeyd edirik.

Ex : Lili est très belle, mais elle a un caractère insupportable. - Lili çox qəşəngdir, amma, onun dözülməz xasiyyəti var.

Ex : Michel n'a pas eu le temps de tout faire, pourtant il s'est levé très tôt. - Tezdən durmağına baxmayaraq, Mişelin hər şeyi etməyə vaxtı çatmadı.

Demain, c'est le 21 mars, donc les enfants auront une semaine de vacances de printemps. - Sabah 21 martdır, beləliklə, uşaqların bir həftə yaz tətili olacaq.

La proposition de subordination – Tabeli mürəkkəb cümlə

Tabeli mürəkkəb cümlənin bir tərəfi o biri tərəfə tabe olur. Tabe edən tərəf baş cümlə tabe olan tərəf isə budaq cümlə adlanır və baş cümləyə tabelilik bağlayıcıları ilə bağlanır. Tabelilik bağlayıcıları aşağıdakılardır:

Qui - mübtəda budaq cümləsinə (proposition subordonnée de sujet) baş cümləyə bağlayır.

Qui cherche trouve. – Axtaran tapar.

Qui langue a, à Rome va. – Çox dil bilən yol biləndir..

Que, qui, dont, où – təyin budaq cümləsinə (proposition subordonnée d'attributive) baş cümləyə bağlayır.

Ex :Nous voyons les garçons qui jouent au football. – Biz futbol oynayan oğlanları görürük.

Ex : Les jeunes filles que vous voyez devant la caisse sont mes sœurs. – Kassanın qabağında gördüyünüz qızlar mənim bacılarımdır.Etc....

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PEDAGOGICAL CONDITIONS FOR EFFECTIVE INSTRUCTION IN OCCUPATIONAL HEALTH AND SAFETY FUNDAMENTALS WITHIN THE SYSTEM OF HIGHER EDUCATION

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Abstract. In the context of increasing professional risks, digitalization of production processes, and rising demands for safe professional behavior, the improvement of occupational health and safety (OHS) education in higher education has become a pressing pedagogical challenge. This study aims to theoretically substantiate and experimentally verify pedagogical conditions for effective instruction in the fundamentals of occupational health and safety in higher education. The research was conducted at Ilyas Zhansugurov Zhetysu University and involved 92 undergraduate students divided into control and experimental groups. The experimental design integrated Scenario-Based Learning and Reflective Learning Circles, supported by a Competency-Based Assessment Framework. Quantitative analysis was performed using the Effectiveness Growth Index and comparative gain indicators. The results demonstrate a significantly higher level of competency development in the experimental group compared to the control group, particularly in cognitive-behavioral and motivational-value components of OHS culture. The findings confirm that the systematic integration of active and reflective pedagogical methods enhances students' professional readiness for safe occupational behavior and supports the sustainable formation of occupational safety culture in higher education.

Keywords: occupational health and safety education; higher education; pedagogical conditions; scenario-based learning; reflective learning circles; safety culture; competency-based assessment; professional risk prevention

In the context of socio-economic transformations, the digitalization of production processes, and the increasing complexity of professional activities across various fields, the issue of ensuring safe working conditions and fostering a sustainable culture of occupational health and safety among future specialists becomes particularly relevant. The modern system of higher education is oriented not only toward the transmission of professional knowledge and skills, but also toward the preparation of graduates capable of acting consciously in conditions of professional risk, complying with regulatory safety requirements, and assuming responsibility for the preservation of their own life and health, as well as that of others. In this regard, instruction in the fundamentals of occupational health and safety within higher education functions as a significant component of professional training and requires scientifically grounded pedagogical support.

Despite the existence of a regulatory and legal framework and the mandatory inclusion of occupational health and safety-related disciplines in higher education curricula, their practical implementation is often characterized by fragmentation, formalism, and insufficient orientation toward professionally relevant situations. Instruction is frequently reduced to the assimilation of theoretical provisions and regulatory requirements without their deep comprehension or practical application. This leads to a decline in student motivation, superficial knowledge acquisition, and an inadequate formation of competencies that ensure safe professional behavior. This situation indicates the need to reconsider pedagogical approaches to teaching the fundamentals of occupational health and safety and to identify the conditions that ensure its effectiveness within the system of higher education.

Contemporary pedagogical research emphasizes that learning effectiveness is determined not only by the content of instructional material, but also by the set of pedagogical conditions under which the educational process is implemented. Such conditions include the purposeful integration of occupational health and safety content into professionally oriented disciplines, the use of active and interactive teaching methods, the modeling of real and potentially hazardous occupational situations, as well as the organization of systematic monitoring and assessment of the formation of relevant competencies. The implementation of these conditions makes it possible to transform instruction in occupational health and safety from a formal component of the curriculum into an effective instrument for the professional and personal development of students.

Of particular importance in this context is pedagogical modeling of the educational process oriented toward the formation of a conscious attitude to occupational safety issues. The use of case-based methods, problem-oriented and scenario-based learning, as well as simulation and digital technologies, contributes to the activation of students' cognitive activity, the development of analytical thinking, and the ability to make well-reasoned decisions under conditions of professional risk. Such approaches ensure a transition from the reproductive acquisition of knowledge to the activity-based mastery of occupational health and safety content, which corresponds to the contemporary requirements of the competency-based paradigm of higher education.

The scientific literature notes that the formation of an occupational health and safety culture is a complex and multi-level process that includes cognitive, value-motivational, and behavioral components. Effective instruction in the fundamentals of occupational health and safety is possible only under conditions of their integrated development, which requires systematic pedagogical support. In this regard, particular relevance is attached to the identification and substantiation of pedagogical conditions that ensure the coordinated formation of knowledge, skills, abilities, and professionally significant personal qualities of students aimed at compliance with safety standards and the prevention of occupational risks.

Thus, the relevance of the present study is determined by the contradiction between the social and professional demand for training specialists with a high level of occupational health and safety culture and the insufficient scientific and methodological elaboration of pedagogical conditions for effective instruction in occupational health and safety within the system of higher education. Under conditions of modernization of educational programs and the introduction of innovative pedagogical technologies, there emerges an objective need for the theoretical substantiation and experimental verification of a set of pedagogical conditions that contribute to enhancing the effectiveness of teaching the fundamentals of occupational health and safety. This determines the purpose of the study, which consists in the theoretical substantiation and experimental verification of pedagogical conditions for effective instruction in occupational health and safety in higher education, and also necessitates the formulation of corresponding research objectives aimed at improving higher education instructional practice.

In scientific research over the past decade, the problem of teaching the fundamentals of occupational health and safety (OHS) in higher education has been examined within the broader context of the transformation of professional training aimed at developing sustainable competencies for safe professional activity. International studies emphasize that traditional, normatively oriented approaches to OHS education fail to ensure an adequate level of learners' awareness and behavioral readiness for managing occupational risks. In particular, Hämäläinen and Saarela (2020) argue that the predominance of reproductive instructional practices constrains the development of systems thinking in the field of safety and significantly reduces the transfer of acquired knowledge into professional practice [1].

Contemporary scholars increasingly conceptualize occupational health and safety as an integrative pedagogical phenomenon closely linked to the formation of the professional identity of future specialists. Fadier, De la Garza, and Didelot (2021), for instance, interpret safety education as a process of constructing professional experience, in which risk analysis and error management function as core didactic mechanisms [2]. A similar perspective is articulated by Márquez, González, and Hernández (2021), who emphasize that embedding OHS content within professionally oriented disciplines facilitates students' holistic understanding of the interdependence between production processes and safe occupational behavior [3].

In a meta-analytic study, Salas et al. (2020) demonstrate that scenario-based and simulation-based learning leads to significantly higher levels of behavioral safety skill acquisition compared to traditional instructional formats [4]. These findings are corroborated by Burke et al. (2021), who show that active learning strategies exert a meaningful influence not only on the cognitive dimension, but also on the behavioral component of occupational safety culture [5].

A distinct strand of research addresses the digitalization of OHS education in higher education. Radianti et al. (2020), along with Makransky and Petersen (2021), substantiate the high pedagogical potential of virtual and augmented reality technologies for modeling hazardous professional situations, highlighting their effectiveness in fostering practice-oriented competencies while minimizing real-world risks [6; 7]. At the same time, these authors emphasize that the mere use of digital technologies does not automatically guarantee educational effectiveness and must be supported by pedagogically grounded instructional design and integration.

From the standpoint of contemporary didactics, the effectiveness of OHS education is determined by the coherence among learning objectives, content, instructional methods, and assessment systems. Within the framework of constructive alignment theory, Biggs and Tang (2022) argue that discrepancies between intended learning outcomes and applied pedagogical strategies significantly diminish educational effectiveness, particularly in applied and interdisciplinary domains such as occupational health and safety [8]. This argument is further developed in the work of Lohmeyer and Taylor (2021), who underscore the importance of reflective practices and formative assessment in the teaching of safety-related disciplines [9].

Psychological and pedagogical dimensions of occupational safety culture formation also occupy a prominent place in international research. Reason (2020) conceptualizes safety as the outcome of complex interactions among individual, organizational, and educational factors, emphasizing the critical role of educational institutions in the prevention of occupational risks [10]. Similarly, Griffin and Neal (2021) demonstrate that students' motivational engagement constitutes a decisive factor in compliance with OHS standards, thereby necessitating targeted pedagogical interventions aimed at strengthening intrinsic motivation and responsibility [11].

Kolb et al. (2021) substantiate the effectiveness of experiential learning approaches, in which students master the fundamentals of occupational health and safety through the analysis of professional situations, structured reflection, and practical action [12]. In turn, Zhao, McCoy, and Kleiner (2022) show that the implementation of a comprehensive set of pedagogical conditions including content integration, active instructional methods, and systematic assessment results in

a statistically significant increase in OHS-related competencies among students across diverse fields of study [13].

Despite the substantial body of existing research, a critical analysis of the literature reveals several unresolved issues. The majority of studies focus either on individual pedagogical technologies or on specific digital tools, whereas a comprehensive substantiation of pedagogical conditions for effective instruction in the fundamentals of occupational health and safety within higher education remains insufficiently developed. Moreover, relatively few studies propose models oriented toward the systemic integration of OHS education into professional training and their experimental validation. These gaps underscore the need for further research aimed at the development and empirical testing of pedagogically grounded models for teaching occupational health and safety in the system of higher education.

The methodological framework of the study was grounded in contemporary pedagogical and assessment approaches aligned with the competency-based model of higher education and the development of occupational health and safety (OHS) culture among future specialists. The empirical study was conducted at Ilyas Zhansugurov Zhetysu University and involved 92 second- and third-year undergraduate students enrolled in pedagogical and engineering-technical degree programs.

Participants were assigned to an experimental group ($n = 47$) and a control group ($n = 45$) based on comparability in baseline knowledge levels, age characteristics, and academic performance, which ensured the validity of the comparative analysis. No statistically significant differences between the groups were identified at the pre-test stage.

Scenario-Based Learning (SBL) served as the primary didactic method. The approach was originally developed by Jonassen (2011) and further conceptualized by Errington (2014). SBL involved the systematic modeling of professionally relevant situations associated with potential occupational risks and violations of OHS regulations. Within the learning process, students analyzed scenarios, identified sources of hazard, developed safe action strategies, and justified their decisions. The implementation of SBL was designed to support the development of both cognitive and behavioral components of OHS competencies.

The assessment of professional competence formation was conducted using the Competency-Based Assessment Framework (CBAF) proposed by Mulder (2014) and adapted for higher education contexts by Biemans et al. (2020). Assessment was carried out according to predefined criteria:

- (1) ability to identify occupational risks;
- (2) justification of selected safe actions;
- (3) correctness in applying OHS regulatory requirements;
- (4) quality of decision-making argumentation.

Each criterion was evaluated using a four-level rating scale, allowing for the generation of quantitative indicators of competency development.

The motivational and value-based component of OHS culture was assessed through Reflective Learning Circles (RLC), developed by Korthagen (2017). This method involved structured reflective sessions during which students analyzed their actions in simulated scenarios and articulated their personal attitudes toward occupational safety. Evaluation criteria included awareness of the significance of OHS, the level of professional responsibility, and the capacity for self-reflection.

To quantify the effectiveness of the implemented pedagogical conditions, the Effectiveness Growth Index (EGI) was employed. This index has been used in educational research by Hattie (2012) and adapted for comparative experimental designs by Zhao et al. (2022). The EGI was calculated using the following formula:

$$EGI = \frac{(X_{post}^{EG} - X_{pre}^{EG}) - (X_{post}^{CG} - X_{pre}^{CG})}{X_{max} - X_{min}}$$

Where

X_{post}^{EG} and X_{pre}^{EG} represent the post-test and pre-test mean scores of the experimental group;

X_{post}^{CG} and X_{pre}^{CG} represent the corresponding values for the control group;

X_{max} and X_{min} denote the maximum and minimum possible values of the assessment scale.

The application of this index enabled the identification of competency growth attributable specifically to the experimental pedagogical intervention while controlling for the effects of natural learning progression.

Additionally, the magnitude of the pedagogical effect was estimated using Cohen's d , a widely accepted measure in educational and psychological research:

$$d = \frac{M_{EG} - M_{CG}}{SD_{pooled}}, SD_{pooled} = \sqrt{\frac{SD_{EG}^2 + SD_{CG}^2}{2}}$$

Where

M_{EG} and M_{CG} are the mean scores of the experimental and control groups, respectively;

SD_{EG} and SD_{CG} are the corresponding standard deviations.

The combined use of contemporary pedagogical approaches (Scenario-Based Learning, Competency-Based Assessment Framework, and Reflective Learning Circles) together with quantitative analytical indicators (Effectiveness Growth Index and Cohen's d) ensured the methodological rigor, objectivity, and reproducibility of the study. This methodological design enabled a valid and reliable evaluation of the effectiveness of pedagogical conditions for teaching the fundamentals of occupational health and safety in higher education.

At the first stage of results analysis, the dynamics of the formation of cognitive and behavioral components of occupational health and safety competencies developed through scenario-based learning were examined. Particular attention was given to changes related to students' ability to identify occupational risks, justify the selection of safe action strategies, and provide reasoned arguments for decision-making in simulated professional situations. A comparative analysis of pre-test and post-test indicators made it possible to determine the nature and direction of changes in both the experimental and control groups (fig.1).

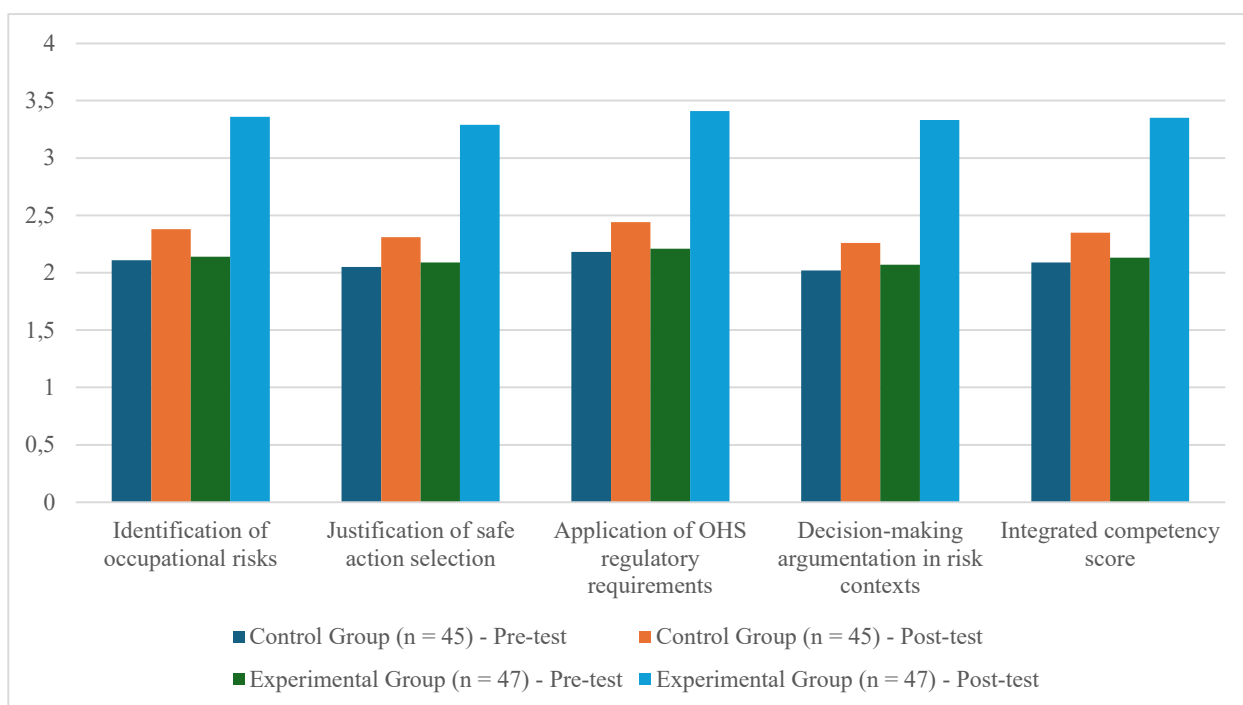


Fig.1. Mean Scores of Occupational Health and Safety Competencies Before and After the Pedagogical Intervention

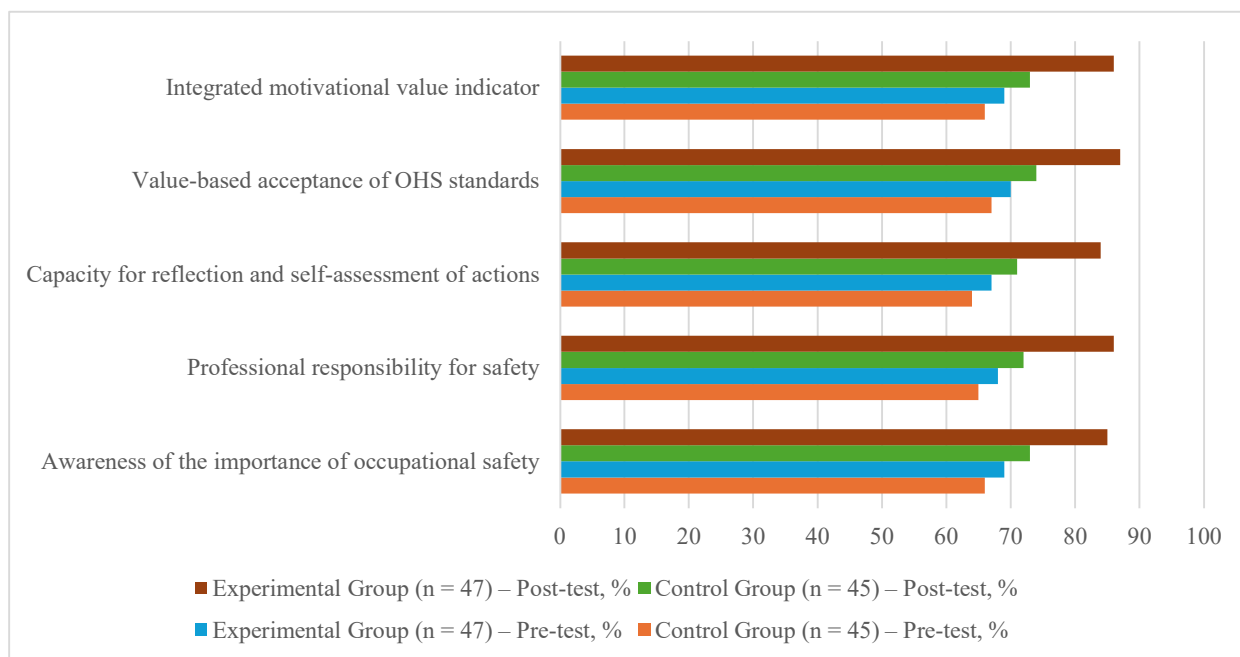
The obtained results indicate fundamentally different trajectories in the development of occupational health and safety competencies among students in the control and experimental groups. The modest increase observed in the control group may be interpreted as a consequence of traditional instruction focused primarily on the assimilation of normative and theoretical content, where learning is largely oriented toward the reproductive reproduction of knowledge. This pattern of change corroborates findings reported in previous studies, which demonstrate that, in the absence of learners' active engagement in risk analysis and decision-making processes, occupational safety education fails to facilitate the transition from declarative knowledge to practice-oriented action. The lack of pronounced improvement in decision-making argumentation and risk identification further indicates the limited capacity of traditional pedagogical approaches to support the formation of the behavioral component of occupational safety culture.

In contrast, the experimental group demonstrated a stable and substantial increase across all assessment criteria, allowing scenario-based learning to be considered an effective pedagogical tool for the development of practice-oriented occupational health and safety competencies. The significant improvement in professional risk identification and the justification of safe action strategies can be attributed to the fact that scenario-based modeling creates a cognitively rich learning environment closely aligned with real professional conditions. Within such environments, students are required to integrate regulatory knowledge, analytical skills, and personal responsibility, which contributes to the formation of устойчивых patterns of professional thinking and a conscious attitude toward occupational safety issues.

Particular importance is attached to changes in the integrated competency indicator, which reflects the systemic nature of the pedagogical intervention. The growth of this indicator in the experimental group suggests not only the acquisition of individual elements of occupational safety knowledge, but also the formation of a coherent competency structure encompassing cognitive, behavioral, and regulatory components. From a pedagogical perspective, these findings confirm the effectiveness of scenario-based learning in facilitating the transition from fragmented knowledge acquisition to holistic professional readiness. The results are consistent with contemporary international research emphasizing that the modeling of professionally significant

situations represents a key condition for fostering occupational safety culture in higher education and for ensuring the sustainability of learning outcomes beyond the classroom context.

Within the analysis of the second method, the dynamics of the motivational and value-based component of occupational health and safety culture, developed through reflective engagement with learning and professional experience, were examined. Particular attention was paid to the comparison of baseline indicators in the control and experimental groups, which were comparable in terms of initial levels of development, as well as to the assessment of change patterns following the implementation of reflective practices. This analytical approach minimized the influence of initial differences and enabled a more objective evaluation of the pedagogical



effect of the applied method (fig.2).

Fig.2. Dynamics of the Motivational and Value-Based Component of Occupational Health and Safety Culture (%)

The analysis of results obtained through the application of the Reflective Learning Circles method demonstrates a positive dynamic in the development of the motivational and value-based component of occupational health and safety culture among students in both groups, given comparable baseline indicators. The relatively small difference in initial values between the control and experimental groups (3-4 percentage points) indicates that the observed post-intervention changes cannot be attributed to initial sample heterogeneity. The moderate increase in indicators observed in the control group reflects a natural enhancement of awareness and responsibility within the framework of traditional instruction; however, this growth remains limited and does not lead to a substantial transformation of internal attitudes that underpin the sustainable observance of occupational safety standards.

In the experimental group, a more pronounced increase across all assessment criteria was identified, indicating the targeted impact of reflective practices on the development of internal regulators of safe professional behavior. Structured reflection on learning and professional experience facilitates the comprehension of cause-effect relationships between professional actions and their potential consequences, thereby strengthening the personal internalization of occupational safety norms. The growth observed in professional responsibility and value-based acceptance of safety requirements suggests a transition from externally imposed norms to internally motivated behavior, which is regarded in pedagogical theory as a key prerequisite for the sustainability of educational outcomes.

Particular significance is attributed to the integrated motivational-value indicator, which reflects the systemic nature of the changes induced by reflective instructional methods. The achievement of high post-test values in the experimental group, in the absence of abrupt fluctuations, allows the results to be interpreted as the outcome of a consistent and pedagogically grounded process of occupational safety culture formation. Collectively, the findings confirm that Reflective Learning Circles function as an effective complement to active instructional methods by deepening the personal meaning of professional safety and creating conditions for the long-term adherence to occupational health and safety standards in future professional practice.

To quantitatively assess the effectiveness of the reflective method, percentage indicators were used to represent the proportion of students who achieved sufficient and high levels of development of the motivational and value-based component of occupational health and safety (OHS) culture. An integrated indicator was applied as a summary measure. Its values were as follows:

- Control group: 66% (pre-test) and 73% (post-test);
- Experimental group: 69% (pre-test) and 86% (post-test).

The absolute gain in the control group was:

$$\Delta CG = 73 - 66 = 7 \text{ percentage points (pp)}$$

The absolute gain in the experimental group was:

$$\Delta EG = 86 - 69 = 17 \text{ pp}$$

The difference in gains between the experimental and control groups was therefore:

$$\Delta_{diff} = 17 - 7 = 10 \text{ pp}$$

These values indicate a more pronounced positive dynamic in the experimental group, associated with the implementation of reflective practices.

To determine the net effect of the pedagogical intervention, the Effectiveness Growth Index (EGI) was calculated using the following formula:

$$EGI = \frac{(X_{post}^{EG} - X_{pre}^{EG}) - (X_{post}^{CG} - X_{pre}^{CG})}{100}$$

Substituting the empirical values yields:

$$EGI = \frac{(86 - 69) - (73 - 66)}{100} = \frac{17 - 7}{100} = 0.10$$

The obtained value of $EGI = 0.10$ indicates a moderately expressed but pedagogically meaningful effect of the Reflective Learning Circles method on the formation of the motivational and value-based component of OHS culture.

The relative gain in the experimental group was calculated as:

$$RG_{EG} = \frac{86 - 69}{69} \times 100 = 24.64\%$$

The relative gain in the control group was:

$$RG_{CG} = \frac{73 - 66}{66} \times 100 = 10.61\%$$

Thus, the relative gain in the experimental group exceeds that of the control group by more than 2.3 times, providing additional evidence of the targeted impact of reflective practices on the development of stable value orientations related to occupational safety.

The results of the quantitative analysis demonstrate that the observed changes cannot be explained solely by natural educational progression. The moderate increase in the control group reflects the background effect of traditional instruction, whereas the substantially higher gains and the EGI value observed in the experimental group confirm the effectiveness of Reflective Learning Circles as a pedagogical method aimed at fostering an internally motivated and conscious attitude toward occupational health and safety. The quantitative findings are consistent with qualitative observations and indicate the systemic nature of the pedagogical intervention, contributing to the sustainability of educational outcomes.

The present study substantiated the effectiveness of a set of pedagogical conditions aimed at improving instruction in the fundamentals of occupational health and safety (OHS) within the system of higher education. The findings demonstrate that traditional, predominantly normative approaches to OHS education ensure only limited progress in students' competency development and do not sufficiently support the formation of practice-oriented, value-based, and behaviorally sustainable safety competencies. In contrast, the purposeful integration of active and reflective pedagogical methods significantly enhances the quality and depth of students' learning outcomes.

The implementation of Scenario-Based Learning contributed primarily to the development of cognitive and behavioral components of OHS competencies by immersing students in professionally relevant risk situations that required analytical reasoning, decision-making, and justification of safe action strategies. Reflective Learning Circles, in turn, proved effective in strengthening the motivational and value-based foundations of occupational safety culture, facilitating the internalization of safety norms and the development of professional responsibility. Quantitative analysis confirmed that the observed improvements in the experimental group were not attributable to natural learning progression, as evidenced by the Effectiveness Growth Index and comparative gain indicators.

Overall, the results confirm that the formation of a sustainable occupational health and safety culture in higher education requires a systemic pedagogical approach that combines scenario-based modeling, reflective practices, and competency-oriented assessment. The proposed pedagogical framework ensures not only measurable growth in OHS-related competencies, but also their internal consolidation, which is essential for long-term compliance with safety standards in professional practice. The findings of this study contribute to the advancement of pedagogical theory and practice in OHS education and may serve as a methodological basis for the modernization of higher education curricula.

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LEARNING ENGLISH THROUGH FAIRY TALES: STUDYING ENGLISH WITH THE HELP OF KAZAKH FAIRY TALES AND AI IN PRIMARY SCHOOL

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This article explores the integration of Kazakh fairy tales with artificial intelligence (AI) tools in the process of teaching English to primary school learners. The purpose of this study is to investigate how the combination of culturally meaningful storytelling and modern digital technologies can improve the process of language acquisition. The research employed linguistic analysis of fairy tales, AI-generated interactive exercises, classroom observation, and learner motivation surveys. The findings indicate that the use of AI-supported tasks based on Kazakh fairy tales contributes to the enrichment of students' vocabulary, improves their text comprehension, and increases their engagement during lessons. The integration of traditional narrative materials with adaptive AI technologies creates an effective and age-appropriate learning environment. This approach supports both language development and the understanding of national cultural values among young learners.

Keywords: Kazakh fairy tales, artificial intelligence, English learning, primary school, storytelling, motivation, digital education

ИЗУЧИТЬ АНГЛИЙСКОГО ЯЗЫКА ЧЕРЕЗ СКАЗКИ: ОБУЧЕНИЕ АНГЛИЙСКОМУ ЯЗЫКУ С ПОМОЩЬЮ КАЗАХСКИХ СКАЗОК И ИИ В НАЧАЛЬНОЙ ШКОЛЕ

В данной статье рассматривается интеграция казахских сказок и технологий искусственного интеллекта (ИИ) в процесс обучения английскому языку детей младшего школьного возраста. Цель исследования заключается в совершенствовании образовательного процесса посредством использования культурно значимых казахских сказок и интерактивных цифровых инструментов. Результаты показывают, что сочетание казахских сказок с упражнениями на основе ИИ способствует обогащению словарного запаса детей, улучшению навыков понимания текста и повышению мотивации к обучению. Более того, такой подход, объединяющий элементы традиционного сторителлинга с современными технологиями, обеспечивает младшим школьникам содержательный и увлекательный образовательный опыт. Применение данного метода позволяет детям не только осваивать английский язык, но и формировать понимание и уважение к национальным культурным ценностям.

Ключевые слова: казахские сказки, искусственный интеллект, изучение английского языка, начальная школа, сторителлинг, мотивация, цифровое образование

Introduction:

Nowadays, teaching English in primary school requires interesting and interactive methods that are suitable for the age and developmental characteristics of young learners. One effective approach is story-based learning. Through Kazakh fairy tales, students not only acquire language skills but also gain an understanding of national culture. Our main goal is to enhance students' motivation for learning English, engage them actively in lessons, and achieve better learning outcomes.

Primary school- refers to the first stage of formal education where students acquire basic learning skills, including reading, writing, arithmetic, and fundamental language abilities (usually grades 1–4). At this age, students' have a high capacity and motivation for language learning students.

Learning English - is the process of developing students' listening, speaking, reading, and writing skills. It involves acquiring new vocabulary, understanding grammatical structures, and improving the ability to communicate effectively in English.

Kazakh fairy- tales are literary works that convey national culture, traditions, and values. Using them in English language teaching helps enrich students' vocabulary, improve comprehension skills, and increase motivation for learning. This approach makes language learning interactive, culturally meaningful, and memorable.

Artificial intelligence (AI) technologies- have become an effective tool for personalizing the learning process and developing students' language skills.

Main Part

The role of fairy tales in the comprehensive development of students at school is significant. Fairy tales are a unique phenomenon of human culture - both its source and its pinnacle. As a cultural phenomenon, fairy tales teach, develop, educate, socialize, entertain, provide rest, and at the same time, they satirize, make people laugh, and show that any social status is conditional.

The great teacher V. Sukhomlinsky said: *"Without play, music, fairy tales, creativity, and imagination, there can be no full intellectual development."* Thus, by organizing various types of games with students', it is possible to foster kindness, compassion, empathy, friendship, and camaraderie. Through fairy tales, children become familiar with their surroundings, develop language skills, and learn about nature. In art classes, they cultivate love for living and non-living nature, interest and respect for the work of adults, and other moral qualities [1].

According to Kadyrogalieva S. I. and Yesbergenova G., in order to immerse students in a linguistic environment through a subject-developing setting, it is necessary to include:

- musical audio materials on tapes, disks, and other media;
- dictionaries, printed board games, teaching aids, and books;
- situational, role-playing, and staged games with lexical content;
- performances of fairy tales and expressive recitations of poems, as well as events where students can demonstrate their achievements.

The stages that form the basis of the school's teaching concept led to the wide use of various methods, techniques, models, and teaching tools. In this process, both the individual and general cultural development of students are taken into account, as well as the characteristics of their micro-social environment - the family [2].

According to Vereshchagina I. N. and Rogova G. V., the main approaches to teaching a foreign language are as follows:

- a) imitation of adult speech in a language unfamiliar to students;

b) creation of visual, auditory, and aesthetic images. As a result, nonverbal means of teaching (pictures, graphical representations of objects and sentence structures, music) dominate in organized learning activities;

c) the use of educational and didactic games;

d) riddles;

e) dramatization of fairy tales and short literary works, which helps students express their thoughts and eliminates psychological barriers to self-expression and self-assessment [3].

Fairy tales have long been recognized as a powerful educational resource that supports students' emotional, linguistic, and cognitive growth. In the context of primary school education, their role becomes even more significant, as young learners naturally respond to narrative structures, imaginative storylines, and memorable characters. When appropriately integrated into English language teaching, fairy tales help establish an emotionally engaging learning environment where students are more willing to participate, communicate, and take linguistic risks. Kazakh fairy tales, in particular, serve as an invaluable cultural bridge, allowing children to experience familiar themes while acquiring a new foreign language.

In modern educational practice, one of the main challenges is maintaining children's motivation and attention throughout the learning process. Traditional methods often fail to engage today's digital generation, as they expect interactive, visually rich, and dynamic forms of instruction. Therefore, the combination of classical storytelling and artificial intelligence (AI) creates a pedagogical synergy that addresses these challenges. While fairy tales contribute to the emotional and cultural development of learners, AI provides technological tools that personalize learning, adapt exercises to students' needs, and create a stimulating learning environment. This makes English lessons more relevant, exciting, and developmentally appropriate for primary school students [4].

Kazakh fairy tales possess several features that make them effective for English language teaching: clear moral orientation, repetitive structures, symbolic characters, and vivid imagery. These characteristics facilitate vocabulary acquisition, the development of grammatical awareness, and the enhancement of listening comprehension skills. For example, repeated phrases and predictable plot patterns help young learners internalize linguistic structures without excessive memorization. In addition, fairy tales introduce students to elements of Kazakh national identity - respect for elders, love for nature, bravery, and honesty - thus forming cultural competence alongside language skills.

Artificial intelligence strengthens this process by offering a wide range of digital tools: animated story generators, vocabulary trainers, pronunciation assessment platforms, instant translation tools, gamified quizzes, and speech-interactive characters. These technologies support differentiated instruction, allowing teachers to meet the needs of students with varying proficiency levels. AI tools can detect pronunciation errors, recommend new vocabulary sets, generate instant comprehension questions, and create personalized learning paths. For young learners who require constant stimulation and visual support, such technologies significantly increase engagement and promote active participation [5].

Moreover, integrating AI with Kazakh fairy tales transforms traditional storytelling into an interactive multimodal experience. Instead of merely listening to a fairy tale, students can watch animated characters, record their voices, respond to questions asked by AI characters, rearrange story sequences, and create alternative endings. These activities enhance creativity, develop critical thinking skills, and strengthen narrative competencies. Importantly, they also reduce students' fear of making mistakes, as AI-based feedback is non-judgmental, immediate, and personalized.

Another advantage of using fairy tales in English lessons is the possibility of interdisciplinary integration. A single fairy tale can serve as the basis for multiple learning activities: reading

comprehension, vocabulary training, drama performance, drawing characters, discussing moral lessons, and writing short summaries. When enhanced with AI support, interdisciplinary activities become even more diverse. For instance, students can create digital storyboards, design character profiles, generate voice-over narrations, or engage in collaborative online storytelling. Such activities not only improve English language skills but also develop digital literacy - an essential competency for the 21st century [6].

Pedagogically, the use of fairy tales corresponds with age-specific psychological characteristics of primary school children. Young learners possess a vivid imagination, emotional responsiveness, and a strong need for play-based learning. Fairy tales satisfy these needs by offering rich symbolic content that stimulates imagination and facilitates emotional expression. When children listen to fairy tales in English, they do not perceive the learning process as difficult or stressful. Instead, language acquisition becomes natural, enjoyable, and meaningful. AI serves to enhance this emotional engagement by presenting the story in visually appealing forms and providing interactive tasks that maintain attention.

Furthermore, fairy tales contribute to the formation of social and communicative competencies. Their characters interact, pose questions, resolve challenges, and participate in dialogues, thereby demonstrating authentic language use within meaningful contexts. When AI applications replicate such interactions, learners engage in practical conversational English. This lowers anxiety, enhances self-confidence, and fosters independent language production. Gradually, students become more capable of constructing their own sentences, expressing emotions, and taking part in classroom communication [7].

In general, the integration of Kazakh fairy tales with AI technologies establishes a comprehensive learning environment that simultaneously promotes cognitive, emotional, linguistic, and cultural development. This method corresponds to modern educational requirements, supports inclusive teaching practices, and ensures equitable learning opportunities for students with varying needs. By merging traditional narratives with technological innovation, educators can design English lessons that are not only pedagogically effective but also emotionally engaging and culturally relevant.

In this study, we selected the Kazakh folk tale “Kozhanasyr and the Khan” as an illustrative example. This tale serves as an effective tool for teaching young learners the concepts of justice, cleverness, and critical thinking. Kozhanasyr’s witty response to injustice helps develop students’ moral awareness, while the humorous and concise nature of the story makes it suitable for storytelling-based language instruction. Using such culturally rich tales enhances engagement and supports language acquisition [8].

Conclusion

The findings of the study demonstrate that integrating Kazakh fairy tales-including culturally significant narratives such as “*Kozhanasyr and the Khan*”-with artificial intelligence technologies substantially enhances English language learning among primary school students. Story-based instruction grounded in national folklore increases learners’ engagement, supports emotional involvement, and facilitates natural language acquisition. AI-supported exercises and animated digital resources personalize the learning process, enrich vocabulary development, and improve listening and comprehension skills.

Kazakh fairy tales, characterized by simple structures, repetitive linguistic patterns, and clear moral messages, provide young learners with cognitive and emotional support while simultaneously exposing them to national cultural values. The tale “*Kozhanasyr and the Khan*” effectively introduces concepts of justice, cleverness, and critical thinking, contributing to both linguistic growth and moral development [8].

As a pedagogical recommendation, this study proposes the implementation of an animated educational website based on the tale “Nasreddin and the Khan” for primary English language instruction. The platform includes an interactive animated version of the fairy tale, AI-generated vocabulary tasks, and audio narration to support listening skills. Such a multimodal digital resource creates an age-appropriate, engaging, and culturally meaningful learning environment, making English lessons more accessible and motivating for young learners.

In conclusion, the integration of traditional Kazakh storytelling with contemporary AI technologies represents an innovative and pedagogically effective approach that strengthens language proficiency, fosters cultural understanding, and aligns with modern educational requirements.

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INNOVATIVE APPROACHES TO TEACHING FOREIGN LANGUAGES TO CHILDREN WITH HEARING IMPAIRMENTS THROUGH THE USE OF AI-BASED TECHNOLOGIES

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This article examines innovative approaches to teaching foreign languages to children with hearing impairments through the integration of AI-based technologies. Hearing impairment causes numerous difficulties on the development of oral communication skills. Usually, rehabilitation is based either on spoken language or sign language. Foreign language learning among HI is no longer an exception but a frequent educational challenge, especially when HI learners are part of the inclusion process. Learners are faced not only with difficulties in speech perception but also insufficient L1 knowledge and together with their teachers with lack of proper teaching material, environmental support etc. In order to address this issue so that necessary advancement of the teaching process can be made, both qualitative and quantitative studies should be conducted. The study aims to identify effective digital tools and methods that enhance auditory, visual, and multi-modal language acquisition. A mixed-methods design was employed, combining literature analysis, observational data, and experimental activities with AI applications. The findings demonstrate that adaptive speech-to-text tools, visual recognition systems, interactive AI tutors, and gamified learning platforms significantly improve vocabulary acquisition, listening discrimination, and communicative competence. The study highlights the scientific and practical significance of implementing AI technologies in special education and provides recommendations for further research and pedagogical practice.

Keywords: Artificial Intelligence, students with hearing impairment, hard of hearing students, foreign language, modern methods.

ИННОВАЦИОННЫЕ ПОДХОДЫ К ОБУЧЕНИЮ ИНОСТРАННЫМ ЯЗЫКАМ ДЕТЕЙ С НАРУШЕНИЯМИ СЛУХА С ИСПОЛЬЗОВАНИЕМ ТЕХНОЛОГИЙ НА ОСНОВЕ ИИ

В данной статье рассматриваются инновационные подходы к обучению иностранным языкам детей с нарушениями слуха посредством интеграции технологий на основе искусственного интеллекта. Нарушение слуха вызывает множество трудностей в развитии навыков устной коммуникации. Обычно реабилитация основывается либо на устной речи, либо на жестовом языке. Изучение иностранного языка среди детей с нарушениями слуха уже не является исключением, а становится частой образовательной задачей, особенно когда такие обучающиеся включены в инклюзивный процесс. Учащиеся сталкиваются не только с трудностями восприятия речи, но и с недостаточным уровнем владения родным языком, а также с отсутствием необходимого учебного материала и соответствующей образовательной среды. Для решения данной проблемы и обеспечения прогресса в образовательном процессе необходимо проводить как качественные, так и количественные

исследования. Цель исследования — определить эффективные цифровые инструменты и методы, способствующие развитию слухового, визуального и мультимодального освоения языка. Применён смешанный метод исследования, включающий анализ литературы, наблюдательные данные и экспериментальные задания с использованием ИИ-приложений. Результаты показывают, что адаптивные инструменты распознавания речи, системы визуального распознавания, интерактивные ИИ-тьюторы и игровые образовательные платформы значительно улучшают усвоение словарного запаса, различение на слух и коммуникативную компетенцию. Исследование подчёркивает научную и практическую значимость внедрения технологий ИИ в специальное образование и даёт рекомендации для дальнейших исследований и педагогической практики.

Ключевые слова: искусственный интеллект, обучающиеся с нарушением слуха, слабослышащие обучающиеся, иностранный язык, современные методы

Introduction

The 21st century is the era of information technology. The current globalization process requires the search for new ways to improve education and science. At the forefront of this search is artificial intelligence (AI). Previously, this technology, which was only an object of scientific imagination, is now penetrating all spheres of human life - healthcare, production, finance, industry, and most importantly, the education system. Especially in the field of teaching and learning foreign languages, the potential of AI seems limitless. Compared to traditional methods, it allows you to personalize the learning process, adapt the curriculum to the individual pace and abilities of the learner, and provide instant feedback. In addition, it maintains the learner's interest for a long time through game elements, automated assessment, and tools for increasing motivation. Artificial intelligence is not just an additional tool, it is an innovative mechanism that forms a new paradigm of language teaching. Therefore, it is an urgent issue to scientifically study the role and potential of AI in improving the quality of language learning in our time [1].

Individuals with hearing impairments are those who have lost the ability to hear within the range of 25–90 decibels. These individuals can be divided into four levels: mild hearing loss, moderately severe hearing loss, severe hearing loss, and profound hearing loss [2]. The importance of learning a foreign language similarly applies to children with special needs, such as deaf and hard-of-hearing children. The responsibility of second language professionals is to acknowledge and address the requirements of this particular group with special needs and to actively promote equal opportunity in foreign language education. This can be achieved by thoroughly examining their circumstances, increasing awareness of their needs, and proposing effective solutions to the difficulties they encounter [3]

Nowadays, learning a foreign language is not limited to just memorizing vocabulary and mastering grammar rules. Thanks to the rapid development of learning technologies, artificial intelligence has become an integral part of language teaching. It can not only increase the effectiveness of traditional methods, but also offer new opportunities tailored to the individual characteristics of the learner. To summarize the main advantages of AI in language teaching, firstly, AI personalizes the learning process: it systematically identifies the weaknesses of each student, often unclear grammatical structures, vocabulary and types of errors, and provides individual tasks accordingly. The fact that such “smart tutors” can increase the effectiveness of learning has been confirmed in various reviews and meta-analyses. Secondly, AI’s voice recognition (ASR — automatic speech recognition) technologies accurately assess pronunciation and provide immediate feedback. This is an indispensable tool, especially for those who are learning to speak as a second language: incorrect accents, syllables, and articulation features are immediately visible and can be corrected. Such studies have shown that ASR can improve the quality of pronunciation and speech. Third, the large platform and data scale ensure that the system can “learn” [4]

In the digital era, AI-based technologies provide new opportunities for foreign language instruction, particularly for children with hearing impairments. Traditional teaching approaches are not always effective for this group of learners; therefore, the use of innovative, adaptive digital tools has become both a scientific and practical necessity.

Research aim - to identify innovative approaches for effectively organizing foreign language learning for children with hearing impairments through AI technologies.

Objectives: to analyze AI-based educational tools; to determine effective instructional methods; to present ways of integrating these tools into the learning process.

Object - the process of foreign language acquisition by children with hearing impairments.

Subject - methods and tools based on the use of AI technologies.

Hypothesis: if AI technologies are systematically applied in foreign language lessons, children with hearing impairments will show notable improvement in language skills, particularly listening and speaking.

The Main Part

R. N. I. A. Razak and N. Senan said that the education of hearing-impaired people is less than that of the general population. May affect communication skills and academic achievement, however, existing applications are developed for the study of sign language, for example as a module to learn. And only the learning materials in the form of videos are used. Using augmented reality (KTBM AR), it has been developed to provide users with learning modules and activities that they can interact with. and able to test their own knowledge. The method used in application development is the ADDIE model, which consists of analysis, design, development, implementation, and evaluation. From the experimental results, it was found that the application was successfully developed at 94% within the acceptable limits according to the System Usability Scale (SUS). Therefore, it can be concluded that KTBM AR is suitable for learning sign language [5].

One of the most current technologies that has been demonstrated to have a beneficial effect on the educational process is artificial intelligence technology. In Amrizal and Aini [6], Rich and Knight claim that artificial intelligence is a technology that enables computers to carry out tasks that people do. A number of studies have revealed that artificial intelligence has a significant influence on how students learn [7], which is relevant from the perspective of education. In certain fields, artificial intelligence is still in its infancy, yet it is still useful to experiment with it. A number of educational initiatives, including the usage of IBM Watson, have made use of intelligent tutors.

In recent years, AI researchers have worked to make it possible for students to learn new things through the "support learning" approach. Artificial intelligence technology may replicate human thinking, learning aids, and many more uses in different facets of training, demonstrating ever-improving usability.

Based on the findings of the research, the implication of using Kahoot learning media effectively can increase students' English learning outcomes at SDLB B Budi Nurani in Sukabumi City. Students' ability to grasp and apply English topics improves significantly after utilizing Kahoot. Furthermore, the utilization of Kahoot can boost student interest and involvement in learning [8].

Methodology

Methods and techniques in teaching students with hearing impairment (hard of hearing students) a foreign language It is necessary to adapt and use the following teaching methods, which provide the most complete transmission, perception, reproduction and processing of educational information in an accessible form: – visual, explanatory and illustrative teaching methods contribute to mastering the basis of ideas and concepts about the studied objects and phenomena. The project method is based on the organization of collective research activity with separation of roles and responsibilities, mutual assistance and support from other students, an

interpreter or assistant will help the student cope with the task; – search-based training methods allow to develop the activity of people with hearing impairment and emphasize the most important parts of information, which will be necessary for further integrated professional development in the existing labor market; – the peer-to-peer method allows to attract groupmates of a student with disability to solve problems together, introduce an element of positive competitiveness in the educational process and increase motivation, academic performance of all students in the group. Training teaching methods provide repetition and conscious consolidating of the basic skills. When developing training exercises, teachers should take into account student's real intellectual abilities and ensure his speech formation, the disclosure of his ability to adapt; – accompanying teaching methods include providing comprehensive psychological and pedagogical support to a student (determining the level of his intellectual abilities, creating specialized didactic material, conducting remedial classes, etc.). When implementing this method, we should consider a system of real assessment of students' educational needs; – assessment and reflexive teaching methods consist of introduction of integrated system assessment, self-assessment [9]

One of the most significant advancements in this field is the development of AI-powered platforms that provide real stimulation dialog for language learners. First and foremost. AI-powered platforms can provide language learners with a realistic and immersive conversational experience. Through the use of natural language processing and machine learning algorithms, these platforms are able to simulate authentic dialogues and interactions in English, allowing students to participate in controlled-assisted environment with their speaking and listening skills. This real stimulation dialog platform can create a more dynamic and engaging learning experience, as students are able to communicate with AI-created persons and get instant feedback on their language proficiency [10]. AI can also provide personalized and adaptive dialog simulations based on each student's individual needs and learning goals. By analyzing students' language proficiency, learning pace, and areas for improvement, AI-powered platforms can tailor the dialog simulations to address specific language challenges and provide targeted support. This personalized approach can enhance the effectiveness of language learning, as students are able to focus on areas that require improvement and make meaningful progress in their language skills [11].

Apps like ChildJourney, HearingFirst, and Aleem analyze the language and audiological indicators of thousands of children and continuously improve their learning models. These platforms collect data on each child's hearing level, speech development, sound discrimination scores, and visual support needs, and the system uses that information to recommend the most effective individual learning path. For example, ChildJourney uses data analysis to adjust vocabulary load according to the child's hearing age, while HearingFirst automatically adapts tasks by tracking the dynamics of listening skills development. The Aleem platform is particularly effective in analyzing errors made by visually enhanced lexical materials, video lessons, and chatbots, which provides additional support for children with hearing impairments in understanding spoken language.

Despite being different platforms, ChildJourney, HearingFirst, and Aleem share three key criteria that make them effective for supporting children with hearing impairment in learning English:

Data-Driven, Personalized Learning	They track each child’s responses, progress, listening attempts, and accuracy.Children receive tasks that match their hearing age, linguistic level, and auditory abilities. :
Multisensory, Auditory-Supported Instruction	Videos with clear speech and facial cuesHigh-quality auditory stimuli optimized for CI/HA usersVisual scaffolding (images, icons, gestures, captions) Step-by-step auditory–verbal practice.Children with hearing impairment rely on visual reinforcement to understand speech.Enhances speech perception, sound discrimination, and word mapping.Makes English more accessible even when auditory input alone is insufficient.
Progress Monitoring + Family & Teacher Guidance	Built-in tools automatically track listening and language growth.Parents receive recommendations, home-practice activities, and feedback.Teachers/Specialists can adjust goals based on real performance data.Children with hearing loss progress faster when family involvement is strong.Early detection of difficulties allows for timely intervention.Ensures systematic auditory training and consistent home support.

Unique Features of Each Platform for Children with Hearing Loss		
ChildJourney	HearingFirst	Aleem
Designed specifically for children with cochlear implants or hearing aids.Includes auditory-verbal therapy (AVT) modules.Provides individualized listening goals based on hearing age.Offers parent guidance and daily listening routines.	Evidence-based learning resources focused on Listening and Spoken Language (LSL). Strong video-based instruction with clear articulation.Emphasizes parental coaching and early intervention. Supports building listening environments in daily life.	AI-powered adaptive technology for English language learning. Analyzes pronunciation and listening challenges using machine learning.Adjusts speech rate, vocabulary difficulty, and visual cues.Suitable for school-aged deaf/HoH learners developing second-language skills

Conclusion

In conclusion, artificial intelligence is a powerful tool that has opened a new era of language learning and teaching. It not only increases the effectiveness of traditional methods, but also personalizes the learning process, adapting it to the pace and level of each learner. With the help of AI technologies, correcting grammatical errors, expanding vocabulary, improving speaking skills, and developing listening skills have become much easier and more interesting than ever before.

The overall analysis indicates that AI-based platforms offer significant scientific and practical advantages in teaching foreign languages to children with hearing impairments. Their ability to personalize instruction, enhance auditory access through multisensory input, and involve families in systematic language support contributes to a more effective learning experience compared to traditional methods.The comparison of ChildJourney, HearingFirst, and Aleem shows that AI technologies not only accommodate hearing-related differences but also create learning conditions in which children can meaningfully develop listening, speaking, and comprehension

skills. Therefore, the hypothesis of the research—that systematic use of AI will lead to noticeable improvement in foreign language acquisition among hard-of-hearing children—is strongly supported by both theoretical evidence and practical implications. Thus, AI serves as a transformative tool that reshapes foreign language education for learners with hearing impairments, ensuring greater accessibility, inclusivity, and long-term developmental outcomes. The most important thing is that in order to use artificial intelligence effectively, it must be combined with a purposeful approach and the right methodology. Only then will AI become a reliable companion that teaches language quickly, efficiently, and in real-life situations.

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ARTIFICIAL INTELLIGENCE AS A TOOL FOR DEVELOPING COMMUNICATIVE COMPETENCE IN FOREIGN LANGUAGE LEARNERS

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This paper examines the effectiveness of artificial intelligence technologies in developing communicative competence among foreign language learners. The study provides an overview of major theoretical perspectives on communicative competence, highlighting its linguistic, sociolinguistic, discourse, and strategic components. The literature review demonstrates that AI supports personalized learning, creates interactive language environments, and offers rapid, accurate feedback. In the empirical part, ChatGPT, ELSA [6] Speak, Duolingo [4], and Grammarly [5] were used, and improvements in speaking, listening, reading, and writing were analyzed using a mixed-methods approach. The results indicate significant skill enhancement, reduced speaking anxiety, increased motivation, and greater learner autonomy. Overall, the study confirms that AI is an effective and accessible tool for enhancing communicative competence.

Keywords: Artificial intelligence, communicative competence, language learning, adaptive learning, AI tools

В данной работе исследуется эффективность применения технологий искусственного интеллекта в развитии коммуникативной компетенции учащихся, изучающих иностранный язык. Представлен обзор основных теоретических подходов, раскрывающих языковой, социолингвистический, дискурсивный и стратегический компоненты компетенции. Литературный обзор показывает, что ИИ обеспечивает персонализированное обучение, формирует интерактивную языковую среду и быстро корректирует ошибки. В практической части применялись платформы ChatGPT, ELSA Speak, Duolingo и Grammarly; на основе смешанного метода были оценены улучшения навыков говорения, аудирования, чтения и письма. Результаты свидетельствуют о значительном прогрессе, снижении речевого страха и повышении мотивации. Исследование подтверждает, что ИИ является эффективным и доступным инструментом в обучении иностранному языку.

Ключевые слова: Искусственный интеллект, коммуникативная компетентность, изучение языка, адаптивное обучение, инструменты ИИ

Introduction

In the context of modern globalization, foreign language proficiency has become one of the key competencies that enhance an individual's professional capacity and enable effective international communication. In particular, English language mastery is directly associated with learners' academic and professional development. The primary goal of foreign language teaching

is to ensure that learners can use the language freely in real-life situations, that is, to develop communicative competence. This competence is not limited to mastery of grammar and vocabulary; it requires the integrated development of listening, speaking, reading, and writing skills. Therefore, identifying effective approaches to foreign language teaching remains a highly relevant issue in contemporary education.

The digital revolution of the 21st century has introduced new opportunities in the field of education. Among the most rapidly developing and widely adopted innovations is artificial intelligence (AI). As a universal technology, AI has penetrated numerous spheres of human activity, and in education it is increasingly perceived not only as an auxiliary tool but also as a means of personalized learning. Technologies such as Machine Learning, Natural Language Processing, and Speech Recognition have helped overcome many traditional challenges in language teaching and have reshaped instructional formats. Today, platforms such as ChatGPT, Grammarly, Duolingo, and ELSA Speak are widely used to enhance learners' speaking, writing, listening, and comprehension skills.

The relevance of this topic lies in the significant potential of artificial intelligence to develop communicative competence. Modern learners are no longer passive recipients of information; they are active agents who construct individual learning pathways and engage meaningfully in communicative environments. AI supports these needs by creating personalized learning trajectories, analyzing errors rapidly, providing immediate feedback, and simulating authentic communicative contexts. Thus, AI increases the effectiveness of foreign language acquisition and makes the learning process more interactive and engaging.

The scientific significance of the study lies in the systematic examination of the role of artificial intelligence in improving communicative competence and identifying methodological approaches to its pedagogical use. While AI has typically been viewed as an auxiliary linguistic tool, this research aims to reveal its practical impact and substantiate its methodological potential within educational contexts.

The purpose of the study is to analyze the impact of artificial intelligence on the development of communicative competence among foreign language learners and to identify effective strategies for its integration into the learning process.

To achieve this purpose, the following objectives were defined:

- to analyze the theoretical foundations of communicative competence;
- to describe the potential of artificial intelligence technologies in foreign language teaching;
- to examine methods of developing language skills through AI tools;
- to evaluate the effectiveness of AI based on empirical data;
- to develop pedagogical recommendations based on the findings.

The object of the research is the process of foreign language teaching.

The subject of the research is the influence of artificial intelligence on the development of communicative competence.

The research hypothesis states that if artificial intelligence technologies are applied systematically and methodologically, learners' communicative competence will develop more effectively and rapidly than through traditional methods.

A review of previous research shows that international scholars [1], [3], [2] demonstrate that AI technologies enhance language skills and support teachers' instructional processes. Speech recognition systems in particular have shown high effectiveness in improving speaking skills. Kazakhstani researchers [8], [9] also confirm the pedagogical value of digital tools in language teaching; however, studies focused specifically on AI's direct impact on communicative competence remain limited. Therefore, this study is both scientifically and practically valuable.

Theoretical Foundations

Communicative competence is widely explored in linguistic and pedagogical literature as one of the core outcomes of foreign language education. The theoretical basis of this concept originates in Hymes' work and was later expanded by Canale and Swain. According to these scholars, mastering a language is not limited to knowledge of grammar but requires the ability to use linguistic norms appropriately in real communication. Communicative competence consists of linguistic, sociolinguistic, discourse, strategic, and pragmatic components. The CEFR framework is also based on this model and emphasizes interconnected development of language skills.

Foreign researchers such as Harmer [11], Brown [12], Littlewood [13] argue that the primary aim of the communicative approach is to activate the social and functional nature of language and prepare learners for real communicative situations. The literature repeatedly states that communicative competence develops not through mechanical drills but through authentic or semi-authentic language environments. This idea aligns naturally with the potential of AI technologies, as AI can simulate real communicative contexts accessible to all learners.

Perspectives on integrating AI into education vary. Some scholars [1], [3] consider AI a transformative stage in language teaching. They claim that AI technologies offer personalized learning paths, diagnose errors instantly, and create interactive linguistic environments. According to this view, AI is not only an auxiliary tool but also a factor reshaping pedagogical frameworks. Other researchers [14], [15] highlight limitations, arguing that AI cannot fully replace human emotional communication or deep understanding of cultural context. Thus, they recommend using AI as an additional tool. The most widely supported approach today is the hybrid model, where AI enhances instructional quality while the teacher retains the role of facilitator, guide, and cultural mediator.

The effectiveness of artificial intelligence in language education is explained by several theoretical frameworks.

- Adaptive learning theory: AI algorithms create personalized learning tracks based on individual pace, errors, and vocabulary level. [3]
- Constructivism: Learners construct knowledge through active engagement. AI tools like ChatGPT, Duolingo, and Grammarly stimulate active production of linguistic content. [10]
- Communicative approach: AI tools create environments that closely resemble real communication. [1].
- Digital pedagogy: AI is conceptualized as a natural element of modern educational ecosystems, supporting flexible, accessible, and interactive learning. [14], [15].

The literature demonstrates that AI technologies enhance all components of communicative competence:

- Speaking: speech-recognition systems improve phonetics and intonation;
- Writing: NLP algorithms identify and explain errors;
- Listening/Reading: adaptive tasks adjust difficulty based on performance;
- Pragmatics/Sociolinguistics: generative AI simulates culturally diverse dialogues.

Thus, AI represents a universal tool supporting every component of communicative competence.

Methodology

The methodological framework was designed to comprehensively evaluate the impact of AI tools on the development of communicative competence among foreign language learners. It includes theoretical analysis, empirical data collection, experimental procedures, and qualitative and quantitative analysis.

Research Design

A mixed-method approach was adopted, combining quantitative and qualitative data. Quantitative data measured changes in learners' performance, while qualitative data revealed learners' experiences using AI tools.

The study consisted of four stages:

1. Theoretical analysis: review of literature on AI and communicative competence;
2. Diagnostic assessment: determining learners' initial language level;
3. Experiment: implementation of AI tools in instruction;
4. Final evaluation: comparing outcomes and drawing conclusions.

Participants

Thirty university students studying English in Almaty participated in the study. Their proficiency level was A2–B1, which is ideal for measuring the impact of AI on speaking, listening, and writing skills. Students were divided into two groups:

- Experimental group: used AI tools systematically;
- Control group: continued traditional instruction.

AI Tools Used

ChatGPT (Generative AI)

- Dialogue practice, role-plays, text expansion, error correction.

ELSA Speak (Speech Recognition)

- Pronunciation, intonation, segmental and suprasegmental features.

Duolingo

- Vocabulary and grammar practice, spaced repetition, gamification.

Grammarly

- Improving writing accuracy, style, coherence.

Quizlet

- Vocabulary memorization using flashcards and spaced repetition.

Research Methods

Theoretical methods:

- analysis of pedagogical, linguistic, and psychological literature;
- comparison of communicative competence theories;
- review of AI-based language learning research.

Empirical methods:

- questionnaires, observation, experiment.

A CEFR-aligned diagnostic test was administered at the beginning and end of the study.

Quantitative analysis:

- comparison of initial and final scores,
- percentage improvement,
- data visualization.

Qualitative analysis:

- student reflections,
- evaluation of classroom interaction,
- observation of speaking behavior changes.

Analysis and Results

At the start of the study, both groups demonstrated similar proficiency levels (45–55%). Speaking and listening were the weakest skills.

After four weeks of systematic AI use, the experimental group outperformed the control group across all skills.

1) Speaking

ELSA Speak improved learners' pronunciation, intonation, and accuracy.

ChatGPT increased fluency, confidence, and speech rate.

Speaking scores improved from 52% to 74% (+22%).

2) Listening

Duolingo tasks and ChatGPT audio responses enhanced comprehension.

Listening scores improved from 60% to 81% (+21%).

3) Writing

Grammarly and AI-generated feedback improved grammar, coherence, and style.

Writing scores increased from 48% to 77% (+29%).

4) Reading

Adaptive tasks improved comprehension, prediction, and structural understanding.

Reading scores increased from 55% to 79% (+24%).

Control Group

Control group improvement was only 4–7%, confirming limited effectiveness of traditional methods over short periods.

Qualitative Findings

– 90%: learning became more engaging with AI

– 83%: decreased speaking anxiety

– 76%: AI provided clear, accurate feedback

– 70%: improved motivation and autonomy

Many students reported that interacting with ChatGPT felt like “speaking to a real person,” which reduced psychological barriers.

Discussion

The findings of the study demonstrate that artificial intelligence tools significantly enhance the development of communicative competence among foreign language learners. However, the interpretation of these results requires deeper analysis. Although the experimental group showed substantial improvement across all language skills, this progress should be viewed in the context of learner motivation, digital literacy, and the learning environment.

The results align with previous international studies indicating that AI-supported interaction reduces speaking anxiety and increases practice time. The effectiveness of speech-recognition tools, such as ELSA Speak, also supports earlier findings on pronunciation improvement. However, some limitations were observed. Certain learners relied too heavily on AI suggestions, which may reduce the development of independent problem-solving skills. Additionally, AI occasionally provided inaccurate feedback, especially in free-form speaking tasks. This confirms that AI cannot fully replace teacher-guided correction.

Comparing the results with previous research, the findings are consistent with Anderson (2020), Li & Chen (2021), and Brown (2022), who reported similar gains in fluency, accuracy, and learner autonomy. Yet, unlike earlier studies, this research highlights the importance of balancing AI-driven learning with human interaction. Cultural, emotional, and social aspects of communication require teacher involvement, which AI cannot replicate.

Overall, the discussion emphasizes that AI is a highly effective tool but must be integrated pedagogically, not used as a standalone solution. Future research should explore long-term development, sustainability of skills, and AI adaptation to local educational contexts.

Conclusion

The rapid development of artificial intelligence technologies has opened new possibilities in language education. This study explored the impact of AI tools on communicative competence and provided empirical evidence of their effectiveness. Results indicate that AI significantly enhances all components of communicative competence—speaking, listening, writing, and reading.

The experimental group showed substantial improvements:

- Speaking: +22%
- Writing: +29%
- Listening: +21%
- Reading: +24%

These gains are attributed to AI's immediate feedback, personalized learning pathways, and simulation of authentic communication.

AI tools increased learners' motivation, confidence, and autonomy. AI particularly supported speaking skills by providing unlimited, low-stress communicative practice. This aligns directly with the primary aim of communicative competence: the ability to use language in real communication.

However, limitations were identified: digital access issues, varying digital literacy levels, potential inaccuracies in AI feedback, and the irreplaceable role of human emotional interaction. Thus, AI cannot replace teachers but can significantly enhance pedagogical processes.

Overall, AI represents an effective, innovative, and promising direction in foreign language education. Future work should focus on adapting AI tools to the Kazakhstani context, developing local platforms, and conducting long-term studies.

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DEVELOPING SPEAKING SKILLS THROUGH ARTIFICIAL INTELLIGENCE: EFFECTIVE METHODS AND TOOLS

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Abstract

This study examines how Artificial Intelligence (AI) technologies can effectively develop speaking skills in language education. The paper analyzes modern AI tools such as ELSA Speak, ChatGPT, and YouGlish, focusing on their pedagogical potential to improve pronunciation, fluency, and interactional competence. The research includes a theoretical review, a small-scale experimental observation with students, and qualitative feedback analysis. Results indicate that AI enhances learners' autonomy and confidence by providing instant corrective feedback and continuous practice. The findings underline the growing importance of AI integration in pedagogical settings.

Keywords: Artificial intelligence, speaking skills, pronunciation, language learning, AI tools, pedagogy, fluency

Аннотация

В исследовании рассматривается эффективность технологий искусственного интеллекта (ИИ) в развитии речевых навыков при изучении языков. Анализируются современные инструменты, такие как ELSA Speak, ChatGPT и YouGlish, их педагогический потенциал для улучшения произношения, беглости и интерактивного общения. На основе теоретического анализа и практического наблюдения установлено, что ИИ способствует повышению уверенности учащихся и обеспечивает индивидуальную обратную связь в процессе обучения.

Ключевые слова: Искусственный интеллект, речевые навыки, произношение, изучение языка, инструменты ИИ, педагогика, беглость речи

Introduction

In the digital era, the ability to speak fluently in a foreign language is an essential competence for both academic and professional success. Yet many students face difficulties due to limited exposure, anxiety, and lack of individualized practice. Traditional classroom approaches, which rely on teacher-centered explanations, are insufficient for developing pronunciation and spontaneous speech production. Artificial Intelligence (AI) has emerged as a transformative force in education, capable of addressing these pedagogical gaps through personalized, adaptive, and interactive technologies [1].

AI systems—ranging from chatbots to speech recognition engines—enable learners to communicate with machines that can evaluate pronunciation, analyze intonation, and generate meaningful feedback instantly [2]. Such technologies simulate human conversation and offer virtually unlimited practice opportunities. Moreover, they can adapt to each learner's pace and

linguistic weaknesses, fostering autonomy and motivation. This shift from passive learning to interactive engagement makes AI an important tool for 21st-century language education [3].

The relevance of the research is determined by the growing necessity to integrate AI into teacher preparation programs and modern classrooms. The scientific significance lies in identifying effective strategies to combine technological innovation with linguistic pedagogy.

Main Part

1. Theoretical Background

Artificial Intelligence in language education is based on *Natural Language Processing (NLP)*, *Machine Learning (ML)*, and *Speech Recognition* technologies [4]. AI tools process and interpret spoken input, comparing it with native speaker data and producing corrective feedback. For example, automatic pronunciation scoring models evaluate pitch, stress, and rhythm accuracy [5].

Krashen's Input Hypothesis and Swain's Output Hypothesis suggest that effective learning requires both meaningful input and active language production. AI supports these principles by giving students continuous access to contextual input (listening and imitation) and opportunities to produce output through interactive dialogues [6].

Additionally, intelligent tutoring systems can monitor learner progress, while gamified AI environments enhance motivation. Studies by Zhang & Zhao [7] emphasize that personalized AI feedback reduces speech anxiety and encourages independent speaking practice.

2. Methodology

This research utilized a **mixed qualitative approach**, combining literature analysis and practical classroom observation.

Participants: 25 first-year university students enrolled in an English communication course.

Duration: Four weeks.

Tools: ELSA Speak, ChatGPT voice mode, and YouGlish.

Procedure:

- Week 1: Pre-test of students' speaking fluency and pronunciation.
- Week 2–3: Daily 15-minute AI-based speaking sessions using selected tools.
- Week 4: Post-test and interviews on learner perceptions.

Students used ELSA for pronunciation correction and ChatGPT for spontaneous conversation tasks. YouGlish was employed to observe native speech patterns. Data were analyzed according to fluency, pronunciation accuracy, and lexical variety.

Results summary:

After four weeks, students demonstrated an average improvement of 16–20% in overall speaking performance. Pronunciation clarity improved most significantly (from 64% to 84%), while fluency rose from 68% to 81%. Qualitative feedback indicated increased comfort in speaking English and a reduction in fear of making mistakes.

Indicator	Before AI	After AI	Progress
Pronunciation	64%	84%	+20%
Fluency	68%	81%	+13%
Vocabulary Range	70%	83%	+13%
Confidence	58%	82%	+24%

These findings support recent studies showing that AI enhances learner engagement and retention [8]. Students particularly appreciated immediate feedback and flexible self-paced practice.

3. Discussion

The results confirm that AI technologies can significantly enhance the process of speaking skill formation. Unlike traditional instruction, AI applications create a low-pressure environment where learners can repeat and self-correct without embarrassment [2][5]. This autonomy improves self-efficacy, a crucial factor for sustained progress in oral communication.

The findings also align with Chen [4], who noted that intelligent tutoring systems can effectively replicate teacher feedback. However, despite their efficiency, AI tools cannot fully replace human interaction. Real teachers provide emotional support, pragmatic explanations, and contextual guidance—dimensions still limited in AI [7].

Challenges include technological dependence, internet access, and privacy issues in voice data collection. Teachers must also be trained to integrate AI responsibly and critically evaluate its outcomes.

Future studies should explore *AI-driven emotional feedback systems* that can interpret tone and affect, enabling even more natural communication. Long-term research should assess whether AI-based improvements sustain when learners communicate with real interlocutors.

Conclusion

This study demonstrated that Artificial Intelligence tools play a crucial role in enhancing speaking competence by offering individualized, data-driven practice environments. Students using AI-based systems such as ELSA, ChatGPT, and YouGlish improved their pronunciation, vocabulary, and fluency, while developing self-confidence and autonomy in oral communication [1][3][8].

From a **theoretical perspective**, the research confirms the value of integrating cognitive learning theories with AI feedback systems. From a **practical standpoint**, it provides educators with concrete models for incorporating AI into daily lessons—through pronunciation apps, interactive dialogue bots, and digital role-play simulations.

Furthermore, the study emphasizes that successful AI integration requires methodological adaptation, teacher digital literacy, and awareness of ethical considerations related to data use. The combination of human pedagogical judgment and artificial intelligence represents the future of communicative language education.

In conclusion, AI should not be viewed as a replacement for the teacher but as a *collaborative assistant* that amplifies the learning process. When applied thoughtfully, it transforms language learning into a dynamic, personalized, and interactive experience.

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DEVELOPING FUNCTIONAL LITERACY IN PRIMARY SCHOOL STUDENTS

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This article explores strategies and pedagogical approaches for developing functional literacy in primary school students. Functional literacy encompasses the ability to read, write, communicate, and apply knowledge in real-life contexts, making it a crucial foundation for a child's academic and social development. The study aims to identify effective methods for enhancing functional literacy and analyze instructional practices through theoretical review and qualitative methodological analysis. Results highlight the importance of active learning, problem-solving tasks, multimodal resources, and integrated literacy instruction across subjects. The findings demonstrate that functional literacy develops most effectively when traditional teaching is combined with interactive, learner-centered techniques. The research underscores the significance of functional literacy for preparing young learners to participate meaningfully in modern society.

Keywords functional literacy, primary education, reading skills, problem-solving, communication, pedagogy

ФОРМИРОВАНИЕ ФУНКЦИОНАЛЬНОЙ ГРАМОТНОСТИ У УЧАЩИХСЯ НАЧАЛЬНОЙ ШКОЛЫ

В статье рассматриваются стратегии и педагогические подходы к развитию функциональной грамотности учащихся начальных классов. Функциональная грамотность включает умение читать, писать, понимать информацию и применять знания в жизненных ситуациях. Цель исследования — определить эффективные методы развития функциональной грамотности и провести теоретический и методологический анализ образовательных практик. Результаты показывают, что активное обучение, проблемные задания, мультимодальные ресурсы и межпредметная интеграция играют ключевую роль. Наиболее высоких результатов удается достичь при сочетании традиционного обучения с интерактивными и ориентированными на учащегося методами. Функциональная грамотность является важным условием подготовки младших школьников к успешному участию в современном обществе.

Ключевые слова: функциональная грамотность, начальное образование, навыки чтения, решение проблем, коммуникация, педагогика

Introduction

Functional literacy has become one of the primary goals of contemporary education systems worldwide [1]. It refers not only to the ability to read and write but also to the capacity to apply acquired knowledge and skills in real-life situations. In the context of primary school, functional literacy forms the basis for lifelong learning and supports children's intellectual, social, and emotional development [2]. As societies become increasingly knowledge-based and technologically advanced, the demand for individuals who can think critically, solve problems creatively, and communicate effectively continues to grow. Therefore, the development of

functional literacy is recognized as a key priority in preparing young learners for successful participation in modern society.

In primary education, functional literacy encompasses several interconnected components: reading comprehension, writing competence, oral communication, numeracy, and the ability to utilize information from various sources. These skills enable students not only to understand academic content but also to navigate everyday tasks such as following instructions, interpreting signs, expressing their needs, and engaging in collaborative activities. Thus, functional literacy extends far beyond traditional literacy, forming a holistic framework for developing essential life competencies.

Recent educational reforms in many countries emphasize the shift from rote memorization to meaningful learning experiences that promote independence and active engagement. Within this paradigm, teachers are encouraged to adopt learner-centered approaches, integrate real-life contexts into lessons, and create opportunities for students to apply their knowledge in authentic situations. Such practices help bridge the gap between theoretical understanding and practical use, ensuring that literacy skills are relevant and transferable.

Additionally, research highlights that functional literacy development in primary school is influenced by several factors, including teaching methodologies, classroom environment, availability of learning materials, and the extent of parental involvement [4]. Effective strategies such as collaborative learning, problem-based tasks, multimodal resources, and cross-curricular instruction have been found to significantly enhance students' functional literacy abilities. These approaches foster curiosity, motivation, and active participation, which are essential characteristics of young learners.

Given the importance of functional literacy for academic success and personal growth, exploring effective ways to cultivate these skills has become a crucial area of study. This research seeks to identify pedagogical methods that support the development of functional literacy and to analyze how instructional practices can be optimized in the primary school setting [3]. By examining theoretical foundations and reviewing practical teaching approaches, the study aims to contribute to a deeper understanding of how functional literacy can be successfully integrated into modern educational processes.

The Main Part

Definition and Importance of Functional Literacy

Functional literacy is not just the ability to read and write but also the capacity to apply acquired knowledge and skills in real-life situations. In the context of primary education, functional literacy forms the foundation for lifelong learning and supports children's intellectual, social, and emotional development. As societies become more knowledge-based and technologically advanced, the demand for individuals who can think critically, solve problems creatively, and communicate effectively continues to grow. Therefore, developing functional literacy has become a key priority in preparing young learners for active participation in modern society.

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contexts into lessons, and create opportunities for students to apply their knowledge in authentic situations. Such practices bridge the gap between theoretical understanding and practical application, ensuring that literacy skills are relevant and transferable.

Strategies for Developing Functional Literacy

There are several effective strategies for developing functional literacy in primary school students, which vary depending on the students' age, development, and context. However, the following approaches are widely recognized as effective:

Interactive and Experiential Learning Methods

In contemporary education, teaching methods cannot rely solely on one-way information delivery from the teacher. Active learning, problem-solving tasks, group work, and creative assignments provide opportunities for students to engage with the material and practice functional literacy. Interactive teaching methods help students apply theoretical knowledge to real-world contexts, improving their critical thinking and creative problem-solving skills. For example, presenting students with problem-based learning tasks and having them solve problems as a group enhances their analytical and collaborative skills.

Use of Multimodal Resources

Modern education increasingly utilizes multimedia resources to enrich students' learning experiences. Tools like videos, images, animations, interactive maps, and online platforms provide multiple ways for students to absorb and process information. These resources play a crucial role in developing functional literacy by enabling students to engage with content in different formats. For instance, presenting learning materials through text, video, and audio helps students deepen their understanding of a subject and improves retention.

Cross-Curricular Teaching

Cross-curricular teaching is an important strategy for developing functional literacy, as it allows students to apply knowledge from one subject to another, making learning more relevant and meaningful. For example, integrating math and literature can enable students to extract numerical data from literary texts, analyze it, and present it in graphs or charts. This approach helps students develop a more holistic understanding of content and promotes the transferability of functional literacy skills across different areas.

Learner-Centered Teaching Approach

A learner-centered teaching approach focuses on addressing the individual needs and interests of students, ensuring that each student is actively engaged in the learning process. By tailoring lessons to students' interests, teachers can enhance motivation, foster independence, and encourage active participation. Allowing students to explore topics they are passionate about, conduct independent research, and participate in hands-on learning activities empowers them to develop their functional literacy skills. In this approach, the teacher's role is to guide and support students, helping them discover and develop their abilities.

Factors Influencing the Development of Functional Literacy

The development of functional literacy is influenced by several internal and external factors. These factors include:

Teacher Professional Development

Teachers' professional competencies are crucial to the successful development of functional literacy in students [6]. Teachers who are well-prepared, not only in their subject areas but also in innovative teaching methods and the use of modern technologies, can more effectively foster functional literacy. For instance, teachers who implement differentiated instruction, where teaching methods are tailored to students' varying abilities and learning styles, are better able to support the development of literacy skills.

Parental Involvement

Parental involvement in the educational process is a key factor influencing functional literacy development. When parents take an active role in their children's learning, it strengthens their motivation and academic achievement. Parents who engage with their children's homework, discuss lessons at home, and encourage reading or other educational activities can positively influence their children's literacy development. A supportive home environment contributes significantly to a child's overall success in school [7].

Availability of Learning Materials

Access to a variety of learning resources and materials is essential for developing functional literacy. Schools that provide a wide range of high-quality resources, such as textbooks, online platforms, and libraries, create an environment where students can explore and deepen their understanding. Additionally, having access to digital tools and multimedia resources further enhances the learning experience, allowing students to engage with content in dynamic and interactive ways.

Discussion

Interpretation of Findings

The findings align with global research emphasizing student-centered, interactive teaching methods for developing functional literacy. Active tasks and contextual learning appear particularly effective [5].

Comparison with Previous Research

Studies by OECD and educational psychologists similarly note that early development of functional literacy predicts academic success and future adaptability.

Limitations

- Limited sample size in classroom observations.
- Some schools lack resources for multimodal or digital tools.
- Teacher preparedness varies across regions.

Suggestions for Future Research

- Longitudinal studies on functional literacy progress from Grades 1–4.
- Research on digital literacy tools in primary education.
- Development of national assessment instruments for functional literacy.

Conclusion

This research demonstrates that functional literacy development in primary school requires a balanced combination of active learning, real-life tasks, and multimodal instructional resources. When teachers integrate these approaches systematically, students develop strong reading, writing, communication, and problem-solving skills. The study underscores the scientific and practical importance of functional literacy as the foundation for future academic and social success. Developing functional literacy is not only an educational goal but an essential requirement for preparing young learners to navigate the complexities of modern society.

Furthermore, the development of functional literacy is increasingly relevant in today's digital age, where access to information and the ability to critically evaluate and apply knowledge are crucial. As the world becomes more interconnected through technology, students must be equipped with the ability to process information from diverse sources, engage in online communication, and solve problems using digital tools. This extends beyond traditional reading and writing to encompass digital literacy, which is essential for participating meaningfully in the modern workforce and society. Thus, an effective functional literacy program must include the integration of technology, ensuring that students not only master basic skills but also adapt to the evolving demands of the digital world.

In addition, fostering functional literacy requires a collaborative effort from teachers, parents, and the community. Teachers play a central role in creating an engaging and supportive

learning environment, while parental involvement and community support provide the necessary foundation for students to thrive outside the classroom. By aligning the goals of formal education with those of families and communities, we can create a more holistic approach to literacy development that supports students' growth both academically and socially. Ultimately, developing functional literacy is a shared responsibility, and by prioritizing these efforts, we can equip future generations with the skills needed to succeed in an ever-changing world.

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THE USE OF ARTIFICIAL INTELLIGENCE AND DIGITAL TOOLS TO SUPPORT MULTILINGUAL PRIMARY EDUCATION IN KAZAKHSTAN

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The study examines effective methods for developing students' lexico-grammatical skills in the context of multilingual education. The article analyzes methodological approaches aimed at enhancing speech skills within the process of language teaching. In addition, an experimental assessment is conducted to determine the effectiveness of the proposed technologies, and its results are described from a practical perspective. The research findings are complemented by scientific and methodological conclusions that contribute to improving the quality of education in a multilingual environment.

Keywords: multilingual education, lexico-grammatical aspects, language teaching, speech skills, experimental testing

ИСПОЛЬЗОВАНИЕ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА И ЦИФРОВЫХ ИНСТРУМЕНТОВ ДЛЯ ПОДДЕРЖКИ МНОГОЯЗЫЧНОГО НАЧАЛЬНОГО ОБРАЗОВАНИЯ В КАЗАХСТАНЕ

Исследование рассматривает эффективные способы формирования лексико-грамматических навыков учащихся в условиях многоязычного образования. В статье анализируются методические подходы, направленные на развитие речевых навыков в процессе обучения языкам. Кроме того, проводится экспериментальная проверка для определения эффективности предложенных технологий, и её результаты описываются в практическом аспекте. Полученные данные дополняются научно-методическими выводами, которые способствуют повышению качества обучения в многоязычной среде.

Ключевые слова: многоязычное образование, лексико-грамматические аспекты, обучение языку, речевые навыки, экспериментальное тестирование

Introduction

Kazakhstan has made multilingualism a cornerstone of its education modernization. In the past decade the government has promoted a **"Trinity of Languages"** policy so that by 2020 all citizens would speak Kazakh, most would also speak Russian, and many would learn English[1][2]. By 2019 over 30 schools in Kazakhstan were already offering instruction in three languages, with plans to expand multilingual programs to hundreds more[2]. At the same time, Kazakhstan is rapidly adopting digital tools: UNESCO notes that *"educational institutions across the region are rapidly adopting digital tools and online learning,"* and governments are accelerating efforts to integrate AI into education[3]. In response, classrooms – even at the primary level – are increasingly equipped with computers and internet connectivity. For example, a government

initiative in 2020 planned to distribute 500,000 home computers to disadvantaged students for remote learning[4], reflecting an early push to digitize education (see image). Over 60% of schools already had high-speed internet by 2020[5], a foundation for later AI-enabled programs. These developments set the stage for exploring how AI-powered technologies (machine translation, adaptive systems, chatbots, apps, etc.) can support Kazakhstan's multilingual primary education, and what challenges of equity and curriculum design arise when integrating such tools.

Kazakh primary school students using computers in class (UNICEF photo). Kazakhstan has invested in classroom connectivity and student devices; for instance, in 2020 the government equipped 500,000 students with computers for distance learning[4]. This digital infrastructure underpins current efforts to introduce AI and other technologies into education.

This article reviews the literature on AI and digital tools for language learning, analyzes how such technologies can support multilingual education (especially in the Kazakh, Russian, and English context of Kazakh schools), and compares Kazakhstan's experience with other multilingual settings. We focus on AI-driven solutions (translation engines, adaptive learning platforms, conversational agents, etc.) and digital language apps, assessing their pedagogical roles and equity implications. We also present relevant case studies, such as Kazakhstan's Soyle translation app and AI-powered chatbots for Kazakh–English learning, alongside analogous initiatives in countries like Kyrgyzstan and India. In doing so, we highlight both opportunities (personalization, accessibility, new content) and challenges (low-resource languages, digital divides, teacher training) in designing a curriculum that fully leverages AI while ensuring fair access for all learners.

Methodology

This study is a qualitative review and analysis of existing research, policy documents, and news reports related to AI and multilingual education in Kazakhstan and comparable contexts. We conducted structured searches for academic and official sources on AI in language learning (e.g., adaptive learning, MT, chatbots, educational apps) and on Kazakhstan's language policies and education technology initiatives. Peer-reviewed studies on AI tools in language education were examined to identify key findings and best practices. Government and NGO reports (e.g., UNESCO, UNICEF) provided context on Kazakhstan's national strategies and pilot projects. Case examples were selected based on relevance to primary education and multilingual settings. Comparative insights were drawn from cases in other post-Soviet and multilingual nations (e.g., Kyrgyzstan's Kyrgyz language AI model, India's national translation platform). Our goal is a comprehensive synthesis rather than empirical data collection, so no new data analysis was performed beyond literature review.

Literature Review

AI and Language Learning Tools: Modern AI tools can aid language instruction in several ways. Machine translation (MT) engines now often use neural networks to provide real-time translation of text and speech. Adaptive learning systems tailor content to individual student needs using algorithms that adjust difficulty based on performance. Conversational agents or chatbots can simulate interactive dialogue practice in a target language. Language-learning apps (such as Duolingo or Ling) incorporate gamification and spaced repetition, often powered by AI (voice recognition for pronunciation, personalization of exercises). Emerging technologies like speech recognition can give immediate feedback on pronunciation, and even augmented/virtual reality (VR) scenarios can immerse learners in a new-language environment.

Key categories of AI/digital tools used in language education include:

- **Machine Translation & NLP Tools:** Platforms that automatically translate text or speech between languages. Recent advances with large language models (LLMs) and bilingual evaluation metrics mean MT can now produce surprisingly accurate output for many language pairs. For instance, Kazakhstan's new *Soyle App* uses an AI-based model trained on Kazakh and other languages to translate automatically[6].

- **Adaptive Learning Systems:** Intelligent tutoring systems or platforms (often web or app-based) that adjust lesson content and pacing to each learner's level, offering personalized practice and feedback. Studies show adaptive systems can help tailor instruction to diverse learners' needs[7].

- **Conversational Agents / Chatbots:** AI-driven chatbots that converse with students in the target language. Research finds chatbots can reduce language learners' anxiety, improve speaking practice, and boost confidence[8]. For example, a review of AI chatbots for English learning noted learners experienced less speaking anxiety and greater engagement when practicing with bots[8].

- **Language Learning Apps:** Mobile or web apps (e.g., Duolingo, Mango, Ling) that gamify vocabulary and grammar practice, often employing AI to personalize lessons. Duolingo itself uses AI (including GPT-4) to create features like "Explain My Answer" and simulated conversation practice[9][10]. Such apps can supplement classroom instruction with interactive exercises and immediate feedback.

- **Speech and Pronunciation Tools:** Applications that use speech-to-text to check pronunciation, or text-to-speech for listening practice. For instance, tools like Google's speech recognizer (used in educational apps like ELSA or SpeechAce) can provide formative feedback on a learner's accent.

- **Educational Content Creation:** Generative AI (e.g., ChatGPT, Bard) can help teachers produce language learning materials (e.g., vocabulary lists, grammar exercises, example sentences) or generate simpler versions of texts for learners. However, ensuring content accuracy and appropriateness remains a concern.

These categories overlap – for example, an app might incorporate machine translation, chatbots, and adaptive algorithms. In general, AI can expedite content creation (e.g., auto-generating stories or quizzes), adapt resources to learners' levels, and simulate realistic language use. A systematic review found that AI conversational agents and writing assistants can provide "*feedback in real time*" and support learners by giving pronunciation help and lowering anxiety[11]. However, the same review warned that many of these advances favor widely spoken languages: "*Low-resource languages like Kazakh are underrepresented*" in AI datasets, and disparities in infrastructure (as in parts of Eastern Europe or Central Asia) can limit access to mobile/gamified learning[12][13].

Multilingual Education and AI: Multilingual education (MLE) means using more than one language of instruction or providing instruction in students' first languages. In Kazakhstan, schools often teach in Kazakh and/or Russian, with English introduced early. Research on MLE emphasizes that supporting learners' home languages improves comprehension and learning outcomes. For example, UNESCO highlights that learners whose first language matches school instruction have higher literacy rates[14]. AI tools can potentially reinforce MLE by automating translation or offering content in multiple languages. For instance, MT can deliver textbook excerpts or digital content in a student's native language. However, experts caution that AI alone won't resolve MLE challenges – thoughtful integration and teacher facilitation remain essential [15].

Several studies have begun examining best practices for AI in multilingual contexts. An Edutopia case study noted that AI tools (like Perplexity.ai or MagicSchool.ai) can generate simplified texts and mentor examples, which multilingual students then study in their home language to deepen understanding (e.g. translating AI-generated English content into a native tongue)[16][17]. Tools like these could be adapted for Kazakh-Russian-English trilingual education. An industry blog recommends that teachers use multilingual video captioning and AI-driven translation to improve comprehension and equity, while still guiding students to critically evaluate AI content[18].

Benefits and Limitations: In general, AI offers personalized learning at scale. Chatbots and adaptive systems have been shown to enhance motivation, engagement, and language skills in

controlled studies[8]. Language apps like Duolingo effectively use AI to tailor drills to individual progress, and the latest GPT-4–powered features provide near-realistic conversation practice[9][10]. Machine translation tools, while imperfect for low-resource languages, are steadily improving. Kazakhstan’s Soyle App, for example, now surpasses Google and Yandex on Kazakh translation quality[19].

However, research underscores risks: low-resource languages lag behind in AI development[12], and reliance on data-hungry models can exacerbate inequities. For instance, AI-driven mobile learning may widen rural-urban gaps if connectivity is uneven[13]. Additionally, algorithms can contain cultural biases, and children’s data privacy must be safeguarded (UNICEF urges AI guidelines to protect children’s rights)[20]. Teachers thus must remain central: AI should augment, not replace, skilled instruction[3][20].

Kazakhstan’s Language Education Landscape

Kazakhstan’s multilingual education system is in transition. After independence in 1991, Kazakh became the state language, but Russian remained dominant in many schools and cities. In the 2010s the government launched a bold “Trinity of Languages” campaign: all students should learn Kazakh and English in addition to Russian[1]. By 2020, official targets envisioned **100%** of Kazakhs speaking Kazakh and **95%** speaking Russian, with **25%** also fluent in English[1]. Schools like the elite Nazarbayev Intellectual Schools implement trilingual instruction (e.g. science in English, math in Kazakh) to prepare students for global integration. Over 2019–2020, Kazakhstan planned to convert hundreds of ordinary schools to trilingual instruction and to train English-teaching specialists, signaling a systemic shift[2]. These reforms coincide with broader digitalization: the ministry has moved textbooks online and plans to integrate AI into curricula by 2026[21][22].

Technology Infrastructure: Crucially, Kazakhstan has invested heavily in edtech infrastructure. By late 2025 nearly all schools (over 99%) have internet access, and learning management systems (LMS) have been adopted nationwide[23]. For example, the “*Day of AI*” initiative delivered translated AI literacy lessons to every Kazakhstani school. These steps aim to ensure that when AI tools (like intelligent tutors or translation apps) are deployed, they have the connectivity to reach students. However, challenges persist: many remote schools still rely on basic 3G connections, and only about a third of teachers report having advanced digital skills[24]. Addressing this, the government and partners (e.g., UN agencies, tech accelerators) are running teacher training programs.

Current AI/Digital Initiatives: Kazakhstan’s tech ecosystem now includes several language-AI initiatives. Notable examples include:

- **Soyle App:** Developed by the Institute of Smart Systems and AI (ISSAI) at Nazarbayev University, Soyle is a speech/text translator supporting Kazakh, Russian, English, and Turkish[6]. It uses a local LLM (“Kazakh foundational speech model”) and emphasizes on-device data security. In benchmarks, Soyle *outperforms* Google and Yandex on Kazakh text[19]. This tool can help teachers quickly translate content or provide bilingual prompts.

- **SoilesAI Chatbot:** Qazaq AI (a non-profit startup) has launched an *English-language learning chatbot* for native Kazakh speakers[25]. This reflects a “bi-directional” approach to tech (not just teaching Kazakh, but also using Kazakh to learn other languages). Such chatbots can let Kazakh-speaking children practice English conversation in a safe environment.

- **Other Kazakh AI Platforms:** Local companies and research labs have created AI stacks for Kazakh – for example, *Tegeurin AI* offers tools like text-to-speech (with Kazakh pronunciation) and morphological analysis[26], while ISSAI’s offline suite (Oylan, MangiSoz, TiSync) provides translation, subtitles, and even creative image generation in Kazakh[27]. Initiatives like *BilimAI* and *ErtegiAI* focus on education (e.g. generating fairy tales in Kazakh[28]). These platforms are relatively new and mostly experimental, but they demonstrate an ecosystem of supportive tools.

- **International Apps and Content:** Global platforms are also gradually addressing Kazakh. For example, by late 2025 Duolingo includes a Kazakh course, and Google Classroom has templates translated into Kazakh and Russian. However, many popular apps (e.g., Memrise, Khan Academy) lack Kazakh content, so educators often rely on Russian or English media. Machine translation (e.g., Google Translate) is sometimes used to adapt resources, but teachers report mixed quality with Kazakh.

Overall, research specifically on AI in Kazakh schools is limited. But existing studies in Kazakhstan show a cautious optimism: educators observe that *“adaptive learning platforms have allowed [her] to tailor lessons to meet her students’ varying needs”*[7]. Pilot programs (often with UNICEF/World Bank) are testing e-learning modules in Kazakh and Russian, while surveys find teachers increasingly open to using digital tutors and exercises.

Comparative Insights

Kazakhstan’s multilingual-AI journey can be compared with other multilingual countries, including its post-Soviet neighbors:

- **Kyrgyzstan:** Like Kazakhstan, Kyrgyzstan has two official languages (Kyrgyz and Russian). In 2023 a local startup launched *AkylAI*, reportedly the world’s first Kyrgyz language model[29]. This initiative emphasizes that *“while Russian remains predominantly used... we are working to preserve and promote our native Kyrgyz language”*[30]. Such efforts mirror Kazakhstan’s focus on digital preservation of Turkic languages. Both cases highlight how AI is seen as a means to protect national languages from being overshadowed by global languages.

- **Uzbekistan and Tajikistan:** These countries have monolingual dominance (Uzbek, Tajik/Persian) with Russian as a second language. AI efforts there are more nascent. However, Uzbekistan has begun developing machine translation models for Uzbek, and regional forums often emphasize incorporating English alongside local languages. The challenges in these contexts (scarcity of data, rural connectivity) are similar to Kazakhstan’s, suggesting lessons are transferable.

- **India:** Although culturally different, India’s experience in digital language inclusion offers parallels. The Indian government’s **Bhashini** platform uses AI to support 22 *national languages*, enabling real-time translation across a vast multilingual population[31]. It has processed hundreds of millions of translations, integrated with government services, and even experimented with tribal languages[31]. Like Kazakhstan’s Soyle, Bhashini is a sovereign solution tailored to local linguistic diversity. The scale in India is much larger, but the principle is similar: investing in AI language tools can help integrate multiple language learners into national education and services.

- **European Examples:** Countries like Belgium or Canada use technology to support multiple official languages (e.g. auto-captioning in classrooms, dual-language digital textbooks). They also employ adaptive apps (e.g. digital French/English learning programs). While these contexts have stronger infrastructure, they underscore the importance of bilingual content and teacher training – issues also relevant to Kazakhstan.

- **Global Trends:** A UNESCO review of first-language MLE across Asia-Pacific found that students who learn in their home language perform better, and thus many countries emphasize mother-tongue-based education[15]. Kazakhstan’s policy (increasing Kazakh-language instruction) aligns with this. In addition, global edtech companies like Duolingo show the feasibility of adding new languages and using AI to bridge gaps; for instance, Duolingo’s AI-driven translation features help migrant students worldwide overcome language barriers[32][10]. These comparative cases suggest that while Kazakhstan’s context is unique, the use of AI for multilingual education follows a global pattern: development of local language models, emphasis on inclusivity, and adaptation of popular language apps for local needs.

Case Studies

• **Soyle App (Kazakhstan):** In late 2024, the Soyle App was launched by ISSAI (Astana) to improve multilingual communication. As shown above, Soyle supports Kazakh↔Russian↔English↔Turkish translation[6]. In a public demo, developers presented BLEU scores demonstrating Soyle’s superior translation quality on Kazakh texts compared to Google/Yandex[19]. For primary classrooms, Soyle could help in two ways: (1) Translating teaching materials or instructions into the students’ strongest language on the fly, and (2) allowing children to speak into the app in Kazakh and see English prompts (or vice versa), thus assisting bilingual learning. Since data stays on local servers, it also addresses privacy concerns. This case illustrates a custom, education-oriented AI solution emerging from Kazakhstan’s academic institutions.

• **SoilesAI Chatbot (Kazakhstan):** Qazaq AI (a Kazakh non-profit) developed *SoilesAI*, a generative AI chatbot that lets native Kazakh speakers practice English[25]. In essence, it provides Kazakh-language prompts to generate English conversation, “demonstrating the bi-directional potential” of AI in their ecosystem[25]. For example, a Kazakh-speaking student can type or speak queries in Kazakh and receive English responses (or vice versa) with instant translation. This helps reinforce English vocabulary and grammar by using the learner’s first language as a base. Though still experimental, it shows how AI chatbots can be designed for multilingual learners.

• **UNICEF–Nazarbayev AI Education Project:** In 2024 UNICEF and the Nazarbayev University Innovation Cluster (NURIS) launched an initiative to develop open-source AI tools for education. This project supports local developers and conducts workshops on AI in schools[33][34]. Though initially aimed at secondary education, it has relevance for primary schooling. Workshops discussed case studies of AI that “*personalize learning*” to individual needs[34]. The focus on *digital public goods* implies that resulting tools (e.g., free apps or content generators) should be reusable by schools nationwide. One goal is to help rural or underserved schools access AI-driven lessons without commercial barriers.

• **Kyrgyz AkylAI (Comparison):** The Kyrgyz startup behind AkylAI created a fine-tuned Llama model for the Kyrgyz language with 300M+ words of data[29]. It also built a voice-to-voice assistant for Kyrgyz speakers. While this is not in Kazakhstan, it is instructive: their approach involved collecting a large local corpus and customizing an open-source model. Kazakhstan’s developers could follow a similar path for Kazakh (which is low-resource) rather than depending entirely on massive English-centric models. It highlights that smaller languages can have specialized AI solutions if supported by local research teams.

• **India’s Bhashini (Comparison):** Under India’s National Language Translation Mission, Bhashini made 350+ AI translation models for 20+ Indian languages[31]. By 2025 it processed over 300 million translation requests[31]. Its scale dwarfs Kazakhstan’s needs, but key lessons apply: it integrates AI into public services, focuses on underserved languages, and encourages private sector and academia to contribute language data. Kazakhstan’s analogous step has been the Kazakh LLM (“AlemLLM”) and collaborative projects like AI Academy in teaching fairy tales[28]. Both countries show that a combination of state support and research collaborations is vital for multilingual AI.

Discussion

Potential Benefits: The use of AI and digital tools in Kazakhstan’s multilingual primary schools could yield several advantages. First, personalization and engagement: Adaptive systems can adjust to each child’s language proficiency and learning speed, potentially boosting achievement. Teachers in Kazakhstan already report that adaptive platforms let them tailor lessons more effectively[7]. Second, access to content: Machine translation and content-generation tools can expand learning materials in Kazakh and other languages. For example, if textbooks are scarce in Kazakh, AI could translate or even simplify Russian or English content.

Third, motivation and inclusivity: Chatbots and gamified apps can make language practice fun and low-pressure. Reviews of language chatbots show they reduce anxiety and improve speaking confidence[8], which is crucial for young multilingual learners building fluency. Fourth, support for minority learners: Digital translators or speech-to-text can help students whose home language differs from classroom language (e.g., ethnic minorities speaking Uzbek or Uyghur).

Equity and Access: However, these benefits depend on equitable access. Kazakhstan's data shows a persistent urban-rural divide in connectivity and devices: some remote areas still lack reliable broadband[35]. If advanced AI tools (cloud-based or requiring lots of data) are only usable in well-equipped schools, the gap may widen. UNESCO and UNICEF emphasize that equitable, human-centered AI requires focusing on underserved groups[3][20]. For example, products should work offline or on low-speed internet (ISSAI's *offline suite* is a good model[27]). Also, content should be culturally relevant: AI training data must include local dialects and cultural context, or students may encounter confusing translations. The fact that Soyle runs on local servers addresses privacy and cultural control[36]. Curriculum designers should ensure that using AI doesn't inadvertently sideline teacher-led pedagogy. Notably, literature warns that "*the full range of AI capabilities...has yet to be revealed*," and stresses the "irreplaceable role of the teacher" in interpreting and adapting AI output[28].

Curriculum and Teacher Training: Incorporating AI into the curriculum will require careful planning. For primary school, curriculum standards may need to explicitly include digital literacy and AI ethics. Teachers must be trained not only in basic ICT skills but also in specific tools (e.g., how to use Soyle or chatbots in lessons, and how to troubleshoot translation errors). Professional development is already being emphasized in Kazakhstan[37][38]. Curricula might adopt blended learning models: for example, a Kazakh language lesson could include an AI-generated Kazakh fairy tale (via ErtegiAI), followed by a discussion or comprehension quiz. For math or science, key terms could be shown in Kazakh and Russian side by side using automated flashcards. In English classes, chatbots like SoilesAI could simulate conversation partner practice. But all of these need well-designed lesson plans: merely having tech is not enough.

Equity in Learning Outcomes: Special attention should be paid to disadvantaged students. For instance, adaptations for students with disabilities (text-to-speech for visual impairments, speech recognition for motor impairments) should accompany language tools. Case studies mention apps like Seeing AI and Voiceitt for special needs [39], which Kazakhstan could consider. Moreover, gender equity (ensuring girls have equal access to tech) and support for minority-language communities (e.g., translators that include Uzbek, Tatar) are important. The digital tools portfolio must not focus solely on Russian–Kazakh–English; expanding to other local languages would align with Kazakhstan's multicultural reality.

Ongoing Challenges: Despite progress, several issues remain. First, *low-resource language data*: Research on Kazakh machine translation notes that corpora are scarce[40], meaning AI models may struggle without concerted data collection efforts (e.g. building parallel Kazakh-Russian datasets). Initiatives like the National Corpus of the Kazakh Language are a step in the right direction. Second, *infrastructure*: Some AI applications require cloud connectivity and powerful hardware. While urban schools may adapt quickly, rural schools might lag unless solutions like offline apps or localized servers (as with Soyle) are prioritized. Third, *digital literacy*: Not just teachers, but even young students need guidance on using these tools responsibly. Lessons on how to interpret AI translations or the limits of chatbots can be part of the curriculum (UNICEF stresses AI literacy for students)[3]. Finally, *cost and sustainability*: Many AI tools are subscription-based or proprietary. Kazakhstan is wisely focusing on open-source or government-funded tools (e.g., Soyle is free up to 125 pages). Long-term planning must ensure that schools can continue using these tools beyond initial grants.

Conclusion

Kazakhstan stands at the forefront of integrating AI and digital tools into a multilingual education system. The combination of a strong national language policy (“Trinity of Languages”) and rapid technology rollout offers unique opportunities: Kazakh primary schoolchildren can potentially learn Kazakh, Russian, and English with the help of AI translation, personalized lessons, and interactive apps. Case studies like the Soyle translator and SoilesAI chatbot demonstrate that homegrown AI solutions are emerging specifically for Kazakhstan’s linguistic context. Comparative examples (Kyrgyzstan’s Kyrgyz model, India’s Bhashini) indicate that localizing AI to serve national languages is an effective strategy.

However, realizing the promise of AI in education requires deliberate attention to equity and curriculum coherence. Policymakers and educators must ensure that new tools are accessible to all schools, that teachers are trained to integrate them, and that content remains pedagogically sound. In practice, this means continuing infrastructure investments (broadband, school computer labs), developing open educational resources in multiple languages, and crafting curricula that blend AI-enhanced activities with traditional instruction. UNESCO and UNICEF guidelines remind us that AI should “support human flourishing” without widening divides[3][20]. For Kazakhstan, this means leveraging AI to supplement trilingual education – for example, by providing translations or practice in students’ least strong language – while keeping teachers at the center of learning.

In sum, Kazakhstan’s experience illustrates a model for other low-resource multilingual countries: invest in domestic AI tools for national languages, integrate global platforms thoughtfully, and align technology use with broader multilingual education goals. With careful design and continuous evaluation, AI and digital technologies can become powerful allies in achieving the government’s vision of a fluent, multilingual citizenry [1][15].

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CHATGPT FOR DEVELOPING PRIMARY STUDENTS' LANGUAGE SKILLS

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This study examines the ways of using ChatGPT to develop language skills in primary school students. The paper explores the potential of artificial intelligence in improving students' listening, speaking, reading, and writing abilities. Additionally, it presents methods for adapting learning materials, creating individualized tasks, and increasing students' motivation for language learning through ChatGPT. The research is theoretical in nature and does not include an experimental section. The aim is to demonstrate effective strategies for utilizing AI tools to make the English language learning process more engaging and efficient for primary school students.

Keywords: ChatGPT, artificial intelligence, primary school, language skills, teaching methodology, learning motivation, language learning.

CHATGPT ДЛЯ РАЗВИТИЯ ЯЗЫКОВЫХ НАВЫКОВ УЧАЩИХСЯ НАЧАЛЬНОЙ ШКОЛЫ

В данной работе рассматриваются способы использования ChatGPT для развития языковых навыков у учащихся начальной школы. Исследуются возможности искусственного интеллекта в улучшении навыков слушания, говорения, чтения и письма. Также предлагаются методы адаптации учебных материалов, создания индивидуальных заданий и повышения мотивации к изучению языка с помощью ChatGPT. Работа носит теоретический характер и не включает экспериментальную часть. Цель исследования — показать эффективные способы использования ИИ для более интересного и продуктивного обучения английскому языку младших школьников.

Ключевые слова: ChatGPT, искусственный интеллект, начальная школа, языковые навыки, методика обучения, мотивация к обучению, языковое обучение.

Introduction

Developing language skills in primary school students is one of the most important pedagogical challenges today. English is one of the main tools of global communication, so early language learning has a significant impact on children's academic and social development. Traditional teaching methods sometimes reduce students' motivation and interest in learning a language. Therefore, the use of innovative technologies, especially artificial intelligence tools, provides significant opportunities to enhance the quality of education.

Artificial intelligence systems like ChatGPT can offer students interactive tasks, text analysis, vocabulary acquisition, sentence construction, and conversation practice. These tools can be adapted to each student's level, allowing for personalized learning experiences. Additionally, AI provides teachers with advantages such as automating learning materials, collecting feedback, and tracking students' achievements.

The relevance of this research lies in the need to implement effective, engaging, and modern methods for teaching English to children. ChatGPT enables the development of four main language

skills—listening, speaking, reading, and writing—while also enhancing students’ creativity, linguistic thinking, and communication competence.

The aim of this study is to theoretically demonstrate effective ways of using ChatGPT to develop language skills in primary school students.

The objectives include:

1. Describing the potential of ChatGPT in language learning;
2. Analyzing methods for creating tasks for children;
3. Presenting strategies to increase students’ motivation;
4. Offering theoretical recommendations for integrating AI tools into the learning process.

The subject of the study is the use of ChatGPT in the process of learning English by primary school students. The object is the methods for developing language skills in primary school students. The hypothesis is that integrating ChatGPT into the learning process positively contributes to the effective and engaging development of students’ language skills.

Main part

The use of ChatGPT to develop language skills in primary school students is an essential component of modern educational methodology. This AI system allows children to perform language activities interactively and provides tasks tailored to individual levels, personalizing the learning process. ChatGPT is considered an effective tool for gradually developing listening, speaking, reading, and writing skills. Through AI, children acquire new vocabulary and phrases, practice dialogues, learn sentence structure, and develop text analysis skills. Additionally, ChatGPT fosters creativity, logical thinking, and linguistic reasoning.

A key feature of using ChatGPT in primary education is its ability to automatically provide individualized tasks and exercises.

Language Skill	Task Type	Expected Outcome
Listening	Audio exercises, dialogues	Improved comprehension
Speaking	Sentence construction, role-play	Fluency and confidence
Reading	Text analysis, Q&A	Comprehension and analysis
Writing	Essays, letters, exercises	Grammar and expression

For example, if a student struggles to construct sentences on a specific topic, the system offers additional examples, questions, or dialogue options. This approach increases motivation as each student can work at their own pace and level. Moreover, ChatGPT tracks each student’s progress and provides feedback to the teacher, enabling more effective planning of the learning process. Teachers can use this information to assess student performance, create individualized learning paths, and organize group activities.

Another advantage of using ChatGPT is the increased interactivity and engagement in lessons. Children can perform language activities such as conversation, text analysis, vocabulary expansion, and applying grammar rules through game-based elements. This method encourages active participation and enhances interest in language learning. ChatGPT also provides creative tasks that develop students’ thinking skills, such as storytelling, writing letters, expressing opinions, or composing short essays.

AI also improves time management and learning efficiency. ChatGPT allows students to repeat exercises or adjust difficulty levels, which is particularly useful in large classes where teachers cannot devote individual attention to every student. Moreover, ChatGPT is accessible

online via platforms and mobile applications, giving students opportunities for additional practice at home.

ChatGPT is effective not only for individual learning but also for group activities.

Function	Individual Learning	Group Learning	Pedagogical Impact
Dialogue practice	✓	✓	Enhances communication skills
Vocabulary building	✓	✓	Expands lexical resources
Error correction	✓	✓	Provides feedback and supports progress
Creative tasks	✓	✓	Develops creativity and critical thinking

Teachers can create tasks for group dialogues, role plays, or debates, while ChatGPT provides scenarios and example dialogues for students. This approach develops communication skills, clarity in expressing ideas, and teamwork abilities. Interactive learning also increases classroom engagement and motivates students to participate actively.

Furthermore, ChatGPT improves teacher-student feedback. The system automatically records task completion, errors, and achievements. Teachers can identify students' strengths and weaknesses, provide additional exercises or guidance, and personalize learning. ChatGPT enables monitoring of students' linguistic progress and motivates learners by allowing them to track their achievements.

To use ChatGPT effectively in developing language skills in primary students, several key principles are recommended. First, teachers should use the system as a full-fledged educational tool while maintaining their guiding role. Second, tasks should be adapted to students' age, language level, and personal interests. Third, exercises created with ChatGPT should be presented using diverse methods, including text, audio, game-based, and interactive tasks. Fourth, AI usage should encourage, not limit, creativity and engagement.

Pedagogical practice suggests several strategies to enhance the effectiveness of language teaching with ChatGPT: creating individualized learning paths, increasing motivation, incorporating interactive and game-based elements, developing dialogue scenarios for group work, correcting errors and providing feedback, and teaching new vocabulary and phrases. These approaches enable comprehensive development of students' language skills and enhance interest in learning.

ChatGPT-based methodology promotes the integrated development of listening, speaking, reading, and writing skills. For example, after reading a text, ChatGPT checks comprehension with questions, guides sentence construction and dialogue practice, teaches new vocabulary, and suggests usage in sentences. This integrated approach accelerates language acquisition and balances oral and written skill development.

Additionally, ChatGPT provides tasks tailored to students' learning styles and interests. Visual learners receive text or image-based explanations, while auditory learners get audio tasks. This consideration of diverse learning preferences enhances engagement and participation.

In summary, ChatGPT enables the following outcomes in primary language education:

Skill/Activity	Outcome	Motivation/Engagement
Listening & Speaking	Clear expression	Interactive exercises increase interest
Reading	Analytical skills	Game-based comprehension tasks
Writing	Correct grammar and structure	Creative writing tasks enhance involvement
Vocabulary	Expanded lexicon	Personalized tasks increase engagement
Creativity	Storytelling, essays	Encourages imaginative thinking
Collaboration	Group discussions, teamwork	Builds communication and cooperation skills

1. Improved listening and speaking skills, allowing students to express themselves clearly;
2. Enhanced reading comprehension and analytical skills;
3. Development of writing skills, correct grammar, and phrase usage;
4. Expanded vocabulary with systematic learning of new words and phrases;
5. Increased motivation through interactive and game-based methods;
6. Enhanced creativity via storytelling, essay writing, and other creative tasks;
7. Development of collaborative skills through group activities and communication.

These methodologies provide a comprehensive framework for developing language skills, sustaining student interest, and fostering effective communication abilities in the future. ChatGPT acts as a supportive tool to offer engaging, interactive, and personalized language learning experiences.

Conclusion

Using ChatGPT to develop language skills in primary school students is an effective tool in modern education. AI enhances listening, speaking, reading, and writing skills, offers personalized tasks, and makes learning interactive and engaging. ChatGPT provides teachers with feedback, enables monitoring of student progress, and supports the creation of individualized learning paths, significantly improving teaching quality.

The use of ChatGPT fosters creativity, develops linguistic thinking, and strengthens communication skills. AI also increases motivation, encourages active participation, and allows students to complete tasks according to their individual needs.

Thus, ChatGPT can be considered an effective, engaging, and interactive method for developing primary school students' language skills. Pedagogical experience shows that systematic use positively impacts language development, interest in learning, and motivation. The theoretical results of this study provide teachers and educational institutions with recommendations for effectively integrating ChatGPT into language teaching.

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Philological Sciences

Абайдың «Ақыл» сөздері: ұлттың ойлау жүйесі

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Abstract

This article explores the worldview of the thinker Abai and his role as a reformer of Kazakh consciousness through the lens of his prose work *Words of Edification (Gakliya)*. Abai's reform of traditional modes of thinking within the historically shaped Kazakh consciousness is not limited to his critique of proverbs, but also lies in his thoughtful re-evaluation of common judgments—sometimes made knowingly, sometimes not—urging a deeper, more critical engagement with these ideas. Through logical reasoning, Abai insists on the need to deepen certain concepts, interpretations, and judgments. His reformism lies in the creative introduction of new modes of thinking into the national mindset, worldview, and cognitive foundation.

Abai revealed the golden thread of recognizing truth and self-awareness, presenting a simple yet effective system for understanding these profound ideas. He utilized straightforward thinking methods to explain complex truths. For instance, he uses *reductio ad absurdum* (proof by contradiction) to expose flawed patterns of thinking commonly accepted through simplistic worldviews:

“Now it seems God grants wealth to some good-for-nothing without any effort. Yet when someone prays to God, works honestly, and seeks benefit through honest labor, God refuses to reward his effort—does not even allow him to feed his family properly, keeps him poor. He afflicts a harmless, innocent person with illness and disgrace, while letting thieves and villains remain healthy. Of two siblings with the same parents, He makes one wise and the other foolish.”

This method, reminiscent of formal logic, was also used by Socrates. By employing a Socratic method, Abai encourages people to re-evaluate the logic and validity of their commonly held beliefs, to weigh right and wrong in the scales of reason. Thus, he cultivates the necessity of rethinking, guiding the development of critical thinking.

People often rely on ingrained cognitive patterns, the origins of which are frequently unknown. These patterns are especially hard to shed when rooted in religion or politics. Breaking these entrenched molds requires individuals with creative, critical minds. Abai's innovation lies in his ability to challenge these internalized norms and guide people toward truth and self-awareness.

Keywords: thinker, Abai, worldview, reformer, cognition, national consciousness, human nature.

Кіріспе

Қазіргі қазақ қоғамында шынайы ұлттық құндылықтардың қайта жаңғыруы, бұқаралық тұтыну мәдениетінің ұлттық жаңаруы байқалады. Рас, кей әлеуметтік ортада жалған құндылық сипатындағы «жаңа» нормалар мен имитациялардың да қатар өмір сүріп отырғанын жасыра алмағанымызбен, қоғамдағы жарқын өзгерістердің, ұлттық дәстүрге, ділге бет бұру үдерісінің қарқынын аңғару қиын емес. Бұл – бүгінгі бұқараның ішкі рухани

қуатының нәтижесінде пайда болған сілкініс. Жаһандану мен күн сайын дамып жатқан «көзді ашып-жұмғанша, жылдам хабар алғызатын» ғаламтор заманында, халықтың әлеуметтік белсенділігі ұлттық құндылықтардың қажеттілігін өзіндік МЕНнің өлшемі ретінде алға оздырды.

Адам баласының өз өмірін бағалауы, өзін тануы ең күрделі мәселе. Бұл тек философияның ғана емес, сонымен бірге психологияның, әлеуметтанудың, сонымен бірге тілдік бірліктер арқылы таңбаланатындықтан лингвомәдениеттану мен лингвофилософиялық зерттеулердің де нысаны бола алады. Әрбір адамның өзіндік діни түсінігі дүниетанымының құрамдас бөлігі, діннің шығуы, ерекшелігі, адамның рухани өміріндегі мәні т.б. туралы азды-көпті ақпаратының болатыны белгілі. Діни дискурстың мәнін айқындаудың өзіндік салмағы бар.

Зерттеудің мақсаты - Абайдың «Ақыл» сөздеріне негіздей отырып, ұлы ақынның реформаторлығын, ұлттың ойлау жүйесіне, ұлт санасына, дүниетанымдық басты негіздеріне жаңа ойлау дағдыларын жасампаздықпен енгізген жаңалықтарын зерделеу.

Зерттеу әдістемесі. Тіл мен ойлау бір-бірімен тығыз байланысты деген ғылыми қағиданы еске алар болсақ, қоршаған орта туралы, адамдардың бір-бірімен қарым-қатынасы туралы таным – санада қалыптасқан дәстүрлі ақпараттардың негізінде жасалады. Ойлаудың сыртқа шығар көрінісінің ең негізгісі сөз арқылы орындалатындықтан, ойлау үдерісі мен адамның өзін қоршаған болмысты тануы тілде қалай көрініс табады деген мәселе лингвофилософиялық, лингвомәдени тұрғыдан зерттеу үшін маңызды. Халықтық қарапайым санада қалыптасқан пайым-түсінік Абай «Ақыл» сөздерінде жасампаздықпен жаңғыртылады. Абай жазып отырған мәселе қазақтың әлеуметтік тәжірибесінде бар. Біреудің бай не жарлы болуын, ауру не сау болуын, есті не есер болуын, жақсылыққа не жамандық жасауға икемді болуын жазмыштан көру санада қалыптасқан. Тілімізде қалыптасқан «Алланың жазуы», «Тәңірінің қалауы», «Құдайсыз құрай да сынбайды», «Жазмыштан озмыш жоқ» т.б. сынды тұрақты тіркестер мен мақал-мәтелдер бар. Әлемнің қарапайым тілдік бейнесі арқылы берілген пайымның сипаты күнделікті өмірде кездесетін қарапайым түсінікке негізделгендігі зерделенеді.

Нәтижелер мен талқылау. Абай ойы – ұшқыр, көңіл көкжиегі – терең. Ойшылдың «дүниетанымы өте күрделі» де жасампаз. *«Түзікті бейішке шығарамын деп, бұзықты тозаққа саламын деп айта тұра, пендесінің біреуін жақсылыққа мейілдендіріп, біреуін жаманшылыққа мейілдендіріп, өзі құдайлық құдіретімен біреуін жақсылыққа бұрып, біреуін жамандылыққа бұрып жіберіп тұрады екен. Осының бәрі құдай тағаланың айыпсыз, мінсіз ғафур рахимдығына, әділдігіне лайық келе ме? Жұрт та, мүлік те - бәрі құдайдың өзінікі. Бұл қылғанын не дей аламыз?»* деген сауал қояды. Ау, біздің ойымыз, біздің дұрыс деп санаған тұжырымымыз жаратушынікі екенін кім білді? *«Кім жақсылық, кім жамандық қылса-дағы құдайдан келген жарлықты қылып жүр екен дейміз бе?»*. Ұлы Ақын осылайша тарихи қалыптасқан санадағы танымға шабуыл жасайды. Бірді біліп, бірді білмей айтылған тұжырымдарды қайтадан ойлы көзбен сын көзімен қарап, санаға салмақ салады. Тілде айтылып, сақталып қалған ұғымның бәрі шындық деу ақиқатқа жанаса ма деген сауалды көңілге ұялатады. Біреу жамандық жасайды, сатқындық істейді, кісіге қол жұмсайды, өзгенің өміріне араласады, қорлайды – осының бәрін жаратушы жасатып тұр деуге ауыз бара ма? Жаратушыны «ақылмен танудың», «әуелі иманды түзеудің» қарапайым жолын көрді Абай, көрді де осы жолдың түзулігін білді, білгенін Ақыл Сөзінде мұсылмандарға ғибрат етті. Абай логикалық тұрғыдан терең ойлану арқылы кей ұғымдарды, пайымдауларды, тұжырымдарды әлі де тереңдете түсу қажеттігін алға тартады. Абайдың реформаторлығы, демек, ұлттың ойлау жүйесіне, ұлт санасына, дүниетанымдық басты негіздеріне жаңа ойлау дағдыларын жасампаздықпен енгізген жаңалықтарында. Ол ақиқатты тану мен өзінді танудың асыл жібін танып, тауып, қарапайым әдістер арқылы оңай

түсінудің жүйесін көрсетті. Шындықты түсіндіру үшін ойлаудың қарапайым әдістерін пайдаланып, *«Енді құдай тағала бір антұрғанға еңбексіз мал береді екен. Бір құдайдан тілеп, адал еңбек қылып, пайда іздеген кісінің еңбегін жандырмай, қатын-баласын жөндеп асырарлық та қылмай, кедей қылады екен. Ешкімге залалсыз бір момынды ауру қылып, қор қылады екен. Қайда бір ұры, залымның денін сау қылады екен. Әке-шешесі бір екі баланың бірін есті, бірін есер қылады екен»* сынды әлемнің қарапайым тілдік бейнесі арқылы қабылданған жалған ойлау қалпының бұрыстығын бірін екіншісінен шығару әдісін қолдану арқылы дәлелдейді. Формальды логиканың бұл әдісін Сократ та осылай пайдаланған еді. Сократтық әдісті пайдалану арқылы қалың елдің өзі таныған тұжырымдарының қисынды-қисынсыздығын санамен ойлап, дұрыс пен бұрыстың арасын қайта салмақтауын, ақыл таразысына салуын ұсынады. Осылайша қайта ойлау қажеттігін қалыптап, танымның сыни тұрғыдан дамуына бағыттайды.

Адамдар, көбінесе, санаға сіңген танымдық қалыптарға тәуелді. Бұл қалыпты кім, қашан енгізгені де белгісіз... әсіресе дінмен, саясатпен енген қалыптардан арылу оңай болмайды. Ал қалыпты бұзу – сыни ойлау деңгейіне жеткен жасампаз тұлғаларға тән. Абайдың жасампаздығы – осындай санада сақталған, қабылданған қалыпты бұза алғандығы, ақиқатқа жетудің дұрыс жолын меңзеп, өзін-өзі танудың оң жолын көрсетуі. Ол қандай жол еді?



1-сурет: «Мені таныған ақылменен таныр»

Адамзаттың өміріндегі ең күрделі және көп сұрақ туғызатын тақырып: адам мен жаратушы арасындағы байланыс, тағдыр, әділет және адамның өз іс-әрекетіне жауапкершілігі. Абай адамдардың өмірде кездесетін әр алуан жағдайына мән бере отырып, терең философиялық тұрғыдан талдау жасайды.

Адам тағдырын Аллаға жүктеп, өзінің әрекеттеріне жауапкершілікпен қарамауын, бәрін Құдай тағаланың жазуынан көруін нақты деректермен жеке-жеке талдай келе, мұндай көзқарастың әрқашан дұрыс боларлық қуаты да, күші де жоқ екенін айқындап, тарихи қалыптасқан көзқарастың бұрыстығына көз жеткізеді. Құдай Тағала әрбір адамға ақыл мен ерік бергенін, ал оның істеген іс-әрекетіне өзі жауапты екенін түсіндіргісі келеді. Қиындықтар мен сәтсіздіктерді тек Аллаға ғана артып, өздері ештеңе өзгертуге тырыспау ақылдың ісі емес. Алла тағала адамға ақыл берген, сол арқылы адам өзінің өмірін өз қолында ұстай алады. Ақынның ойынша, иман мен ғибадат адамның ақылымен толық болуы тиіс. Яғни жақсылық жасау мен жамандық жасау, жолдасты сату мен уәдеге берік болу, мейірімді не зұлым болу – жеке адамның өз таңдауы. Әр жеке адам өз әрекетіне жауап береді.

«Жақсылық, жамандықты жаратқан - құдай, бірақ қылдырған құдай емес, ауруды жаратқан - құдай, ауыртқан құдай емес, байлықты, кедейлікті жаратқан - құдай, бай қылған, кедей қылған құдай емес деп, наным ұқсаң болар, әйтпесе - жоқ» – ой түйіні, сөздің тоқ етері осы. Абайдың философиясы терең ойлануды талап етеді. Ол адамзаттың ақыл, әрекет, иман, парыз арасындағы байланысты терең түсінуін қалайды. Егер адам өз ақылымен дұрыс шешім қабылдап, өзінің іс-әрекетіне жауапты болса, онда оның иманы мен ғибадаты да шынайы болады. Бұл шындық бүгінгі күнде де өзекті екені даусыз. Абайдың жиырма сегізінші сөзіндегі ойлар – адам мен Алла арасындағы терең байланыс пен адамның өз тағдырына деген жауапкершілігін түсінуге шақыратын даналықтың бір үлгісі. Бұл сөздер

қазіргі заманның адамына да маңызды, себебі данышпан бізді өз әрекеттеріміздің салдарына жауапты болуға, ақылмен әрекет етуге шақырады.

Ой түйініндегі әр сөздің нақты қолданысы мен айқын да дәл жеткізілуінің маңызы ерекше. Гумбольдт ілімі бойынша, халықтың дүниетанымы объективті шындықпен емес, халық рухының сыртқы көрінісі болып табылатын тілмен анықталады. Абайдың *«Жақсылық, жамандықты жаратқан - құдай, бірақ қылдырған құдай емес, ауруды жаратқан - құдай, ауыртқан құдай емес, байлықты, кедейлікті жаратқан - құдай, бай қылған, кедей қылған құдай емес»* деп жазғанын оқығанда, ойланбайтын жан болмасқа керек. Қарапайым детальдар арқылы жасалған көрнекті ой жүрекке жетеді де, ақылды адам иман таразысының алдында тұрғандай сезініп, өз әрекетіне жауап іздей бастайтыны анық. Тіл арқылы сақталған тұжырымдар ұрпақтан ұрпаққа жетпек. Ал оның дұрысы мен бұрысы нақты өмір тәжірибесінде айқындалмақ. Жақсылықты не жамандықты жасау адамның өз таңдауы екеніне ақылымен ойлап жету үшін, имандылық пен имансыздықтың ақылмен таңдалып алынғанын түйсінуге үшін, түсіндіруге үшін таңдалып алынған тілдік деректердің күнделікті өмірде жиі кездесетін қарапайым заттар мен құбылыстарды, әрекеттерді таңбалауы аса маңызды. Ұлтымыздың дүниетанымы «халық рухының сыртқы көрінісі» саналатын қазақтың қасиетті ақыл сөзінде жатыр. Сол ақыл сөзді жүйелеп, оның артық-кемін бағалап, тұрасын талдап, бұрысын түзеген Абай данышпанның «Ғақлия сөзінде» жатыр. Адамның ойлауы сөз түрінде көрініс тауып, жүзеге асатындықтан, ойлау процесі мен адамның өзін қоршаған болмысты тануы тілде қалай көрініс табады деген мәселені лингвофилософиялық бағытта зерделеудің маңызы ерекше.

Абайдың басты тұжырымдамасы – ақылмен, қайратпен өз жолыңды тауып, жүректің үніне құлақ асу. Өзіңді өзің табуға, тануға ұмтылу. Өзіңді өзің дамытуға ұмтылу үшін, жүйелі ойлау деңгейіне шығу қажет. Ал бұл үзіліссіз білім алу жолын, ғылым жолын таңдау деген сөз. Өмірдің мәні – дамуда. Заман озады, заманмен бірге адам өзгереді. Әр заманның өз үні, өз сөзі бар, заман сұранысына сай, көзқарастар өзгеріп отырады десек те, адамның рухани болмысын анықтайтын маңызды құндылықтар жүйесі өз мәні мен маңызын сақтайды. Қазіргі заманғы әлем – үміттер әлемі. Үмітті адамның таңдары – білім жолы. Бұл анық. Білім кеңейген сайын біз өзіміздің тұжырымдарымызды толықтырып, білмегенімізді біліп, кемімізді күзеп, бұрысымызды дұрыстап, ... әйтеуір ізденіс үстінде боламыз. Адамның рухани дамуының ең басты тірегі – ізденіс, іздену арқылы өзіңнің жеке басыңдағы кемшілігіңді сынап білу деңгейіне жетуге болады. Санада қалыптасқан қателерді табу және онымен күресу, сол қисындар мен болжамдарды, қағидаға айналған дәстүрлі пікірлерді сынау арқылы жүзеге асады. Адам өзінің немесе басқа адамдардың идеяларын сынап алады. Дұрыс сын – шындықты іздеудің бастапқы шарты да.

Сыни тұрғыдан ойлау жүйесінің тарихы софистік ілімнен бастау алатыны туралы жазылған ғылыми пәссапалық әдебиеттер жеткілікті. Сыни тұрғыдан ойлау деген сөз – ақиқатқа, имандылыққа, адалдыққа, жақсылыққа сәйкес келмейтін әрекетті теріске шығара отырып, оның бұрыстығын дәлелдеу. Еркін ойлы, дүниетанымы кең, білімі терең, тәуелсіз шешім қабылдай алатын кісі сыни тұрғыдан ойлауға қабілетті де, әрі оны еркін айта да біледі. Яки, сыни тұрғыдан ойлау мен оны айтудағы маңызды шарт – ойлау еркіндігі мен сөз бостандығы деуге негіз бар. Софистер арасында «дана болу - еркіндікке ие болу деген сөз, ойды еркін, сауатты сөйлеумен сәйкестендіретін ойлау» деген пікір кеңінен тараған.

Абай данышпан – еркін ойлауға қабілетті, еркін ойды сауатты сөйлеумен де сәйкестендіре алған тұлға. Ақынның еркін ойлы логикалық пайымдаулары мен егжей-тегжейлі дәлелдеулері «Жиырма тоғызыншы» сөзінен айқын көрінеді. Абайдың осы сөзі туралы академик З. Қабдолов былай деп ой толғайды: Абай өзінің «Жиырма тоғызыншы сөзінде» қазақтың кейбір мақалдарын қатал сынға алады. Шынында да көнелеу мақал-мәтелдердің ішінде бір кезде үстем таптың тілек-мүддесінен туған, адамда адастыратын,

зияндылары толып жатыр. Ақын жұртшылыққа соны әшкерелеп, мұндай сөздерге «сақ болу керектігін» түсіндіреді. Сөйтіп, оның бұл арада айтар пікірлері де халықты еңбекке баулыған үгіт-насихаттарына тоғысады: «жарлы болсаң, арлы болма» деген мақалға қарсы шыққан Абай - «ардан кеткен соң, тірі болып жүргені құрысын. Егер онысы жалға жүргенде жаныңды қинап, еңбекпенен мал тап деген сөз болса, ол ар кететұғын іс емес, тыныш жатып, көзін сатып, біреуден тіленбей, жанын қарманып, адал еңбекпен мал іздемек; ол арлы адамның ісі», - дейді.

Сыни тұрғыдан ойлау XX ғасырда қолданылмады. Сыни тұрғыдан ойлау кеңестің саясатқа қайшы келді. Ал Абай толғамдары мен тұжырымдары – сыни ойлаудың төрінде тұр. Абайға Далалықтарға тән ой еркіндігі мен сөз еркіндігін сезіну тән. Қоғам сыни тұрғыдан ойлауға енді мүмкіндік алған XXI ғасыр Далалықтар үшін жасампаздық, жаңғыру заманы болып келмек. Ендігі жас буын алынған ақпаратты талдауға, қорытынды жасауға және талдау негізінде шешім қабылдауға, өз пікірін қалыптастыруға, өз ұстанымын қорғауға мүмкіндік алды. Абайдың аяңдап келіп айтар түзелген сөзін тыңдар *тыңдаушысын* туғызды заман.

Біздіңше, «Жиырма тоғызыншы сөз» алдыңғы Жиырма жетінші, Жиырма сегізінші сөздердің заңды жалғасындай. Ой – ортақ, тұжырымдары – жақын.

Қазақ сөзінің мәйегі саналатын мақал-мәтелдердің әдеби тіліміздегі маңызы ерекше. Мақал-мәтелдерде ұлтымыздың дәстүрлі дүниетанымы көрініс тапқан. Ұлттық мәдениетіміздің құрамдас бөлігі болатын тілдік бірліктердің ерекше бұл түрі қазақ халқының мәдениетінен, салт-дәстүрінен, ділінен мол ақпарат береді. Өзге сөздермен салыстырғанда, мақал-мәтелдердің табиғаты бөлек, мұнда толғамды ой, тұжырымды пікір бар. Далалықтардың данагөй сөзі – осы мақалдарда.

Кез келген тілдегі мақал-мәтелдердің басым бөлігі адамның тұлғалық ерекшеліктерін, ішкі рухани жан-дүниесіндегі мәнді сипаттауымен, сондай-ақ қоғамдағы әр алуан әрекеттерге баға беруімен айқындалмақ. Мақал-мәтелдер – адам болмысының қоғаммен қарым-қатынасындағы егжей-тегжейлі ерекшеліктерін ұрпақтан-ұрпаққа жеткізуші, ғасырлар тереңінен бастап, тәжірибе арқылы қабылданған ақиқатты танытушы. Мұндай мәні терең сөздер арқылы адам санасында жанды әрекеттер қалыптасып, қоршаған әлемге қатысты түрлі бағалауы, адамдардың бір-бірімен қарым-қатынасындағы сезімдері, тарихи тәжірибесі, ішкі жан дүниесіндегі сезімдері жеткізіледі. Мақал-мәтелдердің күнделікті қарым-қатынаста қолданысы арқылы сөз жүйесінің іргелі жасампаздығы айқындалмақ. Тілдік бірліктер арқылы көрінетін санада жинақталған, қорланған, тілдік тәжірибеден өткен ақпараттар ұлт болмысын саралайды, сол арқылы ұлт рухының, дүниетанымың биіктігін танытады.

Әлемнің когнитивті тілдік бейнесі ретінде адам болмысының кемшіліктері мен идеалды адамдардың жоқтығын көрсететін мақал-мәтелдер де молынан кездеседі. Көбінесе мұндай мақалдар бинарлық оппозицияда тұрады.

Мақалдар мен мәтелдер халықтың күнделікті өмірінен ақпар беріп, дүниетанымының тілдегі көрінісі болады дедік. Әлемдік озық ойлардан хабары мол, сыни тұрғыдан ойлаудың биік деңгейін оқып-біліп меңгерген, ең бастысы, еркін ойлы, Ар ілімін жасаушы, «пайда ойлаудан» гөрі «Ар ойлауды» биік қоятын далалық дүниетанымды бала жасынан бойына сіңірген Абай қазақтың кей мақал-мәтелін жөндеуге, оң бағытта халықтың санасын тәрбиелеу ісіне жол салды. Біршама сөзде кеткен мінді түзеді. Аталған мақалдарда *«не құдайшылыққа, не адамшылыққа жарамайтұғыны»* бар еді.

Ақыл сөзді шын ғибрат алып оқыған әрбіріміз Абай көрсеткен кемшілікті тани, мінді түсіне алатынымыз анық. Сыни тұрғыдан ойлау барысында сөзде кеткен міннің дұрыс анықталғанын, оның соқырға таяқ ұстатқандай анық жазылғанын түсіну, көзі қарақты, көкірек көзі ашық жанға қиын болмасқа керек. Ия, XX ғасырдағы кеңестік кезең үшін сыни тұрғыдан ойлауға кісен салынды. Сондықтан көптеген ғалымдар Абай сынынан таптық

қатынастың көрінісін іздеуге талапталды. Мұның уақытша талғажау әрекет екені түсінікті де. Ең бастысы, бұл кезеңдегі жазушылар, ғалымдар кеңестің кескісінен Абайды арашалап алды. Бұл ұлт үшін үлкен рухани жеңіс болды. Кейінгі жылдары Абайдың өзінің сыншылары да көбейіп, «Абай тұлғасын тым биіктету қате, ол да біздей «пенде» ғой» деушілердің шыққанын да білеміз. Абайдың пенде емес, Адам екенін, Қазақ екенін, қазақ Ақыны, Қазақтан шыққан данышпан екенін, данышпан ішінен шыққан Көреген екенін, ал көрегендік әлемдік деңгейде бағаланатынын дәлелдеу қажет болатын заманға куә болып жүргеніміз рас.

Абай заманы – феодалдық қоғамның артта қалып, хандық жүйе тарих қойнына еніп, капиталистік қоғамның жаңа белгілері айқындалып, орыс саясатының өктемдігі артып, колониалдық саясаттың уығы әбден бекіген уағы еді. Саясат өзгеріп, саясатқа сәйкес қоғамдық қатынастар дамып, әлеуметтік сұранысқа сәйкес адам мінезі де, қалыбы мен әдебі де өзгере бастаған тұста:

Әркімді заман сүйремек,
Заманды қай жан билемек?
Заманды жаман күйлемек,
Замана оны илемек – болатыны да анық еді.

Бірақ «малы жанының, жаны Арының садағасы» болған Дала заңы мызғымауы керек. Ал осы жазылмаған дәстүрді жалғау үшін, «Ар», «намыс», «парыз» ұғымдарының мәнін сақтау үшін де Абай мақал-мәтелдерде берілетін мағынаға, мақал-мәтел арқылы берілетін тәрбиеге, ұлт болмысын сақтайтын дүниетанымдық **тіректерге** жауапкершілікті сезіне отырып сын айтады. Бұл сын мін іздеу емес, ащы болса да шындығын айтып, болашақ ұрпақты арсыздықтан, тоғышарлықтан сақтандыру еді.

Жиырма тоғызыншы сөзде Абай мына мақалдардың мәніне терең үңіліп, олардың болашақтағы ұрпақ үшін дәстүрлі ұлттық дүниетанымның көрінісі бола алмайтынын ашық жазады:

- 1) *Жарлы болсаң, арлы болма;*
- 2) *Қалауын тапса, қар жанады, сұрауын тапса, адам баласының бермейтіні жоқ;*
- 3) *Атың шықпаса, жер өрте;*
- 4) *Алтын көрсе, періште жолдан таяды;*
- 5) *Жүз күн атан болғанша, бір күн бұра бол;*
- 6) *Ата-анадан мал тәтті, алтынды үйден жан тәтті.*

Бұл мақал-мәтелдерді қазір де қолданатынымыз бар, әлі де болса, санамыз жаңғырып, жасампаздық жолына түстік деп айта алармыз ба? Арды биік қойып, жеке мүддені пайда көретініміз, ата-анадан мал тәтті деп, оларды жылатып қалдырып, болмаса қарттар үйіне өткізіп жүргеніміз жасырын ба? Осы біздің көкірегімізді имансыздық жайлап алып бара жатқан жоқ па?

Абай көрсеткен әр мақалды жекелей талдап, мағыналық құрылымын танысақ, данышпан көрсеткен кемшіліктер айқындала түседі. Мақал-мәтел мағынасы, әдетте, семантикалық жүйеде талданғанда анығырақ айқындалады. Талданатын ұғымдар арасында мағыналық байланыстарды саралау, мақал-мәтел мағыналарының ұқсастық матрицасын құру – әлеуметтік семантикалық талдаудың қажетті бөлігі. Тілдік санада әбден қалыптасқан сөз мағыналарының кемшілігін, мәнінің бұрыстығын сөз қолданушы іштей бағалап, оны толық мойындауы қажет. Бұл тек лингвистикалық ғылыми қағида үшін емес, ана тілінде сөйлейтіндердің қолдауы мен қолдануы үшін, қабылдауы үшін маңызды.

Қазіргі жастардың бұл мақалдарды қабылдауы мен бағалауы, сөйлеу тәжірибесінде қолдануын анықтау мақсатында психолингвистикалық эксперимент жасалды. Студенттер өзді-өзі диалог құра сөйлесіп, көрсетілген мақалдарды қосып, диалог тізбегін мәніне қарай

қолданып, сабақтастыра жалғастырады. Дискурстық қарым-қатынаста мақал-мәтелдің мағыналық сипаты айқындалып, көпшіліктің қалай қабылдайтыны байқалады.

Әр тәжірибеге екі студент қатысады. Абай сынға алған мақалдар қағазға жазылып, үстелге қойылады да, студент оны өзі таңдайды. Таңдалған мақал бойынша мағынасына лайықты пікір айтылып, мәтіннің бүтіндігі сақталуы міндеттеледі. Сұқбатта мақалдың ішкі мағынасы мен мәні айтушының ішкі ой әлемінің тілдік бейнесіне айналады.

Алынған нәтижені өңдеуге топ студенттері қатыстырылады.

Абай сынға алған мақалға қатысты бинарлық оппозицияда тұратын мақалдар бар. Бұл мақалдарды сұқбатқа қатысқан студенттер тиімді пайдалана отырып, қарсыласын сөзбен тоқтата алды.

Келтірілген мақалдардың мағыналық жағынан оппозициялық қатынасы немесе мәнінің өзге де семантикалық құрылымдарының ерекшелігін айқындау арқылы, бастапқы Абай сынға алған мақалдардың беретін мағыналары ұлттық дүниетанымның сипатын таныта алмайтындығын психосемантикалық эксперимент арқылы дәлелдеуге талаптанамыз.

Сыналған алты мақал-мәтелдің қазақ дүниетанымына сәйкессіздік дәрежесі өзге мақалдардың мағыналары арқылы бағаланады. Нәтижесінде сыналған мақал-мәтелдер туралы көзқарас тек Абайдың ғана жеке пікірі емес, қазіргі қалың көптің де, әсіресе, сыни тұрғыдан ойлауға қабілетті ХХІ ғасыр жастарының тұжырымдарымен сәйкес келетіндігі айқындалды. Мұны түсіндірудің ең оңай жолы: сыналған мақалдар арқылы танылатын әрекеттердің сипаты мәнсіз, ұлттық құндылыққа, имандылық жолға сәйкессіз, қазіргі қазақ дүниетанымының деңгейіне сәйкес келмейді. Әрине, ел арасында әр алуан жағымсыз әрекеттер кездесуі ықтимал, бірақ олар ұлттық құндылық пен ұлттық дүниетанымның негіздері бойынша қабылданбайды, қолдау таппайтын факторлар болмақ. Мәселен:

Жарлы болсаң, арлы болма; Арлы болу не арсыздыққа бару – кез келген кісінің өз таңдауынан болмақ. Жарлы не бай болу жеке тұлғаның арсыз болуының себебі не сылтауы бола алмайды. Арлы болу – адами қасиеттің ең жоғарғы қасиеті. *«Ардан кеткен соң, тірі болып жүрген құрысын»*. Арсыз болып, жақындарыңның, балаларыңның көзіне қарай алмай жүру – бұл дүниенің қорлығы.

Қалауын тапса, қар жанады, сұрауын тапса, адам баласының бермейтіні жоқ; «Қалауын тапса қар жауады» деудің ғылыми негізі бар. Судың формуласы H_2O , оның құрамында оттегі бар; демек оның қалауы табылса жануында ықтималдық бар екені анық. Алайда, өзің сияқты ет пен сүйектен жаралған адамның алдына барып, одан бір нәрсе сұрау, жалыну, аяғына жығылу, өтініш білдіру – жеке тұлғаның азаматтығына, арына сын. *«Сұрауын табамын, қалауын табамын деп жүріп қорлықпенен өмір өткізгенше, малды не жерден сұрау керек, не аққан терден сұрау керек қой»*. Біреуден сұрап, сорлы болғанша, қолыңнан келгенше, өзің ұмтылсаң, өзің істеген нәрсенің берекесі де болмақ, өзің тапқан пайданың, қаржының ырзығы да ерекше.

Атың шықпаса, жер өрте деген мақалдың ішкі мәні – жағымсыз. Жаман, ұнамсыз әрекет жасап, қоғамдағы адамдарға немесе табиғатқа зияныңды тигізіп, атыңды шығару дегеннің өзінде тыңдаушының эмоциялық әрекеті жағымды болмайтыны анық. Атың шықпаса, дегендегі -са тұлғасы шартты мағынаны беретін жұрнақ, демек атыңды елге жаюдың, сен туралы өзгелердің білуінің, хабардар болуының негізгі шарты «жер өртеумен», бір нәрсені бүлдірумен байланысты болғанының не жақсылығы бар? Кез келген жеке тұлға өз атын жақсы да ізгі істерімен шығарса мақұл. *«Аттың атын шығаратын төрт тұяғы, адамның атын шығаратын тілі мен жағы»* деген мақалдың айтары әлдеқайда мол. «Жақсы сөзді жарым ырысқа» балаған қазақ халқы үшін жеке тұлғаның сөйлеген сөзінде көп мән бар. Кісінің атын шығаратын оның дұрыс айтылған, оң жол көрсететін, әділдікпен дұрыс шешім шығаратын, көпке үлгі боларлық өнеге айтатын, арғы-бергі тарихтан тағылымды сыр ақтаратын сөзі деген дүниетаным қазақ ұстаған өмірлік қалыпқа сай.

Алтын көрсе, періште жолдан таяды деген мәтелінің астары тар, кеңдік, биіктің, тереңдік өлшемінен кем. Періштенің тазалығы, ақтығы мен пәктігі, кіршіксіздігі – асыл қасиеті ретінде танылған мұсылмандық дүниетанымда оның «алтын» көріп жолдан таюы неғайбыл. Абай мұны «*Періште алтынды не қылсын, өзінің көрсеқызар сұмдығын қостағалы айтқаны*» дейді.

Жүз күн атан болғанша, бір күн бура бол мәтелінің адам мінезіне қатысы бар. Әрине, әр мақал мен мәтелдің өзіндік мән-мағынасы бар, олардың ешқайсысы екіншісін дәл көшірмейді. Бірақ олардың кейбірі жеке сезімдер жетегінде кетуі де мүмкін екенін жоққа шығар алмаймыз. Барлық мақалдан ақиқаттың алмас қылышындай шындық пен әділдікті күту бекер. *Жүз күн атан болғанша, бір күн бура бол* мәтелінде адами эгоизмнің көрінісі байқалады. Алайда, «*Тәңірге жазып, мінбей-түспей арып, шөмеңдеп диуаналықпен бір күн болған буралық неге жарайды?*». Бұл дүниедегі таңдаған жолың «атандық» болса, бір күнгі «буралық» қылғаның бойыңа күш-қуат берер ме, абырой әкелер ме? Адам өз табиғатынан, өзінің табиғи қажеттіліктерінен азат бола алмайды, кейде өмірдің тарттырар азабынан да тәуелсіз бола алмауы ықтимал. Алайда адам табиғатына тән өзімшілдік қасиет, өзіндік мінез бар. Мұны түсіну де оңай емес.

Ата-анадан мал тәтті, алтынды үйден жан тәтті.

Моральдық кереңдік - бұл мақалдың мәнін шартты түрде осылай атауға болар, бәлкім. Субъектінің өзіне шамадан тыс көңіл бөлуін, адамгершілік, моральдық талаптарды елемейін, әдеп пен ізгіліктен мақұрым, көңіл көкжиегінің тарлығын білдіреді. «*Ата-анасынан мал тәтті көрінетұғын антұрғанның тәтті дерлік не жаны бар. Бұлардың бәрінен де қымбат ата-анасын малға сатпақ ең арсыздың ісі емес пе?*». Мақалда айтылған ойға нақты жауап Абайдың өзінде. Мінез-құлықтың, баланың ата-анаға деген көзқарасын танытатын бір-біріне тікелей қарама-қарсы бағыт ұстанатын мақалдар жеткілікті. Бұл жағдайда ата-анадан малды артық көруден артық арсыздық болмақ емес. Сондықтан Абай сөзі бүгінде де аса өзекті қалпын сақтап қалады. Мәлімдеме түрінде тағылған айыптың маңызы артық, өзектілігін сақтайды. Өкінішке қарай, ата-ананы, үлкенді қадірлей алмау, бағасын байыптай білмеу – қазіргі таңдағы моральдық жағынан озудың емес, азудың көрінісіндей.

Қорытынды. Мақал-мәтел – шындықты түсіну мен қабылдаудағы тарихи тәжірибе. Психолінгвистикалық тұрғыдан, белгілі бір жағдайға сай мақал-мәтелдерді қолдану әрекеттің маңызды жағын анықтап көрсету, тыңдаушыны сендіру, иландыру, пікірді бұрынғы тарихи тәжірибелер арқылы дәлелді ету, айтылған ойды өзекті ету мақсатында болады. Жеке тұлғаның санасында мақал-мәтел – ықшам әрі дәлелді, нақты жауап берудің өзіндік жақсы формасы. Сондай-ақ мәдени нормалар мен дұрыс сөйлеу талаптарын жеткізудің, нормативті мінез-құлықты тәрбиелеу құралы саналады. Абай сынға алған мақал-мәтелдер қазақ ұлтының дүниені танудағы өзіндік көзқарасы, дүниетанымы бола алмақ емес.

Адамзат тарихында, мәдениетінде адам мінезі туралы сөз әрқашан болады және бола бермек, өйткені мінез арқылы қоғамда өзгеріс орын алады, қоғам ілгері дамиды. Қоғамдағы әр алуан қарым-қатынас негізінде уақыт рухы мен әлеуметтік даму үрдістері жаңаша көрініс табады. Сондықтан адам мінезі туралы жазу, ондағы психологиялық факторларды зерделеу әрқашан маңызды да, өзекті болмақ. Адам мінезінің таңғажайып тартымдылығының сыры бәлкім, күрделі мына өмірдегі бірегей тұлға - АДАМ баласының қасиетін білудің шексіздігінен болар. Бірде ашық, бірде тұйық, бірде байсалды да салмақты, бірде қаңбақтай жеңілтектік те жараса қалатын адам мінезінің қыр-сыры танылып болды дей алмас ешкім.

Өмірге жолаушы болып келген кез келген адам өзінің жер бетіндегі жолының бүкіл бөлігінде, өмірдің күнделікті алуан түрлі әрекетінде жүріп, көп қырлы динамикалық қозғалысында мінездегі жасырын өзгерістердің сыртқа шығып жататынын өзі де кейде сезе алмайды. Қарым-қатынастағы сан алуан әрекеттер мен жағдайларға сай мінездің де сан

түрлі қатпарлары ашылып, анықталып, жеке адамның өзіндік келбетін ерекшелей бермек. Қазіргі ғылыми психологиялық интерпретацияда «мінез» феномені өзінің ерекше бай көріністерінің алуан түрлі сипатына жеке адамның материалдық, әлеуметтік және рухани өмірінің де байланысы болатынын көрсетеді. Мінездің ішкі және сыртқы сипаттары жеке тұлғаның қызметіне, әлеуметтік жағдайына, рухани құндылықтарды бағалап, оны керегіне жарата алу мүмкіндігіне, сонымен бірге оның генетикалық ерекшелігіне де қатысты болады.

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Тағам атауларының менталдық бейнесі және фразеологиялық мағына жасаудағы қызметі

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Аңдатпа

Мақала қазақ тіліндегі құрамында (компонент) тамақ, азық-түлік атаулары бар фразеологиялық бірліктердің когнитив репрезентациясын және олардың фразеологиялық бірліктердің жасалуындағы рөлін зерттейді.

Осыған дейінгі зерттеулерде тағам, азық-түлік атаулары кездесетін фразеологизмдер лексика-семантикалық тұрғыдан ғана жүйеленіп, топтастырылып келді, ал когнитивтік лингвистика бағытында терең зерттеу жүргізілмеді.

Зерттеуіміздің жаңалығы қазақ тіліндегі тағамға қатысты фразеологизмдер «когнитивтік метафора теориясы» сүйене отырып, тағам, азық-түлік атауларының нақты өмір тәжірибелердегі абстрактілі ұғымдармен байланыстырылған метафоралық жүйе қалыптастырғаны талданады. Зерттеу нысанасы ретінде құрамында тамақ, азық-түлік атаулары бар фразеологизмдер алынып, бұл фразеологизмдер тақырыптық (концептуалды) жүйеді топтастырылды және олардың мағыналық өрісі құрылды,

I. Кенесбаевтың "Фразеологиялық сөздігі" - 124; А. Қайдардың "Тысяча метких и образных выражений" сөздігінен - 48, жалпы саны - 172 тағам, азық-түлік атауы және фразеологизмдер анықталып, тақырыптық категорияларға топтастырылды, талдау жасалды және зерттеу нәтижелері цифрлық құралдар көмегімен визуализацияланды. Зерттеу нәтижесі тағам атауларының қазақ тіліндегі тұрақты тіркестер құрамында когнитивтік және мәдени репрезентация факторы ретінде маңызды рөл атқаратынын көрсетті.

Тірек сөздер: қазақ тілі, тамақ, азық-түлік атаулары, тұрақты сөз тіркестері, фразеологизм, тағам метафоралары.

In previous studies, phraseologisms containing food and nutrition-related terms have been classified and systematized solely from a lexical-semantic perspective. However, this topic has not been thoroughly examined within the framework of cognitive linguistics.

The novelty of our research lies in analyzing phraseologisms related to food names in Kazakh through the "cognitive metaphor theory", demonstrating that food and nutrition-related terms form a metaphorical system linking concrete life experiences with abstract concepts. As the research object, phraseologisms containing food and nutrition-related terms were identified, categorized within a thematic (conceptual) system, and their semantic fields were constructed.

From Ismet Kenesbayev's "Phraseological Dictionary", 124 entries, and from Abduali Kaydar's "A Thousand Concise and Expressive Expressions", 48 entries were identified, totaling 172 phraseological structures containing food-related terms. These were categorized into thematic groups, analyzed, and visualized using digital tools. The study has shown that food names play a significant role as a cognitive and cultural representation factor in stable expressions within the Kazakh language.

Keywords: Kazakh language, food, nutrition-related terms, fixed expressions, phraseologisms, food metaphors.

Кіріспе

Фразеологизмдер – адамның қоршаған ортаны, өмір сүріп отырған айналасын қабылдау, түйсінуінің және ұлттық сананың тілдік көрінісі ретінде пайда болған дербес мағыналық бірліктер. Тілтанымдық тұрғыдан алғанда, фразеологизмдер тек тілдік мағыналық бірліктер ғана емес, сонымен қатар халықтың ойлау жүйесінің, құндылықтар әлемінің және әлеуметтік сананың тілдегі бейнелі көрінісі ретінде зерттеліп келеді. Осы тұрғыдан алып қарасақ, қазақ тіліндегі тағам, ас, азық-түлік ретінде қолданатын атауларымен байланысты жасалған фразеологиялық бірліктер қазақ ұлтының өмір салтын, дәстүрлерін және тарихын түсінуде маңызды дереккөз бола алады. Қазақ тілі тарих бойынша, көшпелі мәдениет, егіншілік және мал шаруашылығымен тығыз байланысты қалыптасқан өмір салтымен біте қайнасып дамып келеді. Қазақ ұлтының қалыптасуына әсер еткен мәдени, тарихи, салт-дәстүр, наным, сенім, діни көзқарас секілді жағдайлар қазақ тілінің тұрақты сөз тіркестерінің қалыптасуына да өте көп әсер етті.

Тіл білімі зерттеулерінде тағам, азық-түлік атаулары кездесетін фразеологизмдер лексика-семантикалық тұрғыдан ғана жүйеленіп, топтастырылып келді. Қазақ тіліндегі фразеологиялық зерттеулері орыс ғалымы академик Виноградовтың [1,1977] фразеологизмдер тақырыбында жасаған зерттеулері аясында қарастырылды. Қазақ тіліндегі фразеологизмдерді зерттеген Әбдуәли Қайдар [2, 202-220] өзінің "Қазақ тілінің өзекті мәселелері" атты еңбегінде қазақ тіліндегі тұрақты сөз тіркестерін мағыналық, тақырыптық және стильдік тұрғыдан топтастырды.

Зерттеу нысанасы ретінде Ісмет Кенесбаевтың "Фразеологиялық сөздігі" [3, 2007] еңбегінен 124 тұрақты сөз тіркесі; Абдуәли Қайдардың "Тысяча метких и образных выражений" [4, 2003] сөздігінен 48 тұрақты сөз тіркесі, жалпы саны 172 құрамында тағам, азық-түлік атауы бар тұрақты сөз тіркесі тақырыптық категорияларға бөлініп, талдау жасалды және зерттеу нәтижелері цифрлық құралдар көмегімен визуализацияланды. Зерттеу нәтижесі тағам, азық атауларының қазақ тіліндегі когнитивтік және мәдени репрезентация факторы ретінде маңызды рөл атқаратынын көрсетті.

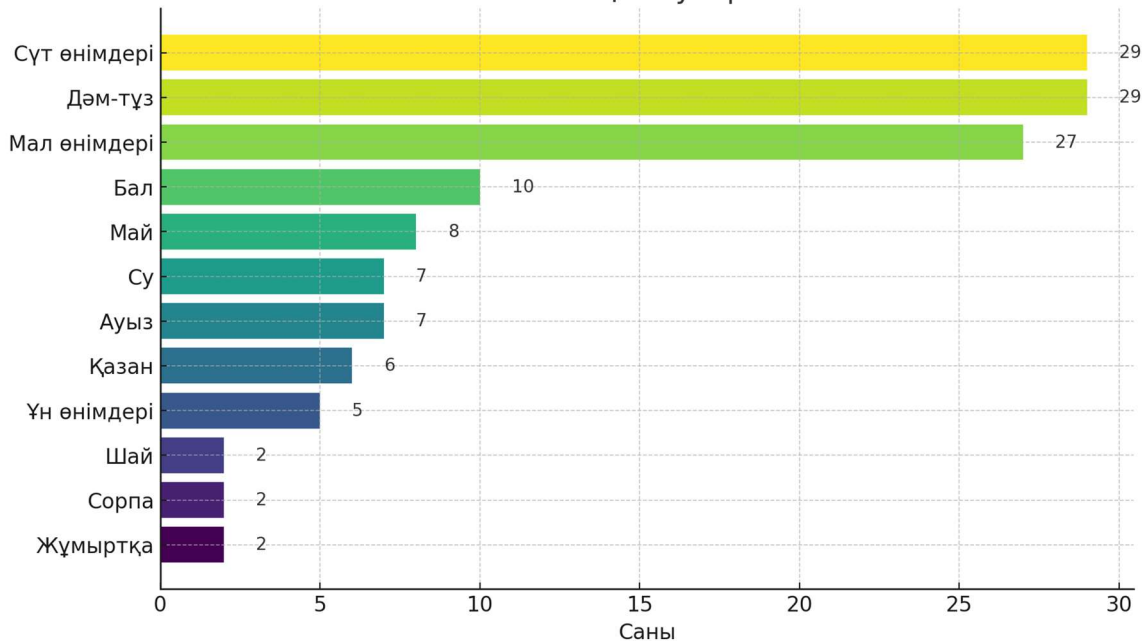
Әдістер мен материалдар

Осы зерттеуде қазақ тіліндегі тағам атауларының когнитивтік репрезентациясы мен фразеологиялық құрылымын зерттеу мақсатында көпсалалы әдіс қолданылды. Зерттеудің негізгі дереккөздері Ісмет Кеңесбаевтың «Фразеологиялық сөздігі» негізге алынып, құрамында 10 мыңнан астам тұрақты тіркес бар осы еңбектен 124 тағамға қатысты фразеологизм анықталды. Абдуәли Қайдардың «Тысяча метких и образных выражений» атты сөздігіндегі 500 фразеологизмнің ішінен 48 тағам атауымен байланысты тұрақты сөз тіркесі талданды. Бұл сөздіктердегі фразеологизмдер қазақ ауыз әдебиеті, көркем шығармалар, мерзімді басылымдар және ғылыми зерттеулерден жинақталған кең ауқымды дерекқорға негізделген. Зерттеу нәтижелері цифрлық технология құралдары қолданылып визуализация жасалды.

Нәтижелер мен талқылау

Мақалада қазақ тіліндегі «тұрақты сөз тіркестері» ұғымы аясында қазақтың тағам, азық-түлік атауларымен байланысты фразеологизмдердің когнитивтік репрезентациясы мен құрылымдық ерекшеліктері талданды. Сөздіктерден анықталған қазақ тіліндегі құрамында тағам, тамақ, азық-түлік атаулары кездесетін тұрақты сөз тіркестерінің (фразеологизм) тек грамматикалық бірлік емес, қазақ ұлтының тарихи, мәдени және өмір тәжірибе, салт-санасын, мораль құндылықтары мен наным, сенім, діни көзқарастарды бейнелейтіні анықталды.

Тамақ атаулары



Қазақтың ұлттық тағамдар атауымен байланысты фразеологизмдерді талдау тіл мен мәдени арасындағы ортақ байланысты айқындайды. Абдуәли Қайдардың «Тысяча метких и образных выражений» еңбегі қазақша тұрақты сөз тіркестерін орыс тілінде түсіндірген сөздігінен алынған 48 тұрақты сөз тіркесі және І. Кеңесбаевтың «Фразеологиялық сөздігінде» орналасқан 124 фразеологизм маңызды дереккөзі ретінде бағаланды. Бұл сөздікте орналасқан құрамында қазақ тағам атаулары бар тұрақты сөз тіркестерінің көшпелі өмір салтынан, мал шаруашылығынан, айнала, қоршаған ортаны түйсіну және қоғамдық қарым-қатынас, адамгершілік құндылықтар туралы қазақ халқының көзқарастарынан хабар беретіні анықталды.

Әсіресе тағамға қатысты фразеологизмдердің халқының тарихи күнкөріс тәсілдері мен тамақтану әдеттерімен тікелей байланысты екендігі анықталды.

Мысалы: "Сүттің бетіндегі қаймақ" бұл тұрақты тіркес қоғамның таңдаулы, зиялы, ардақты тобына қатысты қолданылады. Қазақтар ең құрметті, ең жақсы, зиялы адамдарды «сүттің бетіндегі қаймаққа» теңеген.

"Абыройы айрандай төгілді": Айранның физикалық қасиеттері мен абстрактілі ұғым «абырой» (намыс) ұғымының байланыстырылуы қазақ мәдениетінде тағам метафораларының мықты когнитивтік негізі бар екенін көрсетеді.

Қазақ тіліндегі тағам мәдениетіне байланысты тұрақты тіркестерді белгілі бір тақырыптық топтар бойынша қарастыруға мүмкіндік беретін Абдуәли Қайдардың бұл топтастыруын негізге ала отырып, фразеологизмдер мал шаруашылығы, сүт өнімдері, май мен ет, астық пен ұн өнімдері деп топтастырылды.

1. Мал шаруашылығына байланысты малдардан алынған тамақ, азық өнімдері атаулары арқылы жасалған тұрақты сөз тіркестері (фразеологизм)

Қазақ халқының өмірінде мал, ал шаруашылығына байланысты ұғымдардың ұлттық санадағы рөлі ерекше. Малдан алынатын тамақ өнімдері, азық-түліктер тек тамақ атауы ғана емес, сонымен қатар қоғамдағы, айнала қоршаған ортадағы, өмір тәжірибедегі, адамгершілік қасиеттерді де сипаттайды. Мысалы:

"Жіліктің майлы басы" → Молшылықты бейнелейді.

2. Сүт және сүт өнімдері атауларымен байланысты фразеологизмдер:

Сүт қазақ мәдениетінде тазалық, пәктік және қасиеттілік ұғымдарымен тығыз байланысты. Сүттен жасалған тағамдар мен сусындар тұрақты сөз тіркестерінде адамгершілік құндылықтарды, үйлесімділікті және қоғамдық тәртіпті сипаттайтын метафора ретінде қолданылады:

"Сүттен ақ, судан таза" → Тазалық пен адалдықты білдіреді.

"Айрандай ұйып отыру" → Айналасындағылармен үйлесімділік пен тату өмір сүруді білдіреді.

"Айран сұрап келіп, шелегіңді жасырма" → Шын ниетін ашық айтудан ұялуды, қысылуды білдіреді.

3. Май мен етке байланысты фразеологизмдер

Мал шаруашылығымен айналысқан көшпелі өмір салтында тамақ, азық-түлік атауларының ішінде малдардан алынатын азық-түлік, тамақ атаулары ұғымдар байлық, кедейлік, күш және молшылық, символы болып келеді.

"Бір ұрты май, бір ұрты қан" → Мінездегі қарама-қайшылық сипаты.

"Бұл не деген батпан құйрық?" → Шындыққа жанаспайтын хиялдағы жақсы жағдайды білдіреді.

"Аузыңа май, астыңа тай!" → Береке мен молшылықты тілеу.

4. Астық және ұн өнімдеріне байланысты фразеологизмдер

Астық, әсіресе көшпелі халықтар үшін, өмір сүру мен аштықпен күресті бейнелейді. Қазақ тағамдарында маңызды рөл атқаратын нан мен тары фразеологизмдерде адам мінезімен байланыстырылады.

"Тарысы піскеннің - тауығы" → Жағдайды өз пайдасына жаратып қалу, яғни жағдайды өз пайдасына шешу мінезін сипаттайды.

Қазақ тіліндегі тағамға қатысты фразеологизмдерді Вильгельм фон Гумбольдттың тілдің ішкі әлемі теориясы [5,1988] тұрғысынан қарастырғанымызда, тағамға қатысты атаулардың нақты өмір тәжірибелердегі абстрактілі ұғымдармен байланыстырылған жүйе қалыптастырғаны анықталды.

Тағам, азық-түлік атауы → Абстрактілік өту: Физикалық тамақтану ұғымдары моральдық құндылықтармен байланыстырылған.

Әлеуметтік және мәдени көріністер: тамаққа қатысты метафоралар қонақжайлық, молшылық, кедейлік, байлық секілді әлеуметтік айырмашылықтарды көрсететін маңызды белгілер ретінде функционалды қызмет атқарған.

Қорытынды және ұсыныстар

Бұл зерттеу қазақ тіліндегі құрамында тағам, азық-түлік атаулары бар фразеологизмдердің тек тілдік құрылым ғана емес, сонымен қатар мәдени және когнитивтік жүйенің көрінісі екенін дәлелдейді. Қазақ тіліндегі құрамында тағам, азық-түлік атаулары бар фразеологизмдердің мәдени бірегейлікті, әлеуметтік құндылықтарды және тарихи тәжірибені кодтайтын маңызды тілдік құрылымдар екендігі анықталды. Ең бастысы, қазақ тіліндегі құрамында тағам, азық-түлік атаулары бар фразеологизмдердің тек күнделікті сөйлеу тілі материалы емес, сонымен бірге қазақ халқының ұлттық санасын, тарихи мұрасын және әлеуметтік құндылықтарын бейнелейтін маңызды тілдік бірліктер екенін дәлелдейді.

Жүргізілген талдауларда қазақ тіліндегі құрамында тағам, азық-түлік атаулары бар фразеологизмдердің «тілдік әлем бейнесін» жасау фразеологизмдер диаграммалар арқылы визуализацияланды. Бұл диаграммалар әртүрлі тағам категорияларына қатысты тұрақты тіркестердің қалай ұйымдастырылғанын және олардың когнитивтік репрезентацияларын көрсетеді.

Зерттеудің нәтижелері қазақ тіліндегі тағам атауымен жасалған тұрақты сөз тіркестеріндегі метафоралардың ұлттық құндылықтар жүйесінің ортақ когнитивтік бірліктер қалыптастырып, символдық мәнге ие болатынын дәлелдейді.

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PERSONALITY PHENOMENON: FACTORS INFLUENCING PERSONALITY DEVELOPMENT

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Abstract

The article examines the phenomenon of personality as one of the main research objects of social and humanitarian sciences and explains the leading role of upbringing in its formation on scientific grounds. It is emphasized that personality is a complex system resulting from the interaction of biological, psychological and social factors. It is noted that the upbringing process is a strategic tool that forms the value system of the personality, behavioral models, skills for entering social relations and moral qualities. The article comparatively analyzes the functions of social institutions such as family, school, society and mass communication in the development of personality. The stages of personality development - early childhood, school period and adolescence - are described, and the essence of the upbringing effect at each stage is explained. The analyses show that in conditions of effective upbringing, the creative potential, social adaptation skills and emotional-intellectual development of the individual are formed more dynamically. As a result, the article substantiates the importance of modern upbringing concepts as the main mechanisms affecting the harmonious development of the personality and puts forward scientific and practical recommendations for improving the upbringing system.

Keywords: personality phenomenon, personality characteristics, educational development, personality development.

1. Introduction

Due to the complexity of its structure, personality has been a difficult phenomenon to define since its inception. Due to this difficulty, the concept of personality has long been a focus of interest for researchers. We can say that personality is one of the important stages in an individual's ability to understand both himself and others. Personality is the sum of an individual's emotional, physical and mental characteristics and the manifestation of every behavior, attitude and action in life. According to researchers, personality is the presence of a unique individual and different characteristics. It is a combination of unique human characteristics. It is a pattern formed by a person's unique behavioral reactions and relationships in everyday life. Here, personality has an internal consistency and a predictable aspect. When determining an individual's personality, the presence of different characteristics is considered, and these characteristics distinguish a person in society. The individual is at the center of the journey of personality formation. The individual's parenting style, the emotions he experiences, the events and reactions he encounters affect and shape his personality. Two types of thinking emerge regarding which factors are dominant in the formation of personality (1, pp. 25-28).

The aim of the article is to explain the concept of personality in the context of the theory of personality traits that explains it. In addition, it examines all the dimensions of the differential personality theory and the five-factor personality theory that derives from this theory, which provides the most comprehensive and reliable explanation of personality traits in the literature. Then, the higher-level personality dimensions of stability and flexibility, which are resolved within

the higher-level dimensions of the five-factor personality theory, are examined in light of research in the literature. Finally, the concepts discussed above are discussed in the context of the relevant literature.

1. Theoretical approach to the concept of personality

A review of the literature reveals numerous definitions of personality. Personality is a set of characteristics inherited from parents and formed as a result of interaction with the environment and not easily changed (2; 3).

Personality is a person's face, his identifier. Personality is a set of stable physical and mental characteristics of an individual. Personality is a person who perceives reality and is able to change it. Personality is a biosocial being. One of the most characteristic features of personality is its individuality. This includes its personal characteristics, individual skills and habits, and mechanisms of action. Human personality is unique in its essence.

Personality is formed as a result of the socialization of the individual in the environment surrounding him, his communication with the environment and his interaction. Motivation is an important condition for the formation of personality. Properly selected motives motivate the personality to purposeful activity. Most importantly, these motives should reflect his interests. Interests are manifestations of his internal needs. In order to properly influence personality, interests must be properly satisfied. Satisfying interests helps to overcome deficiencies in the knowledge and skills of the personality and to form it as a whole.

On the other hand, internal processes include all the emotional, motivational, and cognitive processes that develop within us and affect how we behave and feel (4, pp. 26-34; 5, pp. 509-516). Within personality, the individual is expected to have consistency in both his external and internal actions. Personality is a dynamic organization that determines the behavior and thoughts of the individual (6). In other words, personality is considered to be the permanent and stable characteristics that individuals demonstrate in different situations. Personality is a set of psychological qualities that influence the individual's different behavioral patterns. Personality allows the individual to interact with the environment and react in similar situations in the same way (7). Personality manifests itself as the characteristics that an individual acquires at birth and the characteristics that he acquires in social life. When the literature is examined as a whole, heredity and environmental factors come to the fore as determinants of personality.

2. Personality traits. Factors influencing personality development

Personality traits are relatively consistent patterns of behavior that develop over a period of time (8, p. 131-137).

Personality traits distinguish individuals from others and form the basis of our predictions about their future behavior. West and Grazian state that our personality traits are permanent and do not change over time and circumstances. In the light of all these explanations, personality traits can be perceived as consistent behaviors that distinguish individuals from others and the continuity of these behaviors. A review of the literature reveals numerous theories about personality. This study attempts to examine personality through the prism of trait theory, which determines and develops personality traits.

There is a dialectical and metaphysical concept of development about the development of society, its regularities, the causes of events, and the driving mechanism. Naturally, a person-individual develops and is formed as a being. Many prominent world scientists are right to approach the development of an individual from the point of view of heredity (9).

In connection with the development of personality, it is necessary to take into account not only the rich ideas of today's experience, but also pedagogical thought. Azerbaijani educators sought the most positive aspects of personality in its relationships and activities in society, because

relationships are the result of a person's life experience and determine his actions and inner feelings.

A number of factors play an important role in the correct upbringing of a person in society. A person has different physical, mental and spiritual characteristics at different ages. Certain innovations and changes occur in his character. Therefore, a person who is a member of our society should know in what conditions and under what influence factors he develops, what is the role of heredity, environment and upbringing in his development (9).

"Currently, the achievements of the pedagogy and psychological sciences of the educational process are being used. The widespread use of public institutions, educational institutions, out-of-school children's institutions, cultural and educational centers, public organizations, the media, and the family, which is the basic cell of society, which influence the development of the personality, expands the possibilities of educational influence."

The factors influencing the formation of personality are multifaceted: they are internal and external, natural, socially subjective and objective, planned and spontaneous. In the science of pedagogy and psychology, there are 3 main concepts related to the development and upbringing of personality, which can be grouped in the following directions:

1. Biological concept;
2. Sociological concept;
3. Biosocial concept;

The representative of the biological concept (Sigmund Freud) considers personality as a purely natural being and explains it in terms of the needs, interests, and instincts inherent to it. According to the teachings of Z. Freud, the behavior of a person depends on biological influences and instincts, which in turn are signs of fear or satisfaction. Human behavior is subject to two principles - the principle of pleasure and enjoyment and the principle of reality corresponding to the requirements of society.

Representatives of the sociological concept, while accepting the birth of a person as a biological being, defend the idea of gradual socialization under the influence of social groups with which he communicates. The social development of a person begins with his entry into the life of society. Social development is associated with mental, spiritual and intellectual development and change, spiritual development (moral perfection, change of consciousness), intellectual development (enrichment of knowledge; expansion of worldview), etc. The social concept confirms that personality is a social manifestation.

According to the biosocial concept, although mental processes have a biological nature, personality is formed as a result of experience, political, moral and spiritual views, interests, abilities and social phenomena. According to Hegel, a number of human shortcomings arise from his biological essence, from his features that constitute a similarity to animals, and the social essence must correct, dialectically deny and eliminate these shortcomings. The correct attitude of a person to nature is a decisive factor in his formation as a social being.

"It has been known from experience that the more a person is involved in various types of activities, the more he communicates and interacts with groups of people and individuals, the faster the comprehensive development of the personality goes and the higher the level of development is."

The role of the environment in the development and upbringing of the personality is great. When we say environment, we mean primarily the social, and partly the natural-geographical environment. The natural environment - the relief of the territory, fauna and flora, the composition and pressure of the air are factors that significantly affect the development of the personality, its spiritual maturation. The concept of the natural environment includes mountains, valleys, air, water, natural landscapes, mountains, the sun, etc. (10). For example: no one denies that air and water play an important role in physical development and human health. However,

the social environment, social relations play a key role in the development of the personality. The social environment itself is divided into two parts:

- a) macroenvironment (Collective, street, public places);
- b) microenvironment (family environment, with whom the student sits, etc.).

The conducted studies lead to the conclusion that the social environment does not directly affect the development of the personality, but through lifestyle. If this were not the case, then the influence of the environment would be the same for everyone, the diversity of lifestyles leads to the transformation of the influence of the environment.

There have been and still are different ideas about the influence of the personality on its development. For example, representatives of the trends of hierarchism and pragmatism believe that the task of the personality is to adapt to the existing social environment. French materialists also put forward a similar idea and said that a person is a passive product of the environment.

The social environment and the natural environment have a strong influence on the development of the human personality.

The social environment refers to the external conditions surrounding the life activity and development of a person. The concept of social environment includes the social structure, the system of production relations, material living conditions, the nature of the occurrence of production and social processes. The social environment is constantly changing and active, and in the process of activity it changes its environment.

The natural environment and family environment have a strong influence on the development of personality, especially for young and school-age children. The family creates favorable conditions for the realization of their interests and needs. The basis of the moral and social qualities of the personality is also laid in the family.

The upbringing factor is of great importance in the development and formation of personality.

Even the great philosopher of antiquity, Plato, said that if we educate a person correctly, he will be the most peaceful and divine creature. If he is not educated or educated incorrectly, then he will be the most savage of the animals on earth. He said that the power of the state depends on the upbringing of people.

Although upbringing affects the development of a person, it depends in a certain sense on development and is based on the level of human development. The dialectic of the mutual relationship between development and upbringing is also manifested in this.

The ideas of the prominent psychologist S.A. Rubinstein about the significant influence of upbringing on the development of a child as a personality are interesting. He showed that upbringing and development are two sides of a single process. A child develops through education and upbringing and receives education and upbringing as he develops.

“Let us note that although the development of a child is possible in a social environment, that development cannot be equated with its development under the influence of upbringing. The difference between the influence of the social environment on a child and the influence of upbringing is, first of all, that upbringing is organized, purposeful and planned. However, the development process that takes place under the influence of the environment may not be purposeful.”

Upbringing is a special field of activity aimed at the formation of personality. The prominent educator Makarenko said that the essence of upbringing is that the older generation passes on its experience and its beliefs to the younger generation in this process.

The formation of personality occurs under the influence of internal and external factors. Therefore, the factors that affect this process for the formation of personality are factors that attract attention.

Another prominent psychologist S. Rubishteyn shows that “It is necessary to educate children so that we can form and teach them as individuals who learn and learn.” Before implementing any educational measures, the teacher and educator must identify the characteristics of the student being studied and implement the educational measure accordingly.

A. Adler indicates three important attitudes that affect the formation of personality:

- a) Feeling of one's own powerlessness
- b) Attempting to improve, to gain superiority
- c) Feeling of togetherness or social feeling

It is known that a person comes into the world as an individual and is formed as a personality in the system of social relations. The process of upbringing plays a decisive role here. Therefore, it is impossible to open the psychological mechanism of upbringing without knowing the sources and conditions in the formation of a child as a personality.

“The successful solution of education, the formation of the adolescent personality, their inclusion in the new system of economic, political, and social relations depends on the teacher's professional skills, moral position, and individual psychological characteristics.

Human personality is formed as a result of the influence and interaction of many factors. Biological and social factors play their own role in this process.

A person is born as a biological being, therefore the law of heredity affects him. The material carriers of heredity are genes. Hereditary physical traits (face shape, facial structure, eye and hair color, etc.), as well as physiological traits (type of the nervous system, number of nerve cells, etc.) are passed down from generation to generation.

A person acts as a passive object of the environment and upbringing, actively influencing the environment and the process of upbringing, the formation of his own personality. If upbringing perceives children and adolescents only as objects, it will be deprived of much and will not be able to achieve its goal. A person's personal activity manifests itself in various forms: mental, labor, physical, artistic, socio-political activity. The main means of personal activity of children and youth is to involve them in various types of activities”.

Conclusion

The results of the conducted analyses show that the phenomenon of personality acts as a product of a complex interaction between the biological beginning of a person and his social being, and its formation is a long-term, multifaceted, dynamic process. The development of personality is not based only on the psychological characteristics and natural potential of the individual, but also directly depends on the socio-cultural environment of society, the system of moral values, the activities of social institutions and the quality of upbringing.

Upbringing is a fundamental factor that systematically forms the structural components of personality - motivation, emotional-volitional sphere, intellectual skills, social behavioral habits and value orientations. The purposeful and scientifically based implementation of the educational process creates conditions for the harmonious development of the personality, increases its social adaptability, expands its creative potential and strengthens its independent decision-making skills.

At the same time, the coordinated activity of the family, school, public institutions, media and other social institutions plays an important role in the process of education and development of the personality. The effectiveness of interaction between these institutions determines the degree of socialization of the personality and directly forms the intellectual, cultural and ethical level of society.

The results of the study, as shown by modern pedagogical and psychological concepts, indicate that the development of the personality is a continuous process and educational intervention at all age stages of the individual retains its importance. Therefore, the educational system should not be limited only to traditional models, but should be updated in accordance with

changing social realities, enriched with individualized, humanistic and innovative approaches. As a result, the research conducted in the article once again proves that education is the main criterion for the intellectual and moral development of society, and the personality acts as both the subject and object of this development.

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L' emprunt linguistique dans le français

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Abstract:

As we have seen, the vocabulary of the French language, as well as that of any other language, is constantly changing. Its lexicon varies and is enriched at any time. Among the various sources of lexical enrichment, it is necessary to highlight borrowing from other languages. This linguistic phenomenon is closely connected with the development of society, with the history of the people. It is determined by several material and psychological factors. The progress of science and technology, that of political life and human mentality, commercial and cultural relations between peoples largely contribute to borrowing. It is true that the term "loan" has a rather vague meaning, or too broad, in some linguistic works. It is therefore important, above all, to find a definition that is more precise. Leroy, in his book on linguistic borrowing, remarks on the given language that elements that have penetrated it after the more or less precise date marking convey

Key words: vocabulary, getting rich, the source, linguistic phenomenon, development of society, consider, formation, crossing, influence.

1. Entrée:

Comme on l' a vu, le vocabulaire de la langue française, de même que celui de toute autre langue, change constamment. Son lexique varie et s'enrichit à toute époque. Parmi les différentes sources d'enrichissement lexical il faut signaler l'emprunt aux autres langues. Ce phénomène linguistique est étroitement lié au développement de la société, à l'histoire du peuple. Il est déterminé par plusieurs facteurs matériels et psychologiques. Le progrès de la science et de la technique, celui de la vie politique et de la mentalité humaine, les relations commerciales et culturelles entre les peuples contribuent largement à l'emprunt.

Il est vrai que le terme "emprunt" a un sens assez vague, ou trop large, dans certains ouvrages linguistiques. Il est donc important, avant tout, de trouver une définition qui soit plus précise. L. Deroy, dans son livre sur l'emprunt linguistique, fait remarquer que des éléments qui y ont pénétré après la date plus ou moins précise marquant conventionnellement le début de cette langue

En effet, on ne peut considérer comme de vrais emprunts que les mots étrangers acquis au début de la formation du français en tant que langue nationale. Il faut savoir distinguer l'enrichissement du vocabulaire par emprunt de celui qui résulte du croisement de deux langues.

2. L'influence anglaise sur le français:

L'influence anglaise sur le français commence au XVII^e siècle, et au XVIII^e siècle le nombre de mots empruntés à l' anglais augmente considérablement. La pénétration des anglicismes se poursuit au cours des siècles suivants et continue de nos jours.

L'abondance des anglicismes dans la langue française s'explique par le développement politique et économique de l'Angleterre. Au XVII^e siècle

l' Angleterre devient une grande puissance navale, au XVIII^e siècle elle devance rapidement la France en industrie et en technique. Son influence politique grandit, l' Angleterre étant le premier état parlementaire de l'Europe au XVII^e siècle. C'est à l'anglais que le français doit plusieurs termes maritimes: dock, drague, paquebot, tonnage, yacht et d'autres: des termes

se rapportant au commerce et des noms de marchandises: corporation, ticket, flanelle, moire, rhum, etc.

Au XVIII^e siècle le français emprunte des termes ayant rapport au système parlementaire et à la vie politique et sociale: comité, verdict, vote, jury, bill, budget, quaker, congrès, session, club, de même que des termes sportifs et des mots désignant des objets de la vie quotidienne: boxe, jockey, bifteck, grog, punch, pudding, redingote. A la même époque remontent les anglicismes humour et spleen.

Au XIX^e siècle l'emprunt à l'anglais se poursuit avec intensité. La plupart des anglicismes appartiennent à la terminologie technique: rail, tender, tramway, tunnel, wagon, cheviot, macadam. Mais on trouve aussi des termes politiques et sociaux: boycott, interview, leader, meeting, speaker et des mots usuels: cottage, festival, flirt, square, cold-cream, ulster (pardessus d'hiver), brandy. Vers la fin du XIX^e siècle et au XX^e siècle l'anglais fournit une quantité de termes sportifs: football lawn-tennis, match, record, sport, touriste, basket-ball et d'autres.

Au XX^e siècle l'introduction d'anglicismes continue par suite des contacts de deux guerres mondiales et à la faveur du snobisme de certaines couches sociales de France. Ce sont des mots tels que: tank, plastic, jeep, autocar, d'un côté et de l'autre côté des mots, usuels comme stencil, papier paraffiné et perforé, shopping, achat, label, étiquette, building, stock, dépôt, pull-over, home, le chez soi, glasse, verre, jersey, tricot, chandail, short, culotte de sport très courte, week-end, pick-up, cocktail, etc.

3. Le grand nombre d'emprunts anglais:

Le grand nombre d'emprunts anglais est dû à l'intérêt particulier à tout ce qui vient de l'Angleterre, à une vraie anglomanie de certaines couches sociales. On peut trouver dans le vocabulaire français une quantité d'anglicismes dont beaucoup sont superflus. Comme on l'a vu dans les exemples cités ci-dessus, plusieurs mots empruntés à l'anglais ont leurs synonymes français. Plusieurs linguistes éminents dont J. Marouzeau, F. de Grand Combe, E. Ullmann, J. Orr et d'autres s'opposent vivement à la propagation croissante des emprunts anglais qui inondent la langue française. On trouve plusieurs articles sur ce sujet dans les revues "Vie et langage" et "Le Français moderne". R. Georgin, par exemple, considère comme superflu l'emploi des mots étrangers dans les cas où l'on a des mots français exprimant les mêmes notions. Il donne toute une liste de mots anglais qui ont leurs équivalents français. Ainsi, selon Georgin on peut très bien remplacer le mot anglais bar par le mot français buvette, barman par garçon, best-seller par grand succès, garden-party par partie de plaisir, leader par chef et éditorial, living-room par salle de séjour, match par compétition, supporter par partisan, etc.

On trouve la même protestation contre l'anglomanie dans les manuels de français à l'usage des écoliers. On y trouve les exercices suivants:

1. Quels sont parmi les mots ci-dessous, ceux qui vous semblent des emprunts inutiles au français: bar, policeman, cottage, meeting, leader, smart, select, pull-over, hold-up, lock-out, grill-room, Comment proposeriez-vous de franciser leur orthographe?

2. Lesquels vous paraissent des emprunts condamnables, lesquels utiles: film, chewing-gum, week-end, macadam, tourisme, bacon, chips, pick-up?

Certains écrivains français protestent dans leurs œuvres contre l'anglomanie. Ainsi, Pierre Daninos dans son livre "Les carnets du major Thompson" en fait une satire. L'anglomanie a provoqué la création de mots nouveaux au moyen d'éléments étrangers. Ce sont de faux emprunts dont l'existence complique la tâche de reconnaître les vrais emprunts. L. Derooy en donne plusieurs exemples. Tel est le mot footing qui désigne en français l'exercice de marche (son usage, d'ailleurs, déborde largement la langue de sport) et qui n'a pas été pris de l'anglaise ou le même mot signifie point d'appui, tandis que le mot anglais désignant l'exercice de marche est walking. Le mot wattman créé en français en 1897 n'existe pas en anglais ou l'on dit tram driver.

Les mots *shake-and* (poignée de main), *high-life* (grand monde, d'allure très distinguée) *baby-boot* (sorte de jeu) sont aussi des créations françaises. Les pseudo-anglicismes abondent surtout dans le jargon des sports: *sellinger* (cheval qui prend part à un *selling*) *motoball* (sorte de football où les joueurs sont montés sur des motocyclettes), *comingman* (jeune espoir du sport), *recordman* (titulaire d'un record), *tennisman* (joueur de tennis), etc.

4. Conclusion:

Il est à noter que les faux emprunts existent depuis longtemps. On peut trouver parmi eux des pseudo-latinismes: par exemple, *harmonium* a été créé en 1840, par le facteur d'orgues Debain; *motus* est une latinisation plaisante de mot signifiant souvent dans l'ancienne langue 'pas un mot'; *rasibus* qui veut dire 'à ras' et qui tire son origine d'un argot scolaire du XIV^e siècle.

En général on voit les faux emprunts partout où, à une époque donnée, les mots étrangers ont été à la mode. Ils ne sont pas une spécialité française. On peut en trouver dans l'allemand, le hollandais et d'autres langues.

Avant de passer à un autre groupe d'emprunts signalons encore quelques mots pris à l'anglais de l'Amérique. Ce sont, par exemple, les termes de cinéma employés largement en français. Ainsi, le mot *gag* est fixé par le dictionnaire de Quillet comme terme de cinéma avec l'acception de 'jeu de scène', 'péripétie d'une drôle innatendue'. Le dictionnaire Larousse de 1963 donne l'acception du même mot dans la langue commune: 'effet comique, jouant sur la surprise'. Le mot *star* est devenu synonyme de vedette et s'emploie largement dans la presse.

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Қазіргі қазақ әдебиетіндегі түс көру мотиві (А.Алтай «Түсік» әңгімесі негізінде)

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Abstract

This paper explores the motif of dreaming in contemporary Kazakh literature, with a particular focus on A. Altai's short story «Tusik (miscarriage)». Dreams in literature serve as a gateway into the complex inner world of characters, revealing their subconscious desires, fears, and moral dilemmas. Drawing on both Freudian and Jungian psychoanalytic theories, the study examines how dreams function as a symbolic representation of the unconscious, providing insight into the psychological and philosophical dimensions of human existence.

From a Freudian perspective, dreams reflect repressed wishes and internal conflicts, allowing characters to confront moral and emotional challenges within a symbolic framework. Jungian theory further expands this understanding by interpreting dreams as expressions of archetypes and the collective unconscious, highlighting the mythopoetic and transformative aspects of dream experiences.

Through the analysis of «Tusik», the paper demonstrates how the dream motif in Kazakh prose not only advances the narrative but also deepens the psychological portrait of the character, reveals moral and existential crises, and constructs a liminal, metaphysical space between life and death, consciousness and the unconscious. The study concludes that the dream motif in contemporary Kazakh literature is a multi-layered literary device that integrates psychological, philosophical, and mythopoetic functions, enriching both the narrative structure and thematic depth of the work.

Keywords: Kazakh literature, dream motif, psychoanalysis, Freudian theory, Jungian theory, mythopoetics, metaphysical space

The Motif of Dreaming in Contemporary Kazakh Literature: Based on A. Altai's «Tusik»

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Қазақ әдебиеті – бай тарихы мен терең философиясы бар, халықтың рухани байлығын айшықтайтын құнды мұра. Осы бай мұраның ішінде ерекше орын алатын, адамның ішкі әлемін, арман-тілегін, қорқыныштарын айқын бейнелейтін мотивтердің бірі – түс көру мотиві. Түс – адам санасының тылсым әлеміне апаратын есік іспетті. Ол өткенді еске салып, болашаққа жол көрсетіп, кейде тіпті қазіргі шындықтың өзін жаңа қырынан ашуға мүмкіндік береді. Қазақ әдебиетінде түс көру мотиві әр кезеңде, әр автордың шығармашылығында өзіндік сипат алып, әртүрлі мағыналарға ие болды.

Түс көру мотивінің қазақ әдебиетіндегі тамыры өте тереңде жатыр. Атап айтқанда халық ауыз әдебиетінен бастау алады. Батырлар жырында, ертегілерде, аңыз-әңгімелерде кейіпкерлердің түсіне енген көріністер оқиғаның дамуына, кейіпкердің тағдырына әсер ететін маңызды рөл атқарды. Мысалы, батырлардың алдағы жорықтары туралы алдын ала ескертетін түстер, жаудың келуін хабарлайтын белгілер жиі кездеседі. Бұл түстер тек қиялдан туған елес емес, халықтың өмір сүру салтымен, табиғат құбылыстарымен, діни наным-сенімдерімен тығыз байланысты болды.

Дегенмен, қазақ әдебиетінде түс көру мотиві – бұл тек фольклорлық дәстүрдің жалғасы ғана емес, сонымен қатар кейіпкердің ішкі әлемін ашудағы, оның психологиялық және философиялық ойларын тереңдетудегі маңызды көркемдік құрал. Қазіргі қазақ прозасындағы психологизм мәселелерін зерттеген Г. Пірәлиева бұл мотивтің тек оқиғалық функциясымен шектелмейтінін, керісінше, оның күрделі көркемдік құбылыс екенін атап көрсетеді. Оның пікірінше, түс көру – бұл кейіпкердің ішкі өміріне енудегі таптырмас бейнелеу құралы [1, 47].

«Адамның күрделі рухани әлемін, ішкі сезімін тереңдеп талдап көрсететін аналитикалық психологизмнің бір түрі – түс көру тәсілі» [2, 89]. Түс арқылы авторлар кейіпкердің психикасының терең қатпарларын, бейсаналық толғаныстарын, жасырын эмоцияларын ашуға мүмкіндік алады. Бұл – көркем-психологиялық тәсіл ретінде бағаланатын маңызды аспект. Түс көрінісі кейде адам санасының логикалық бақылауынан тыс жатқан күйлерді, Г. Пірәлиева атап көрсеткендей – «бұлыңғыр сәттерді», «жарым-жартылай есті-ессіз күйді» – өрнектеуге мүмкіндік береді [1, 47]. Бұл әдебиеттегі психологиялық талдаудың бір көрінісі болып табылады. Автор атап өткен «эзотериялық нышандар, құпия-белгілер, символдар» түс көрудің тек психологиялық емес, сонымен қатар философиялық қызметін айқындайды. Түс – бұл дүниені танудың, өмірді таразылаудың ерекше бір формасы. Ол адамға өзінің ішкі әлемін, өмірдегі орнын тереңірек түсінуге көмектеседі.

Сонымен қатар, Пірәлиева түс көрінісінің шекаралық күйді («не тірі емес, не өлі емес»), яғни екі әлемнің – бұл дүние мен о дүниенің арасындағы метафизикалық кеңістікті бейнелеуге мүмкіндік беретінін көрсетеді [1, 47]. Бұл – түс мотивінің мифопоэтикалық және символдық табиғатын дәлелдейтін ерекшелік. Бұл ойымызды қазақ жантану ғылымының негізін қалаушы Ж. Аймауытовтың «Адамда екі түрлі «жан» бар: біреуі – жан, екіншісі – тән... Жанды тәннен бөлек, бар нәрсе деп ұғуға – адамның түс көруі себеп болған» - деген пікірі тереңдете түседі [3, 9]. Осындай бейнелеу әдісі арқылы поэтикалық тіл тереңдей түседі, ал кейіпкер санасында болып жатқан күрделі рухани процестер көркемдеу құралдары арқылы ашылады.

Бұл пікірлер түс көру мотивінің әдебиеттегі орнына жаңаша теориялық қырдан қарауға мүмкіндік береді. Яғни түс тек хабаршы немесе болжам жасайтын құрал ретінде емес, адам жан дүниесінің құпия механизмдерін көрсететін, рухани әлемді сипаттайтын көпқабатты көркемдік тәсіл деп айтуға негіз бар. Мұндай көзқарас түс мотивін психологиялық проза, модернистік әдебиет және мифопоэтикалық дәстүрмен байланыстыра отырып, оның әдеби-композициялық маңызын тереңдете түседі.

Қазақ әдебиетінде XX ғасырдың екінші жартысынан бастап Ә. Кекілбаев, М. Мағауин, О. Бөкей, Д. Амантай, Т. Әбдік сияқты қаламгерлер прозасында түс – кейіпкердің ішкі дағдарысын, экзистенциалдық сұрақтарын, ішкі «менімен» күресін ашатын бейнелеу құралы ретінде көрініс тапты.

Жоғарыда атап өткендей, түс мотивінің философиялық мағынасы да айрықша. Түс – екі әлемнің түйісу нүктесі: реалды өмір мен ирреалды кеңістік, тірілер дүниесі мен рухтар әлемі арасындағы шекаралық кеңістік. Бұл межелік күй («межелік сана» немесе «лиминалды болмыс») кейіпкердің рухани дағдарысын, өмір мәнін іздеуін, онтологиялық жалғыздығын

көрсетеді. Мұндай тәсіл мифопоэтикалық дәстүрді жаңғыртып қана қоймай, адам болмысының терең философиялық мәнін ашуға мүмкіндік береді. Бұл теориялық тұжырымдар А. Алтайдың «Түсік» әңгімесінде дәл беріледі: *«Түсінде түсік көрді. Түсік — түсік емес, түсікке айналған мұның өзі. Бармақтай ғана жан иесі екен. Ештеңемен ісі жоқ. Жөнімен жүзіп жүр.*

Жүзіп жүрген мекені — жатыр. Биттің қабығындай жұқа жатыр іші — жұмбақ әлем. Жұқа жарғақ жарылып кетердей толқып-толқып қояды. Жұмсақ құрсақ баяғы балалық шағында шаңырақта үрлеулі тұрған қарындай шайқала толқығанда, көгілдір әлемде балықтай жүзген бұл бесіктей тербеледі. Бірақ тұншықпайды. Емін-еркін тыныстайды» [4]. Биболдың түсіндегі «көгілдір әлем» — бұл жай ғана бір орын емес, бұл шекаралық, метафизикалық кеңістік. Т. Есембеков мұндай кеңістікі «онейрикалық кеңістік» деп бөледі [5, 122]. Ол өмір мен өлімнің арасындағы, бар болу мен жоқ болудың шегіндегі ортақ нүкте. Бұл кеңістікке тап болған адам, өзінің бұрынғы болмысынан айырылып, жаңа, әлі де толық қалыптаспаған күйге ауысады. *«Түсікке айналған адам көк теңіздей көлкіген әлемде армансыз жүзе берді. Алаңсыз жүзіп жүріп: «Әлгіңде ғана адам едім. Неге түсікке айналдым? — деген оқыс ойға тағы келді. — Ал енді, саптан қапқа тамып түсер тамшыдан емес, бірден адамнан айналған түсікті жайлы жатыры жатырқап, жатсынып қалса қайтеді?! Онда тұқымының тұздай құрығаны — жатсынған жатыр сылып тастағаны»* [4].

Адамнан түсікке айналу — бұл белгілі бір дәрежедегі жойылу, жоғалту. Ал тірі жаннан ұрыққа айналу — бұл жаңа бастаманың, әлі де дамудың алғашқы сатысындағы әлсіздіктің белгісі. Бұл екі жағдай да адамның өзінің қалыптасқан «менінен» айырылып, белгісіздікке ұшырағанын көрсетеді. Бұл түс — адамнан түсікке, тірі жаннан ұрыққа айналып, межелік кеңістікке тап болуды білдіреді. Тек түс көру ғана емес, Биболдың ішкі жан дүниесіндегі күрделі жағдайдың, моральдық дағдарыстың айқын көрінісі.

Түс барысында Бибол өзін «түсік» ретінде көруі — оның санадан жасырылған кінәсінің символдық жазасы. Ол шынайы өмірінде, біріншіден парақорлық жасайды, екіншіден саналы түрде екі әйелді де түсік жасатуға итермелейді, үшіншіден моральдық жауапкершіліктен қашады. Осылайша, Биболдың парақорлығы, адам өміріне қатысты жасаған ауыр күнәлары мен жауапкершіліктен қашуы — бәрі де оның бейсанасына терең із қалдырады. Бұл ауыр жүк, бұл жасырын кінә, бейсаналықта «түсік» бейнесі арқылы көрініс табады. Түсінде өзін «түсік» ретінде сезіну — бұл тек кездейсоқ образ емес, бұл оның ішкі дүниесінің айнасы. Ол өзінің жасаған қылмыстарын, жойған өмірлерін, бұзған моральдық нормаларын символдық түрде көреді. Бұл — оның бейсаналық «ішкі соты», оның өз-өзіне берген үкімі, санасының өзіне жасаған ескертуі, ішкі дауысының сыртқа шығуы. Бұл — оның моральдық күйреуінің айқын көрінісі. Жоғарыда келтірілген Ж. Аймауытовтың «жан мен тәнді айыратын күш — түс көру» деген идеясына толық сәйкес келеді [3, 9]. А.Алтай «түс мотивін» маскадан арылту үшін қолданады. Яғни түс арқылы біз өзіміздің ең жасырын ойларымызды, қорқыныштарымызды, кінәларымызды көре аламыз.

Сондай-ақ шығармада түс мотиві архетиптік-мифопоэтикалық қызмет атқарады. Адамды бастапқы күйіне қайта апарып, оның рухани мәнін ашу. Биболдың жағдайында, түс арқылы ол өзінің күнәларынан арылып, өзінің бастапқы, таза жаратылысына оралу мүмкіндігін алады (1-сурет).



Сурет-1. А.Алтайдың «Түсік» әңгімесіндегі түс мотивінің мифопоэтикалық қызметі

Қазіргі қазақ әдебиетіндегі түс көру мотивін Фрейд пен Юнг психоанализ теориялары арқылы зерттеу шығарманың психологиялық тереңдігін айқындауға мүмкіндік береді. А. Алтайдың «Түсік» әңгімесін мысалға ала отырып, түс мотивін психоанализдік тұрғыдан түсіндіруге болады. Алтайдың «Бибол» кейіпкерінің түсіндегі «түсікке айналуы» – бұл Фрейдтің теориясымен тығыз байланысты психологиялық қақтығыстың айқын көрінісі. Бұл түс, кейіпкердің бейсаналық деңгейінде жинақталған күрделі эмоциялар мен моральдық мәселелердің символдық бейнесі болып табылады.

Юнгтің пайымдауынша, әрбір түс – бұл тек кейіпкердің жеке психикасының ғана емес, сонымен қатар адамзаттық архетиптердің бейнесі. Архетиптер – бұл адамзаттың коллективті бейсаналық қабатында сақталған, жалпыадамзаттық, мәдениетке тән бейнелер мен үлгілер. Олар біздің ойлауымызға, сезінуімізге және мінез-құлқымызға әсер етеді. Түстер арқылы осы архетиптік символдармен байланыс орнатуға болады, бұл психологиялық тепе-теңдікке жетуге мүмкіндік беретін құрал болып табылады.

Фрейд пен Юнг теорияларын қолдану арқылы түс көру мотиві тек көркемдік құрал ғана емес, кейіпкердің ішкі психикасының, моральдық күйзелістерінің, бейсаналықтағы құпия сезімдерінің символдық көрінісі екені анықталады. Фрейд тұрғысынан, түс – бейсаналық қалаулар мен қорқыныштарды білдіретін, моральдық жауапкершіліктен қашудың символдық көрінісі болса, Юнг тұрғысынан – архетиптік символдар арқылы кейіпкердің психологиялық және рухани трансформациясын бейнелейтін, межелік кеңістік құратын құрал.

А. Алтайдың «Түсік» әңгімесінде түс мотиві Биболдың ішкі жан дүниесін, моральдық дағдарысын, бейсаналық пен саналық арасындағы күресін көркемдік түрде көрсетуге мүмкіндік береді. Сонымен, түс көру мотиві қазақ прозасында психологиялық, философиялық, мифопоэтикалық тұрғыда көпқабатты мәнге ие болып, заманауи әдебиетте терең эстетикалық рөл атқарады.

Қорыта келгенде, түс көру мотиві қазіргі қазақ прозасында бірнеше деңгейде қызмет атқарады: психологиялық (кейіпкердің ішкі жан дүниесін, моральдық дағдарысын және бейсаналық күйін бейнелейді), философиялық (тіршілік пен өлім, саналық пен бейсаналық арасындағы шекаралық кеңістікті ашады), мифопоэтикалық (архетиптер мен ұжымдық бейсаналық элементтер арқылы адам рухының трансформациясын көрсетеді) және композициялық (шығарманың құрылымын, эмоционалды және идеялық тұтастығын

толықтырады.). Осылайша, қазақ прозасындағы түс мотивінің эстетикалық және рухани мәнін айқын көрсетіп, оның психологиялық, философиялық және мифопоэтикалық қызметін дәлелдейді. Түс мотиві қазіргі қазақ әдебиетінде тек оқиғалық функциямен шектелмей, кейіпкер психикасын терең түсінуге, ішкі жан дүниесін аша отырып, әдеби шығарманың көпқабатты мәнін көрсетуге мүмкіндік береді. Бұл мотивтің қолданылу арқылы қазақ әдебиетінің көркемдік деңгейі жоғарылап, оқырманның рухани әлемі байи түседі. Авторлар түс арқылы кейіпкердің ішкі әлемін ашуда ғана емес, сонымен қатар, ұлттық сананы жаңғыртуда, рухани құндылықтарды насихаттауда да маңызды рөл атқарады. Түс мотивінің әрбір қыры – кейіпкердің ішкі әлемін тереңдету, өмірдің мәнін іздеу, ұлттық сананы нығайту және шығарманың көркемдік құрылымын байыту – қазіргі қазақ прозасының рухани тереңдігі мен психологиялық қатпарларының айнасы іспеттес. Осылайша, түс мотиві қазақ әдебиетінің дамуындағы өзіндік орнын айқын көрсетеді.

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Kazakh Literature and Ecocriticism (Based on the Poems of Abai Qunanbaiuly)

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Abstract

The article examines the ecological issues in Kazakh literature and the artistic-cognitive significance of nature lyric. The study is based on theoretical concepts such as ecocriticism, ecological discourse, artistic ecology, and ecological consciousness, analyzing the interaction between humans and nature within the framework of national worldview. Using the works of Abai Qunanbaiuly as examples, the depiction of nature is considered as a measure of human spiritual and moral responsibility. The article highlights the role of literature in fostering ecological awareness and demonstrates the educational, philosophical, and psychological potential of literary texts.

Keywords: *ecological discourse, ecological consciousness, nature lyric, artistic ecology, anthropocentrism, literary ecocriticism.*

Қазақ әдебиеті және экокритика (Абай өлеңдері негізінде)

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Аннотация

Мақалада қазақ әдебиетіндегі экологиялық проблематика мен табиғат лирикасының көркемдік-танымдық мәні қарастырылады. Зерттеу барысында экокритика, экологиялық дискурс, көркем экология және экологиялық сана сияқты теориялық ұғымдар негізге алынып, адам мен табиғат арасындағы өзара байланыс ұлттық дүниетаным аясында талданады. Абай Құнанбайұлының шығармалары мысалында табиғат бейнесі адамның рухани және моральдық жауапкершілігінің өлшемі ретінде қарастырылады. Мақала әдебиеттің экологиялық тәрбие беру рөлін, көркем мәтіннің тәрбиелік, философиялық және психологиялық әлеуетін көрсетеді.

Кілт сөздер: экологиялық дискурс, экологиялық сана, табиғат лирикасы, көркем экология, антропоцентризм, әдеби экокритика.

Қазіргі әдебиеттануда экологиялық проблематика экокритика, экологиялық дискурс, көркем экология ұғымдары арқылы зерттеледі. Экокритика – әдебиет пен қоршаған ортаның өзара байланысын талдайтын интердисциплинарлы әдіс [1]. Ал экологиялық дискурс көркем мәтінде табиғатқа қатысты идеялар мен құндылықтардың жүйесін айқындайды. Экологиялық сана ұғымы адамзаттың табиғат алдындағы моральдық жауапкершілігін білдіреді. Қазақ әдебиетінде бұл бағыттар ұлттық дүниетаныммен сабақтасып, табиғатты тек эстетикалық объект емес, рухани-аксиологиялық құндылық ретінде танытады.

Дәстүрлі әдебиеттану көбінесе адам тәжірибесі мен әлеуметтік динамикаға назар аударады, ал табиғатқа аз көңіл бөледі. Экокритика керісінше, табиғатты талдау орталығына қойып, әдеби мәтіндердегі табиғат бейнесін, оның кейіпкерлер мен тақырыптарға әсерін зерттейді. Бұл тәсіл антропоцентрлік көзқарасты сынайды және адам мен адам емес тіршілік арасындағы байланысты толық түсінуге шақырады. Осыдан келіп экокритиканың негізгі принциптері айқындалады:

1. Экологиялық сананы қалыптастыру және тұрақтылық. Әдебиеттануда қоршаған ортаны сақтау және экологиялық тәрбие мәселелерін қарастыру маңызды. Бұл принцип әдеби шығармалардың табиғатты қорғау идеясын дәріптеу арқылы экологиялық мәдениетті қалыптастыруға бағытталған.

2. Әдебиет арқылы экологиялық әрекетке шақыру. Шығармалар оқырманға экологиялық сана қалыптастырып, адамдарды табиғатты қорғауға ынталандырады. Әдебиет тек эстетикалық немесе моральдық құрал ғана емес, сонымен қатар экологиялық тәрбие мен белсенділікке жол ашатын коммуникациялық ресурс болып табылады.

3. Мәдени, тарихи және саяси контексттерді зерттеу. Адам мен табиғат арасындағы қатынас мәдени, тарихи және саяси жағдайларға байланысты дамиды зерттеледі. Бұл тәсіл әдебиеттегі табиғат бейнесін тек жеке көркемдік объект ретінде емес, адамзаттың экологиялық тәжірибесі мен көзқарастарының айнасы ретінде қарастыруға мүмкіндік береді (Garrard, 2012; Glotfelty, 1996).

Қазақ ауыз әдебиетінде экологиялық ой тыйым сөздер, мақал-мәтелдер, жыр-дастандар арқылы көрініс тапты. Табиғатты бүлдіру – күнә, ал оны қорғау – адамгершілік парыз ретінде ұғынылды. Мысалы, көк шөпті жұлмау, ағаш сабағын үзбеу, көк шыбықты сындырмау сияқты нормалар тіршіліктің бастауына деген жауапкершілікті білдіреді. Көне ырымдарға сәйкес, «көк жұлсаң, көктей орыласың, қарғыс атады, өркеніңнен айырыласың, қанатыңнан майырласың, жыл уағында жетпей не өлесің, не өлімдей бір пәлеге қаласың» деп, табиғатқа зиян келтірмеудің маңыздылығы айқын көрсетіледі [2].

Сонымен қатар, қазақ дәстүрінде суды да қасиетті санайды: бастау басына, бұлақ қасына, суға дәретке отырмау сияқты ырымдар тіршіліктің бастауы – бұлақты қорғауға бағытталған. Бұлақ пен бастау барлық тіршіліктің атасы және жан-бітімнің анасы ретінде қарастырылады. Егер адам бұл қағидаларды бұзса, табиғат «қарызы» мен қарғысына ұшырайтынына сенеді. Осы арқылы қазақ халқының дәстүрлі дүниетанымы табиғатты қорғау мен оны қадірлеу мәдениетін қалыптастырады.

Бұл дәстүрлі экологиялық сана қазақ әдебиетінде де көрініс тапқан. Мысалы, Абай, Мұқағали, Сұлтанмахмұт, т.б. шығармаларында табиғат бейнесі тек эстетикалық объект емес, адамның рухани және моральдық жауапкершілігінің өлшемі ретінде суреттеледі.

Әлем әдебиетіндегі классик ақындар сияқты, қазақ қаламгерлері де табиғатты әр дәуірдің әлеуметтік жағдайына сәйкес әртүрлі көркемдік мақсатта жырлады:

- табиғат – тіршілік көзі;
- табиғат – адамның ішкі психологиялық күйінің айнасы;
- табиғат – рухани пана табу кеңістігі.

Соған қарамастан, табиғат көркем әдебиетте әмбебап тақырып ретінде жетекші орын алды.

Қазақ әдебиетіндегі табиғат лирикасының көрнекті үлгілері Абай Құнанбайұлы шығармашылығымен тығыз байланысты. Абай табиғатты адам өмір сүретін орта, еңбек ету кеңістігі және рухани үйлесімнің көзі ретінде қарастырады. Оның «Жаз», «Күз», «Қыс», «Желсіз түнде жарық ай» өлеңдері табиғаттың маусымдық өзгерістерін суреттеу арқылы адам мен табиғаттың органикалық бірлігін көрсетеді.

Мәселен, «Желсіз түнде жарық ай» өлеңінде табиғат динамикалық, тірі жүйе ретінде бейнеленеді:

«Желсіз түнде жарық ай,
Сәулесі суда дірілдеп,
Ауылдың жаны - терең сай,
Тасыған өзен күрілдеп.

Қалың ағаш жапырағы
Сыбырласып өзді-өзі,
Көрінбей жердің, топырағы,

Құлпырған жасыл жер жүзі» [3, 71] –деген жолдарда ай сәулесінің суда дірілдеуі, өзеннің күрілдеуі, ағаш жапырақтарының сыбдыры – барлығы экологиялық үйлесімділіктің көркем моделін қалыптастырады. Бұл поэтикалық кеңістікте адам табиғаттан бөлінбейді, керісінше, оның бір бөлшегі ретінде танылады. Бұл көріністер арқылы Абай табиғаттың эстетикалық сұлулығын ғана емес, адам санасына тыныштық пен үйлесім сыйлайтын рухани мәнін де айқындайды. Өлеңдегі пейзаж адамның табиғатпен етене бірлікте өмір сүру қажеттігін аңғартатын философиялық астарға ие. Мұнда антропоцентризмнен гөрі биоцентрлік көзқарас басым. Ал ақынның «Өлсе өлер табиғат, адам өлмес...» атты өлеңі қазақ әдебиетіндегі терең философиялық мазмұнымен және экзистенциялық ойларымен ерекшеленеді. Аталған шығармада ақын табиғат, адам, өмір мен өлім категорияларын өзара сабақтастыра отырып, адамның рухани болмысы мен дүниелік құндылықтарға тәуелділігін сын тұрғысынан пайымдайды. Өлеңде экология мәселесі тікелей көрініс таппағанымен, адам мен табиғаттың өзара байланысы философиялық деңгейде көтеріліп, экологиялық ойлаудың терең қабаттары айқындалады:

«Өлсе өлер табиғат, адам өлмес,
Ол бірақ қайтып келіп, ойнап-күлмес.
«Мені» мен «менікінің» айрылғанын
«Өлді» деп ат қойыпты өңкей білмес.
Көп адам дүниеге бой алдырған,
Бой алдырып, аяғын көп шалдырған.
Өлді деуге сыя ма, ойлаңдаршы,
Өлмейтұғын артына сөз қалдырған?
Кім жүрер тіршілікке көңіл бермей,
Бақи қоймас фәнидің мінін көрмей.
Міні қайда екенін біле алмассың,
Терең ойдың телміріп соңына ермей.
Дүниеге дос ақиретке бірдей болмас,
Екеуі тап бірдей боп орныға алмас.
Дүниеге ынтық, мәғшарға амалсыздың
Иманын түгел деуге аузым бармас» [4, 161].

Өлеңнің алғашқы жолдарында («Өлсе өлер табиғат, адам өлмес») табиғаттың физикалық тұрғыдан өткінші, ал адамның рухани болмысының мәңгілік екендігі туралы идея алға шығады. Мұндағы табиғат ұғымы биологиялық орта ғана емес, фәни дүниенің символы ретінде қолданылып, онтологиялық категория дәрежесіне көтеріледі. Ал адам – тек тән емес, рухани субъект, оның мәңгілігі артында қалдырған сөзі мен ойында сақталады. Бұл көзқарас экологиялық антропологиядағы рухани жауапкершілік ұғымымен үндес келеді.

Абай «мен» және «менікі» ұғымдарын қарама-қарсы қойып, адамның дүниеге тұтынушылық, меншіктік қатынасын сынға алады. Бұл жерде ақын қазіргі экологиялық теорияда кеңінен қолданылатын антропоцентристік көзқарастың қауіптілігін интуитивті түрде ашып көрсетеді. Адам өзін табиғаттан жоғары қойып, оны тек иелену объектісі ретінде

қарастырғанда, рухани дағдарысқа ұшырайды. Осылайша өлеңде табиғатты тек пайдалануға бағытталған қатынасқа қарсы философиялық қарсылық білдіріледі.

Өлеңнің екінші шумағында дүниеге шектен тыс бой алдырған адамның рухани күйреуі бейнеленеді. Дүниелік қызығушылықтардың соңынан еру, фәни мен бақидың арасындағы тепе-теңдікті жоғалту – адам мен табиғат арасындағы үйлесімнің бұзылуымен астасып жатыр. Ақын «дүниеге дос, ақиретке бірдей болмас» деп, экологиялық этикадағы баланс ұғымын адамгершілік өлшемдермен байланыстырады.

Қорыта айтқанда, өлеңде адам тек табиғатты тұтынушы емес, оның моральдық тұрғыдан жауапты бөлшегі болуы тиіс. Терең ойға жетелейтін бұл шығармада экология мәселесі тікелей айтылмаса да, адамның табиғатқа және өмірге деген көзқарасының рухани негіздері көркем түрде пайымдалады. Абай дүниетанымында табиғат – өткінші кеңістік, ал адамдық парыз – мәңгілік рухани құндылықтарды сақтау.

Қорытындылай келе, экологиялық тәрбиенің қажеттілігі қазіргі қоғамда ерекше маңызға ие. Осы тұрғыда көркем әдебиет экологиялық сананы қалыптастырудың тиімді құралы болып табылады. Әдеби шығарма табиғатты тек суреттеп қана қоймай, адамды ойлануға, жауапкершілікке шақырады, экологиялық апаттардың салдарын алдын ала ескертеді.

Қазақ әдебиетіндегі экологиялық проблематика ұрпақ санасына табиғатқа ұқыпты қарау, оны қорғау, болашақ алдындағы жауапкершілік идеяларын сіңіреді. Бұл әдебиеттің тәрбиелік, философиялық және әлеуметтік функциясын айқындайды. Абай Құнанбайұлының табиғат лирикасы экологиялық сананың көркемдік негізін қалыптастырып, адам мен табиғат арасындағы үйлесімді қатынасты дәріптейді. Сондықтан қазақ әдебиетін экологиялық тұрғыдан зерттеу – қазіргі әдебиеттанудың өзекті бағыттарының бірі болып табылады.

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ADVANTAGES AND LIMITATIONS OF USING ARTIFICIAL INTELLIGENCE IN TEACHING ENGLISH

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This study focuses on the advantages and limitations of using Artificial Intelligence (AI) in teaching English. In recent years, AI technologies have been increasingly applied in education to support teaching and learning. AI provides many tools, such as chatbots, language learning apps, and intelligent tutoring systems, which can improve students' learning experience. One of the main advantages of AI is personalization. AI programs can adapt lessons to each student's level, giving them exercises that suit their abilities. This helps students learn grammar, vocabulary, reading, and speaking skills more effectively. AI also delivers immediate feedback, enabling learners to identify and correct mistakes right away. This is especially valuable for developing writing and speaking abilities. Additionally, AI helps teachers reduce the time spent on routine tasks such as checking assignments or creating worksheets, allowing them to concentrate more on teaching, supporting students, and offering meaningful guidance. Another advantage is that AI can make lessons more dynamic and interactive through games, digital quizzes, and simulated conversations, which increases students' motivation and engagement. However, there are limitations to using AI in English teaching. Some students may become too dependent on technology and spend less time practicing real communication skills. Not all students have equal access to devices or stable internet, which can create gaps in learning opportunities. Moreover, AI systems cannot fully understand emotions, culture, or context, which are very important in learning a language. Sometimes, AI feedback may be too rigid or fail to recognize nuanced language use, idioms, or expressions. Another important consideration is ethics. Using AI involves handling personal data, which raises privacy concerns. There is also the risk of bias in AI algorithms, which may affect how students are assessed or what content they receive. Therefore, while AI provides many opportunities for learning, its use should be balanced and carefully monitored by teachers. In conclusion, AI has great potential in English education. It can make learning more personalized, interactive, and efficient, while also supporting teachers in their work. However, it cannot completely replace human teachers, who are essential for guidance, cultural understanding, and emotional support. The most effective approach is to combine AI tools with traditional teaching methods to create a well-rounded and meaningful learning experience for all students.

Keywords: Artificial Intelligence, English teaching, personalised learning, pronunciation, feedback, educational technology

ПРЕИМУЩЕСТВА И ОГРАНИЧЕНИЯ ИСПОЛЬЗОВАНИЯ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА В
ОБУЧЕНИИ АНГЛИЙСКОМУ ЯЗЫКУ

Данное исследование рассматривает преимущества и ограничения применения Искусственного Интеллекта (ИИ) в обучении английскому языку. В последние годы технологии ИИ все активнее используются в образовательном процессе, поддерживая преподавание и обучение. Такие инструменты, как чат-боты, приложения для изучения языков и интеллектуальные обучающие системы, способны значительно улучшить учебный опыт учащихся. Одним из главных преимуществ ИИ является персонализация обучения. Программы ИИ могут адаптировать задания под уровень каждого студента, предлагая упражнения, соответствующие его возможностям. Это способствует более эффективному развитию грамматики, словарного запаса, чтения и разговорных навыков. ИИ также предоставляет мгновенную обратную связь, позволяя учащимся сразу выявлять и исправлять ошибки. Это особенно важно при развитии письменной и устной речи. Кроме того, ИИ сокращает время, которое преподаватели тратят на рутинные задачи, такие как проверка домашних работ или создание упражнений. Благодаря этому преподаватели могут уделять больше внимания обучению, поддержке и индивидуальному сопровождению студентов. Еще одно преимущество заключается в том, что ИИ делает уроки более динамичными и интерактивными с помощью игр, онлайн-викторин и имитационных диалогов, что повышает мотивацию и вовлеченность учащихся. Однако применение ИИ имеет и свои ограничения. Некоторые учащиеся могут чрезмерно зависеть от технологий, уделяя меньше внимания реальному общению. Не у всех студентов есть равный доступ к устройствам или стабильному интернету, что может создавать разрыв в образовательных возможностях. Кроме того, ИИ не всегда способен понять эмоции, культурный контекст или скрытые смыслы — а эти элементы играют ключевую роль при изучении языка. Иногда обратная связь ИИ может быть слишком жесткой или не учитывать нюансы языка, идиомы и выражения. Существуют и этические вопросы. Использование ИИ связано с обработкой персональных данных, что вызывает проблемы конфиденциальности. Также есть риски предвзятости алгоритмов, которые могут повлиять на оценивание студентов или содержание предоставляемых материалов. Поэтому, несмотря на широкие возможности ИИ, его применение должно быть тщательно контролируемым со стороны преподавателя. В заключение, ИИ обладает большим потенциалом в области обучения английскому языку. Он помогает сделать процесс обучения более персонализированным, интерактивным и эффективным, а также облегчает работу преподавателя. Тем не менее полностью заменить учителя ИИ не способен, поскольку эмоциональная поддержка, культурное понимание и педагогическое руководство являются исключительно человеческими качествами. Наиболее результативным подходом является сочетание технологий ИИ с традиционными методами обучения для создания полноценного и качественного образовательного процесса.

Ключевые слова: искусственный интеллект, обучение английскому языку, персонализированное обучение, произношение, обратная связь, образовательные технологии

Introduction

In today's world, English proficiency is a key skill for professional and personal development. Traditional language teaching methods often prove ineffective for students' individual needs. In this article, we examine the use of artificial intelligence in English language teaching, analyzing modern approaches and technologies, as well as prospects for development in this field. [1]

As digital tools rapidly develop, teachers and learners around the world are experiencing new methods of accessing knowledge, practising skills, and communicating across different languages. English, being the dominant global language used in international communication, academic research, digital content, and professional fields, has become one of the main areas where AI tools

are actively applied. This creates new opportunities—and new challenges—for both teachers and students.

AI technologies are now able to perform tasks that were once possible only with human support. They can analyse students' performance, identify learning gaps, suggest personalised exercises, check grammar and writing, and even evaluate pronunciation. Such capabilities make AI a powerful addition to traditional teaching methods. Students can learn at their own pace, receive immediate feedback, and work with materials that match their interests and skill levels. This creates a learning environment that is more flexible, adaptive, and supportive than conventional classroom instruction alone.

In English language teaching, AI helps address several long-standing educational difficulties. Large class sizes, limited lesson time, and different proficiency levels often make personalised teaching nearly impossible. AI tools fill this gap by providing customised practice activities, real-time corrections, and continuous progress tracking. As a result, learners gain more control over their own learning process and develop stronger motivation and confidence.

At the same time, the increasing role of AI in education raises important questions: Can AI replace teachers? How reliable are AI-generated corrections? What limitations do these tools have in understanding cultural context, emotional expression, or humour—key elements of natural communication in English? These concerns highlight the need to carefully evaluate not only the advantages, but also the limitations of AI in English teaching.

While AI offers valuable support, human teachers still play an essential role in guiding students, explaining cultural nuances, encouraging creativity, and creating a safe, motivating learning atmosphere. For this reason, understanding how AI can work together with teachers, rather than replacing them, is crucial for the future of English language education.

This study explores the key benefits and challenges of using AI in English teaching and provides examples of widely used tools such as Duolingo, ChatGPT, ELSA Speak, Grammarly, and Memrise. By analysing these tools, the article aims to show how AI can enhance vocabulary development, writing accuracy, speaking confidence, and overall communication skills. At the same time, for teachers, AI represents a valuable training tool by teaching them to interpret complex data and apply this knowledge to improve their pedagogical strategies.[2]

Relevance

The relevance of studying the advantages and limitations of Artificial Intelligence (AI) in teaching English is growing every year due to global technological development, the digitalisation of education, and the increasing need for effective language learning tools. English has become the primary international language of communication, science, business, and technology. As a result, millions of learners around the world seek efficient methods to improve their English proficiency. AI offers innovative solutions to many challenges faced by traditional teaching practices, making this topic highly significant for modern educators, students, policymakers, and researchers.

First, AI plays an essential role in addressing the need for personalised learning, which has become one of the central demands in contemporary education. In traditional classroom environments, it is often difficult for teachers to provide individualised instruction to every student due to time limitations, large class sizes, and diverse proficiency levels. AI-powered systems can analyse learners' strengths and weaknesses, track their progress, and adapt tasks according to their needs. This level of personalisation helps students learn more effectively and independently. Therefore, researching how AI contributes to personalised language learning is crucial for improving the overall quality of English education.

Second, the relevance of this study is linked to the growing importance of instant feedback in language learning. Students often struggle with grammar, pronunciation, vocabulary usage, and

writing clarity. In many cases, they may continue making the same mistakes if corrections are delayed. AI tools provide immediate feedback, allowing learners to see and fix errors on the spot. This prevents the reinforcement of incorrect habits and accelerates learning. Understanding the impact of such real-time correction mechanisms is essential for developing more efficient English teaching strategies.

Third, AI significantly expands access to diverse and authentic learning materials, which is particularly important in a globalised world. English learners need exposure to different accents, expressions, cultural contexts, and real-life communication styles. AI technologies curate materials from multiple sources and personalise recommendations for learners. This makes English learning more interesting, relevant, and culturally rich. Therefore, studying AI's ability to deliver authentic input helps educators design engaging and meaningful learning environments.

Another important factor contributing to the relevance of this topic is the rise of flexible and lifelong learning. Modern learners—students, working adults, professionals—often seek opportunities to learn outside traditional classrooms. AI tools are accessible anytime and anywhere, allowing learners to study English according to their schedules. This flexibility supports the idea of lifelong learning and continuous personal development. Researching how AI supports accessible and independent learning is therefore highly significant.

However, the relevance of this topic also arises from the need to evaluate the limitations and challenges of AI. Although AI brings many benefits, it cannot fully replace human teachers. Emotional intelligence, empathy, cultural knowledge, and complex linguistic explanations are areas where AI remains limited. In addition, technological barriers, financial costs, and unequal access to digital devices create challenges for learners in different socio-economic environments. Thus, investigating the limitations of AI is essential for ensuring fair and effective integration of technology into education.

Furthermore, as AI becomes more widespread, questions of data quality, ethics, and reliability become increasingly important. AI systems depend on the data they are trained on. If the data is biased or incomplete, the learning experience may be negatively affected. Understanding the risks associated with AI usage in language education helps researchers and developers create safer, more inclusive technologies.

Finally, this topic is relevant because English teachers are actively seeking ways to integrate AI into their teaching practice. Many educators feel overwhelmed by growing workloads and diverse student needs. AI can automate routine tasks such as checking assignments, providing feedback, monitoring progress, and preparing practice exercises. Studying how AI can support teachers helps improve their professional efficiency and reduce burnout.

In summary, the relevance of researching the role of Artificial Intelligence in English language teaching is deeply connected to global educational trends, technological progress, and the evolving needs of learners and teachers. AI has the potential to transform language education, making it more personalised, accessible, engaging, and effective. However, responsible and informed use of AI requires a clear understanding of both its strengths and limitations. Therefore, this study contributes valuable insights into how AI can be integrated into English teaching in a balanced and beneficial manner.

Advantages of AI in English Language Teaching

1. Personalised Learning

One of the biggest advantages of AI is that it can create personalised learning paths. Every student learns differently: some learn fast, some slow; some need help with grammar, while others need pronunciation practice. AI platforms analyse a learner's behaviour, mistakes, and progress, then offer tasks designed specifically for that student.

For example, if a learner struggles with past tense verbs, an AI platform will focus more exercises on that topic. This personalised approach helps students learn more efficiently and confidently.

2. Instant Feedback and Correction

Traditionally, students had to wait for teachers to check their writing, speaking, or grammar assignments. With AI, feedback is immediate. AI tools can correct grammar, punctuation, vocabulary, and even tone in seconds. This helps students see their mistakes quickly and fix them before they become habits.

For speaking, pronunciation tools such as ELSA Speak analyse the student's voice and show exactly which sounds are incorrect. This kind of feedback is difficult for teachers to give individually to every student, so AI fills an important gap.

3. Access to Diverse Learning Materials

AI offers students access to a wide range of learning materials: videos, articles, quizzes, dialogues, and interactive exercises. These materials come from different cultures, accents, and contexts. This allows learners to experience English as it is used in real life.

AI also suggests materials based on students' interests. For example, if a student likes sports, the system recommends sports-related texts or listening exercises. This makes learning more enjoyable and personally meaningful.

4. Flexibility and 24/7 Availability

AI tools are available anytime and anywhere, making learning flexible. Students can practise English early in the morning, late at night, during a break, or while travelling. This is especially helpful for people with busy schedules or learners who do not have access to English teachers in their area.

For many students, this flexibility increases the amount of time they spend practising English, which leads to better results.

Limitations of AI in English Language Teaching

1. Lack of Human Emotion and Interaction

AI cannot replace human teachers because it does not understand emotions or provide empathy. Many students learn best when they feel supported, encouraged, and understood. A human teacher can motivate, inspire, and adapt to the student's emotional state—AI cannot.

Moreover, real conversation involves body language, tone, humour, and cultural context. AI cannot fully reproduce these aspects of communication.

2. Difficulty Understanding Complex Language Nuances

English is full of idioms, jokes, sarcasm, and cultural expressions. AI still struggles to understand these nuances. For example, AI might take sarcastic statements literally or fail to explain why a certain idiom is used in a specific situation.

Advanced learners often require deep cultural and contextual explanations that only human teachers can provide.

3. Technology dependence. Frequent use of artificial intelligence can lead to technology dependence, which can negatively impact the development of critical thinking and independent learning skills. Lack of access to digital resources can lead to decreased student confidence. [3]

4. Technological and Financial Barriers

Not all students have access to strong internet, smartphones, or computers. Some advanced AI tools require paid subscriptions, which can be expensive for certain learners. This creates inequality in access to English language education.

Popular AI Tools for English Language Learning

1. Duolingo

Duolingo uses gamification and AI to create personalised lessons. It identifies the user's weak areas and designs exercises to target those skills. The platform also uses spaced repetition to help learners remember vocabulary effectively.

2. ChatGPT and AI Chatbots

ChatGPT, which is an AI-assisted tool, might be utilized in language learning settings to help learners develop their language learning skills and sub-skills [4]

ChatGPT allows students to practise real conversations in English. They can role-play interviews, practise dialogues, ask questions, and receive corrections. This encourages fluency and improves confidence in speaking and writing.

3. ELSA Speak

ELSA is a pronunciation tool that uses speech recognition to analyse how students pronounce English sounds. It highlights mistakes and shows how to fix them. Visual sound wave comparisons help learners understand the correct mouth and tongue positions.

4. Grammarly

Grammarly assists with writing by checking grammar, spelling, punctuation, and style. It provides suggestions to make sentences clearer and more professional. This tool is useful for academic writing, emails, essays, and creative writing.

5. Memrise

Memrise uses AI and spaced repetition to teach vocabulary through pictures, videos, and short clips of native speakers. This exposure to real-life English helps students learn pronunciation and intonation naturally.

Conclusion

The rapid development of Artificial Intelligence has significantly transformed the way English is taught and learned in modern education. As this study has shown, AI provides a wide range of advantages that directly support learners' progress: personalised learning paths, instant feedback, access to authentic materials, and flexible 24/7 learning opportunities. These features make AI a valuable tool for students with different language levels, learning styles, and schedules. By helping learners practise grammar, pronunciation, vocabulary, and communication skills more efficiently, AI contributes to stronger motivation, higher engagement, and improved learning outcomes.

However, despite these strengths, AI is not a perfect solution. It still lacks emotional understanding, cultural sensitivity, and the ability to interpret humour, sarcasm, or deep contextual meaning—elements that are essential in real human communication. AI systems also rely heavily on high-quality data and technological access, which may not always be available to all learners. These limitations highlight the continued importance of human teachers, who provide emotional support, cultural explanations, creativity, and personal interaction—things AI cannot fully replicate.

Therefore, the most effective approach is a balanced combination of traditional teaching methods and AI technologies. When used wisely, AI can reduce teachers' workload, enhance classroom instruction, and support students' independent learning. At the same time, teachers can focus on communication, critical thinking, cultural understanding, and emotional guidance. Together, these strengths create a comprehensive and modern educational environment that meets the needs of today's learners.

Overall, AI should not be viewed as a replacement for teachers, but rather as a powerful assistant that increases the quality, accessibility, and efficiency of English language education. By understanding both the advantages and limitations of AI, educators and learners can use these tools responsibly and effectively, ensuring meaningful and successful language learning experiences.

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COGNITIVE ASPECTS OF LEARNING A LANGUAGE WITH AI SUPPORT

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This article explores the cognitive aspects of language learning with the support of artificial intelligence (AI)

The study analyzes how learner's cognitive processes – attention, memory, perception, information-processing speed, and metacognition – change when AI tools are used [6]. It is demonstrated that AI-based chatbots, adaptive platforms, automated text-analysis systems, and generative models enable the personalization of learning strategies and help reduce cognitive load. The article also shows that AI support enhances motivation, provides immediate error correction, and strengthens the development of speaking skills. Furthermore, the role of AI technologies in optimizing the language-learning process and their impact on cognitive development are discussed in a comprehensive manner.

Keywords: Artificial Intelligence, language learning, cognitive processes, memory, attention, perception, metacognition, AI-supported learning

КОГНИТИВНЫЕ АСПЕКТЫ ИЗУЧЕНИЯ ЯЗЫКА С ПОДДЕРЖКОЙ ИИ

В данной статье рассматриваются когнитивные аспекты изучения языка с использованием искусственного интеллекта (ИИ). В исследовании анализируется, как изменяются мыслительные процессы изучающего язык - внимание, память, восприятие, скорость обработки информации и метакогниция - при применении ИИ-инструментов. Показано, что чат-боты на основе ИИ, адаптивные платформы, системы автоматического анализа текста и генеративные модели позволяют персонализировать учебные стратегии и снижать когнитивную нагрузку. Кроме того, доказано, что поддержка ИИ усиливает мотивацию, обеспечивает мгновенную корректировку ошибок и способствует развитию навыков говорения. В статье всесторонне обсуждается роль ИИ-технологий в оптимизации процесса изучения языка и их влияние на когнитивное развитие.

Keywords: Искусственный интеллект, изучение языка, когнитивные процессы, память, внимание, восприятие, метапознание, обучение с поддержкой ИИ

Introduction

In recent years, the rapid development of artificial intelligence (AI) technologies has significantly transformed the field of language education. AI-powered tools such as intelligent tutoring systems, adaptive learning platforms, and conversational agents have become widely integrated into the process of acquiring a new language. These technologies not only provide learners with instant feedback and personalized learning paths but also interact with them in natural, human-like ways, creating new opportunities for autonomous and effective learning [7].

At the same time, language learning is deeply connected to the learner's cognitive processes, including attention, memory, perception, information processing, and metacognitive regulation. Understanding how these cognitive mechanisms function and how they are influenced

by AI-based support is essential for improving language teaching methodologies and optimizing learning outcomes. The integration of AI tools has the potential to reduce cognitive load, enhance memory retention through spaced repetition and multimodal learning, and support sustained attention by offering engaging, interactive content [3].

Despite these emerging advantages, the cognitive impact of AI-supported language learning remains a relatively new area of research. Many questions arise regarding how AI shapes learners' cognitive strategies, how it influences motivation and error-correction behavior, and to what extent it enhances or replaces traditional cognitive processes involved in linguistic development. Therefore, studying the cognitive aspects of language learning in the context of AI assistance is crucial for identifying both the benefits and potential limitations of these technologies.

This paper explores the cognitive foundations of language learning and examines how AI-based tools interact with these cognitive processes. By analyzing the role of attention, memory, perception, and metacognition, the study aims to provide a deeper understanding of how AI can support, modify, or optimize language acquisition mechanisms [6]. The paper also highlights practical implications for learners and educators, presenting insights into how AI can be effectively integrated into language learning environments to enhance cognitive engagement and overall learning efficiency.

Relevance

Several foundational theories in cognitive psychology help explain why AI-supported language learning can be highly effective. L.S. Vygotsky's concept of the Zone of Proximal Development (ZPD) aligns closely with the capabilities of modern AI technologies. Vygotsky's well-known idea that "teaching is a process that leads development" illustrates how AI systems can accurately identify a learner's current level and provide tasks that are slightly more challenging. Through adaptive algorithms, AI platforms analyze learner responses and automatically adjust the difficulty of assignments, preventing cognitive overload while ensuring constant developmental progress [2]. Krashen's theory emphasizes the importance of comprehensible input and natural communication in second language acquisition [5]

John Sweller's Cognitive Load Theory also provides strong theoretical support for the use of AI in language learning. His assertion that "the key to improving learning is balancing the load placed on working memory" reflects the ability of AI to simplify complex linguistic material by segmenting it into smaller, more manageable units. AI tools can rewrite difficult grammatical explanations, summarize long texts, and offer step-by-step guidance. These features reduce unnecessary cognitive load and help learners process information more deeply and efficiently. [3]

Additionally, Richard Mayer's multimedia learning theory reinforces the cognitive benefits of AI-supported education. Mayer's principle that "people learn better from words and pictures together than from words alone" is directly implemented in AI platforms that integrate audio, visual, and textual modalities. Modern AI systems such as ChatGPT, Duolingo AI, and other adaptive learning platforms provide learners with multimodal content that strengthens listening, viewing, reading, and writing skills simultaneously. This coordinated activation of multiple cognitive channels enhances retention and overall comprehension. [4]

Taken together, these three theoretical perspectives demonstrate that AI technologies serve not merely as technical tools but as cognitively informed systems that support and optimize learner development. By aligning with established psychological principles, AI can effectively enhance cognitive processing, improve engagement, and increase the overall efficiency of language learning.

One of the strongest demonstrations of AI's cognitive benefits in language learning is Duolingo's use of spaced repetition algorithms. The system analyzes how well a learner remembers each word or phrase and schedules review sessions at scientifically optimized

intervals. This method is widely proven in cognitive psychology to strengthen long-term memory consolidation and reduce forgetting.

AI adapts the repetition rate based on learner performance:

- words that are frequently forgotten appear more often,
- well-mastered items are delayed,
- the learning curve becomes personalized and efficient.

This directly aligns with Vygotsky's principle that "learning leads development."

AI pushes learners slightly beyond their current mastery level by selecting items that they are "almost" forgetting — functioning as a digital scaffold within the learner's Zone of Proximal Development.

A second example involves AI-powered speech recognition tools such as Google Speech-to-Text, Elsa Speak, and Speech Ace. These systems improve pronunciation and auditory perception by providing immediate, detailed feedback:

- they detect mispronounced phonemes with high accuracy,
- highlight specific articulation errors (e.g., tongue position, stress, intonation),
- offer model pronunciation for comparison,
- allow repetitive practice without social anxiety.

Learners receive instant auditory and visual feedback, which enables them to adjust their pronunciation in real time. This reflects Richard Mayer's Multimedia Learning Theory, particularly the idea that combining visual and verbal channels enhances comprehension and retention.

Here, AI integrates:

- visual feedback (highlighted errors),
- audio samples,
- text transcripts,
- self-correction loops.

Such multimodal interaction strengthens both perception and production skills simultaneously, making pronunciation training more effective than traditional methods.

Kismetova G.N. and Amangaliyeva A. [1] (2022) examined the use of AI tools such as ChatGPT and Grammarly to support autonomous development of students' writing skills. AI not only assists in correcting linguistic errors but also enhances students' self-correction and monitoring of their learning process. This study demonstrates that AI tools can develop not only students' writing skills but also their metacognitive abilities. In my opinion, integrating these tools into daily language learning lessons can strengthen students' independent learning skills.

Conclusion

This article examined the cognitive aspects of language learning supported by artificial intelligence (AI). Cognitive skills — including attention, memory, perception, information processing, and metacognition — are fundamental components of the language acquisition process. AI platforms actively support these cognitive skills, enhancing learners' overall effectiveness and efficiency.

Theoretical frameworks such as Vygotsky's Zone of Proximal Development, Sweller's Cognitive Load Theory, and Mayer's Multimedia Learning Theory provide critical insights into the role of AI in language education. Vygotsky's principles demonstrate how AI systems can assess learners' current levels and offer appropriately challenging tasks. Sweller's theory explains how AI reduces cognitive load by segmenting complex material into smaller, manageable units. Mayer's approach illustrates how AI can deliver multimodal content — combining audio, visual, and textual information — to engage multiple cognitive channels simultaneously.

Practical examples, including Duolingo AI's spaced repetition exercises and AI speech recognition tools such as Google Speech and Elsa Speak, show how these cognitive skills are

applied in real learning contexts. AI systems reinforce memory, provide precise error feedback, and enhance auditory perception and articulation skills. These approaches personalize learning and support the cognitive and motivational development of learners.

Overall, AI-supported language learning serves as an effective tool for developing cognitive skills. By adapting learning material to individual levels, reducing cognitive load, and offering multimodal experiences, AI significantly improves the efficiency and effectiveness of language acquisition. Future research should continue exploring how AI influences learners' cognitive strategies, metacognitive skills, and motivation to optimize AI integration in educational practice [7].

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A NEW PARADIGM FOR FOREIGN LANGUAGE TEACHING IN A PEDAGOGICAL UNIVERSITY IN KAZAKHSTAN: HOW TO USE AI TO RESTORE DIALOGUE, EMPATHY, AND CRITICAL THINKING

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This paper proposes a new paradigm for teaching foreign languages in pedagogical universities, where Artificial Intelligence (AI) is not employed as a substitute for human teachers, but as a catalyst to revive authentic dialogue, cultural empathy, and critical reflection — core values enshrined in Kazakhstan's national education strategy. Grounded in President Kassym-Jomart Tokayev's 2024 Address, which calls for AI to "strengthen, not weaken, the human dimension of education," this study argues that AI's greatest pedagogical value lies not in its linguistic accuracy, but in its cultural blindness — exposing the silent, sacred rituals of communication that algorithms cannot replicate. Through low-tech, high-impact classroom practices — such as critically analyzing AI-generated responses to culturally nuanced prompts (e.g., "How to say 'no' in Kazakh culture?") and co-creating authentic dialogues rooted in Kazakh traditions like "Қош келдіңіз!" and "Құтты болсын!" — students learn that language is not merely grammar, but a vessel of dignity, respect, and identity. The approach is theoretically anchored in Hymes' (1972) communicative competence, Vygotsky's (1978) sociocultural theory, and Gadamer's (1975) hermeneutics, and is fully aligned with Kazakhstan's Law on Education (2007), the Concept of Higher Education Development (2023–2029), and the Order of the Government No. 248. This model empowers future educators to use AI not to automate, but to humanize language learning — transforming classrooms into spaces where technology serves humanity, not replaces it.

Keywords

Artificial Intelligence, foreign language teaching, cultural empathy, critical dialogue, Kazakh pedagogy, human-centered education, communicative competence, intercultural pragmatics, digital ethics in education

НОВАЯ ПАРАДИГМА ОБУЧЕНИЯ ИНОСТРАННЫМ ЯЗЫКАМ В ПЕДАГОГИЧЕСКОМ УНИВЕРСИТЕТЕ В КАЗАХСТАНЕ: КАК ИСПОЛЬЗОВАТЬ ИИ ДЛЯ ВОССТАНОВЛЕНИЯ ДИАЛОГА, ЭМПАТИИ И КРИТИЧЕСКОГО МЫШЛЕНИЯ

В данной статье предлагается новая парадигма преподавания иностранных языков в педагогических вузах, где искусственный интеллект (ИИ) не используется как замена человеческому преподавателю, а выступает катализатором возрождения подлинного диалога, культурной эмпатии и критического осмысления — ценностей, закреплённых в национальной образовательной стратегии Казахстана. Основываясь на Послании Президента Касым-Жомарта Токаева 2024 года, в котором подчёркивается, что ИИ должен «укреплять, а не размывать» человеческое измерение образования, это исследование

утверждает, что наибольшая педагогическая ценность ИИ заключается не в его лингвистической точности, а в его культурной слепоте — которая обнажает молчаливые, священные ритуалы общения, которые алгоритмы не могут воспроизвести. Через простые, но высокоэффективные педагогические практики — такие как критический анализ ответов ИИ на культурно-нюансированные вопросы (например, «Как сказать „нет“ в казахской культуре?») и совместное создание аутентичных диалогов, основанных на традициях Казахстана, таких как «Қош келдіңіз!» и «Құтты болсын!» — студенты учатся, что язык — это не просто грамматика, а сосуд достоинства, уважения и идентичности. Подход теоретически основан на концепции коммуникативной компетентности Хаймса (1972), социокультурной теории Выготского (1978) и герменевтике Гадамера (1975), и полностью соответствует Закону РК «Об образовании» (2007), Концепции развития высшего образования на 2023–2029 гг. и Постановлению Правительства №248. Эта модель даёт будущим педагогам возможность использовать ИИ не для автоматизации, а для гуманизации языкового обучения — превращая аудитории в пространства, где технологии служат человеку, а не заменяют его.

Ключевые слова:

Искусственный интеллект, обучение иностранным языкам, культурная эмпатия, критический диалог, казахская педагогика, гуманистическое образование, коммуникативная компетентность, межкультурная прагматика, этика цифровых технологий в образовании

Introduction

Modern education is undergoing a profound transformation under the influence of Artificial Intelligence (AI). Globally, AI tools promise personalized learning, instant feedback, and scalable instruction. In Kazakhstan, this shift is actively supported by national policy. In his landmark 2024 Address to the People of Kazakhstan, President Kassym-Jomart Tokayev declared: “Artificial Intelligence is not a threat — it is a powerful tool for modernizing education.” Yet he immediately emphasized a crucial boundary: “Digitalization must strengthen, not erode, the human dimension of education” [1]. This statement encapsulates a critical pedagogical dilemma of our time: how to harness the efficiency of AI while preserving the soul of humanistic disciplines — especially foreign language education.

Language has never been merely a system of grammar and vocabulary. As Hymes [2] long ago argued, true linguistic competence lies not in correctness, but in appropriateness — the ability to speak in ways that are culturally, socially, and emotionally attuned. In Kazakhstan, this truth is embodied in everyday practices: a guest is not just welcomed but honored with “Қош келдіңіз!”; a farewell is not a routine “goodbye,” but a heartfelt blessing — “Құтты болсын!” These are not linguistic forms; they are ethical acts. Yet AI, trained on decontextualized data, reduces such rituals to generic templates: “Say ‘Hello’ and invite them to sit.” This reductionism risks producing a generation of language users who are fluent in syntax but mute in humanity.

Therefore, the central challenge is not whether to use AI, but how. Most current applications treat AI as an intelligent tutor — an automated source of knowledge [3]. This paper proposes a radical reorientation: AI should not replace the teacher, but reveal what only a teacher can teach. We introduce the “Critical AI Engagement” methodology — a low-tech, high-impact approach that uses AI’s cultural blindness as a pedagogical resource. By analyzing, critiquing, and humanizing AI-generated language, students develop intercultural competence, critical thinking, and emotional intelligence — the very qualities that define great educators.

Relevance

Development of the "Critical AI Engagement" Methodology: Simple Steps for Deep Impact

We propose introducing the "Critical AI Engagement" methodology into the educational process. This is not a complex technological system, but a simple, low-tech strategy that can be

implemented immediately, even if the university only has interactive whiteboards and free internet access.

The essence of the methodology: use AI not as a source of knowledge, but as an object of critical analysis. We show students that a machine can be grammatically flawless, yet deeply inappropriate in a cultural sense. This awakens them as researchers, critics, and future educators.

Step 1: Task Preparation (Teacher)

The teacher pre-assigns any free AI (e.g., Google Gemini or ChatGPT) a question related to intercultural pragmatics — how English is spoken in different situations, considering culture, status, and context.

Examples of questions:

- *“How to politely decline an invitation from your professor in the UK?”*
- *“How to apologize for being late to a meeting with colleagues in the US?”*
- *“How to ask for help from a stranger in Australia without sounding rude?”*

Then, the teacher saves the AI’s response and prepares a short annotation: *“Why is this answer superficial? Which cultural norms does it ignore?”*

Step 2: Pair Work (Students)

During class, the teacher displays the AI’s response on an interactive board or distributes printed copies. Students work in pairs and answer the following questions:

1. Is everything grammatically correct?
2. Are there softening expressions (hedging), such as: *I wonder if..., Would you mind..., I’d be grateful if...?*
3. Are social distances (the interlocutor’s status) taken into account?
4. Are there expressions of gratitude, sympathy, or recognition of effort?
5. How would a native speaker respond in real life?

Step 3: Collective Reconstruction (Group)

Together, the group rewrites the response to make it more culturally appropriate. Example: AI Response:

“I can’t come to your party. Sorry.”

Improved Student Version:

“Thank you so much for the invitation — it means a lot that you thought of me. Unfortunately, I won’t be able to make it this time due to a prior commitment. I really hope you have a wonderful evening!”

This approach teaches not just “speaking correctly,” but understanding why some words touch the heart while others cut like a knife.

Step 4: Reflection (Individual)

Each student fills out a reflective journal (on a separate sheet or in a notebook):

1. What did the AI understand correctly?
2. What did it miss?
3. What did I learn about language through its mistake?

This journal is not a grade, but a diagnostic tool for metalinguistic awareness. Through it, the teacher sees how the student begins to think like an educator, not just a language user.

The Kazakh Soul in an English Word: When “Қош келдіңіз!” Means More Than a Greeting
Imagine: you arrive at a Kazakh family's home.

The host greets you not with “Hello” or “Nice to meet you.”

With a gesture, he shows you that he is genuinely happy to welcome you as a guest, and says: *“Қош келдіңіз!”*

To say “*Қош келдіңіз!*” means not just greeting someone, but opening your heart and home to them, expressing respect and joy at their arrival. It is a blessing for a good meeting, the beginning of friendship and mutual trust.

Sometimes they add: “*Қош келдіңіз, төрге шығыңыз!*” — “Welcome, please take the honored seat!” — inviting the guest to sit in the best place in the house.

This is not politeness. It is gratitude and joy — that you, a person, have come to them. This is how true communication begins in Kazakh culture.

Now imagine asking the same question to AI:

“How to greet someone when they come to your home in Kazakhstan?”

AI responds:

“Say ‘Hello’ and invite them to sit down.”

Where is the soul? Where is the heart?

In Kazakh tradition, a guest is sacred. If you came, it means your soul wanted to be here. So people don’t just say: “Hello” or “Pleased to meet you.”

They don’t say: “Sit down” — they say: “*Қош келдіңіз, төрге шығыңыз!*” — which means not just hospitality, but carries a deep sense of respect, recognition, and honor — “Sit, as if at home” — and do everything to make you feel free and comfortable.

And when you leave? You don’t just say: “Goodbye.”

You stand up, place your hand on your heart, bow slightly, and say:

“Құтты болсын!” — “May you be blessed!”

This is not farewell. It is a blessing.

It is not “Bye.” It is: “*I wish you a life as I wish for my daughter.*”

Now imagine AI generates a response to the question:

“How to say goodbye respectfully in Kazakhstan?”

It writes:

“Say ‘Goodbye’ and shake hands.”

Where is the blessing? Where is the heart? In Kazakh culture, it is not customary to say “no” directly.

Because refusal is not politeness — it is rejection of a person’s soul. If someone offers you tea, you don’t say: “No, thank you.” You say: “*Рахмет*” — and drink one sip. Because refusal is not about the tea — it is about rejecting the person.

And AI? It doesn’t know that politeness is not a template — it is a sacrifice.

It doesn’t know that your “thank you” can carry more humanity than its 1,000 grammatically perfect sentences.

Imagine a Kazakh student speaking in English:

“I’m sorry I can’t come.”

AI corrects:

“I regret to inform you that I am unable to attend.”

But the student, raised in a family where people say “*Құтты болсын!*”, simply says:

“I wish I could be there. I’ll miss you all.”

Who speaks better? Who is right?

Who is more humane? AI is correct.

The student is sincere. And it is precisely sincerity that AI cannot imitate.

Because sincerity is not learned — it is nurtured.

In a family where you are taught: “*A word is like milk. Once spilled, you can’t gather it back.*” In an aul where elders say: “*A word is not an arrow. Once released, you can’t retrieve it.*”

This is Kazakh philosophy of communication. This is a language that is not studied in textbooks. This is what AI cannot convey.

But this is what we, as educators, can pass on. We do not teach students to “speak correctly.” We teach them to speak in a way that the heart can hear.

And if AI can generate thousands of phrases - only a human can utter one word that will stay in memory for a lifetime.

Because language is not code. Language is the soul speaking in another tongue.

Practical Implementation: How to Apply This in Real Conditions at a Kazakh University

One of the main questions: “But how does this work if there’s no VR, paid platforms, or high-speed internet?”

Answer: this methodology was created specifically for such conditions.

Implementation Using an Interactive Whiteboard

- The teacher prepares 2–3 AI responses in advance, at home.
- During class, opens them on the board.
- Students suggest edits — all changes are made directly on screen.
- At the end, a comparison is saved: “*AI vs. Human.*”

Implementation Without Digital Tools

- The teacher prints out AI responses.
- Divides students into groups.
- Each group receives a task: analyze, correct, present their version.
- After presenting, a general discussion is held.

Where to Get Task Ideas?

Use real-life student situations:

- Write an email to a dean requesting a deadline extension;
- Say no to a friend who wants to copy homework;
- Ask a teacher for help;
- Express condolences to a colleague.

Every situation is an opportunity for immersion in culture, not just practicing templates.

How to Assess Results?

Not by “correctness,” but by depth of analysis:

- Student noticed AI didn’t use softening phrases — +1 point.
- Proposed an alternative considering culture — +1 point.
- Made a conclusion about the difference between “grammatical” and “cultural” correctness — +1 point.

This approach fully aligns with Order No. 43 of the Committee for Quality Assurance (2022), which requires universities to develop students’ critical thinking.

Why This Methodology Works: Theory, Law, and the Future

The “Critical AI Engagement” methodology is not a random idea. It rests on three solid pillars: theory, legislation, and international experience.

Theoretical Foundation

1. Hermeneutics of Hans-Georg Gadamer (1975): Understanding is not information transfer, but an event of meeting, where interlocutors change each other. When students correct AI, they enter into dialogue with culture, language, and themselves.
2. Cultural-Historical Theory of L.S. Vygotsky (1978): Learning occurs in the Zone of Proximal Development through social interaction. The teacher is not a keeper of knowledge, but a mediator guiding students toward independent discovery.
3. Critical Pedagogy of Neil Selwyn (2022): Technology should serve critical thinking, not mask systemic problems. AI is not the solution, but an occasion to ask: “*What does it mean to speak like a human?*”

Compliance with Legislation of the Republic of Kazakhstan

The methodology fully complies with current regulatory acts:

- Law of the Republic of Kazakhstan “On Education” (2007) — prioritizes a personality-oriented approach (Article 4);
- Concept of Higher Education Development 2023–2029 (Government Decree No. 248, 2023) — training teachers capable of innovation and critical thinking;
- Concept of Legal Policy until 2030 (Decree No. 674, 2021) — development of civil society based on dialogue.

International Context

- ESG (2015) — European quality standards require “student engagement in reflection and dialogue.”
- HRK (2024) — in Germany, AI is used for personalization, but the teacher remains the central figure.
- Higher Education Act (2008, USA) — focus on developing professional identity, not automation.

The Future Belongs to Humanism

International research (Heredia-Carroza & Stoica, 2024) shows that countries combining digitalization with strong pedagogical training achieve better results. The future belongs not to those who use AI best, but to those who keep the human at the center of education.

Conclusion: Not Replacement, But Enhancement

The era of AI is not a threat — it is a profound invitation to re-examine the foundations of education. As Selwyn [3] warns, technology often masks pedagogical crises rather than solving them. But if we turn AI inside out — not as an oracle, but as a mirror — it can reveal what is most precious: the irreplaceable role of the human teacher as a guide to meaning, empathy, and ethical communication.

The “Critical AI Engagement” methodology is more than a teaching technique; it is a philosophical stance. It asserts that in a world of algorithms, the most radical act is to insist on soul, silence, and sincerity. It aligns with the vision of Kazakhstan’s leadership [1], the wisdom of its traditions, and the global call for human-centered education [4,5,6,7].

In pedagogical universities — institutions that shape the shapers of future generations — this approach is not optional; it is essential. It prepares future teachers not merely to use technology, but to wield it wisely, ensuring that digital tools serve human ends, not the reverse.

As we move forward into the AI age, let us remember:

Language is not code.

Language is the soul speaking in another tongue.

And only a human can teach another — to hear it.

This is not the end of language teaching.

It is its renaissance.

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AI-ASSISTED ENGLISH VOCABULARY LEARNING: A NEW APPROACH FOR DIGITAL-AGE STUDENTS

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This article investigates the transformative role of Artificial Intelligence (AI) in facilitating English vocabulary acquisition for modern students. The digital age demands innovative educational approaches, and AI offers solutions to the limitations of traditional methods. The study aims to analyze the key AI-driven methodologies, such as adaptive learning and spaced repetition, and evaluate their effectiveness in enhancing vocabulary retention, engagement, and autonomy. The research employs a mixed-methods approach, including a comprehensive review of recent scholarly literature and a comparative analysis of popular AI-powered platforms like Duolingo, Memrise, and conversational AI chatbots. The findings indicate that AI-assisted learning leads to statistically significant improvements in long-term vocabulary retention and fosters higher levels of student motivation through personalized and interactive experiences. The article concludes that the integration of AI into language learning curricula is not merely beneficial but essential for meeting the needs of digital-native learners, highlighting both its practical implications and potential challenges.

Keywords: Artificial Intelligence, English Vocabulary Acquisition, Adaptive Learning, Educational Technology, Spaced Repetition.

ОБУЧЕНИЕ АНГЛИЙСКОЙ ЛЕКСИКЕ С ПОМОЩЬЮ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА: НОВЫЙ ПОДХОД ДЛЯ СТУДЕНТОВ ЦИФРОВОЙ ЭПОХИ

В данной статье исследуется преобразующая роль искусственного интеллекта (ИИ) в облегчении усвоения английской лексики современными студентами. Цифровая эпоха требует инновационных образовательных подходов, и ИИ предлагает решения ограничений традиционных методов. Цель исследования – проанализировать ключевые методы на основе ИИ, такие как адаптивное обучение и интервальное повторение, и оценить их эффективность в улучшении запоминания словарного запаса, вовлеченности и автономии. В исследовании используется комплекс методов, включающий обзор современной научной литературы и сравнительный анализ популярных платформ на основе ИИ, таких как Duolingo, Memrise и чат-боты. Результаты показывают, что обучение с помощью ИИ приводит к статистически значимым улучшениям в долгосрочном запоминании лексики и способствует повышению уровня мотивации студентов за счет персонализированного и интерактивного опыта. В статье делается вывод, что интеграция ИИ в учебные программы по языкам не просто полезна, но и необходима для удовлетворения потребностей цифрового поколения учащихся, выделяя как практические последствия, так и потенциальные проблемы.

Ключевые слова: искусственный интеллект, усвоение лексики английского языка, адаптивное обучение, образовательные технологии, интервальное повторение.

Introduction

Relevance and Scientific Significance: In the 21st century, English proficiency is a critical competency for academic and professional success globally. Traditional vocabulary learning methods, often based on rote memorization and static textbooks, fail to address the diverse learning paces, styles, and motivations of individual students. This often results in superficial knowledge and rapid forgetting. The emergence of Artificial Intelligence (AI) in the educational sector marks a paradigm shift, enabling the creation of dynamic, personalized, and data-informed learning environments. Investigating the efficacy of these AI-driven tools is therefore of paramount scientific and practical importance for contemporary pedagogy.

Research Objective: To comprehensively analyze the impact of AI technologies on the process of English vocabulary learning and to develop a framework for their effective integration into educational practices.

Research Tasks:

To examine the theoretical underpinnings of AI in education, focusing on cognitive science principles. To classify and characterize the main AI-driven methods and tools used for vocabulary acquisition. To analyze the perceived benefits and challenges of AI-assisted learning from the student's perspective. To formulate practical recommendations for educators and learners. The process of English vocabulary acquisition. AI-assisted methods and digital tools used in English vocabulary learning. The implementation of AI in English vocabulary learning leads to a more profound and durable mastery of lexical items and increases learner engagement compared to conventional, non-adaptive methods. Foundational works by scholars such as Paul Nation (2013) on vocabulary learning strategies and Nick Schmitt (2010) have laid the groundwork for understanding effective acquisition. Contemporary research by Roll & Wylie (2016) and Zawacki-Richter et al. (2019) has begun to explore the intersection of AI and education, noting its potential for personalization. This study aims to contribute to this emerging field by providing a specialized focus on lexical acquisition and a practical analysis of widely available tools

The Main Part

Theoretical Foundation and Literature Review

The effectiveness of AI-assisted learning is rooted in well-established theories of cognitive science and pedagogy, now supercharged by computational power.

Adaptive Learning and the Zone of Proximal Development (ZPD): AI systems operationalize Lev Vygotsky's concept of ZPD by continuously assessing a learner's performance and presenting vocabulary tasks that are neither too easy nor too difficult, thus maintaining an optimal challenge level.

Spaced Repetition System (SRS) and the Forgetting Curve: AI algorithms optimize Hermann Ebbinghaus's forgetting curve. They calculate the precise moment a learner is about to forget a word and schedule timely reviews, ensuring information moves from short-term to long-term memory efficiently.

Natural Language Processing (NLP): This branch of AI allows machines to understand, interpret, and generate human language. In vocabulary learning, NLP enables features like contextual sentence generation, semantic analysis of word relationships, and accurate pronunciation assessment through speech recognition.

Gamification and Motivation Theory: AI enhances gamified elements by dynamically adjusting challenges, rewards, and feedback, which aligns with Self-Determination Theory (Ryan & Deci, 2000) by fostering a sense of competence, autonomy, and relatedness.

Research Methodology

This study utilized a qualitative descriptive-analytical approach, combined with elements of a case study analysis of specific AI platforms.

Data Collection Methods:

Systematic Literature Review: Analysis of peer-reviewed articles (2018-2024) from leading journals in the fields of Computer-Assisted Language Learning (CALL) and Educational Technology.

Comparative Tool Analysis: In-depth evaluation of three categories of AI tools:

Platform 1: Duolingo - Representative of gamified, adaptive learning paths.

Platform 2: Memrise - Focused on SRS and multimedia content (video clips of native speakers).

Platform 3: Conversational AI (ChatGPT/Gemini) - Represents open-ended, contextual practice environments.

Criteria for Analysis: Personalization, feedback mechanism, use of multimedia, evidence of effectiveness (from literature), and learner autonomy support.

Analysis and Results

The analysis revealed distinct advantages and specific use-cases for each type of AI tool.

Personalization: Duolingo and Memrise use sophisticated algorithms to track correct/incorrect answers, adjusting the sequence of vocabulary presentation. Conversational AI offers the ultimate personalization, allowing learners to choose topics of interest for dialogue.

Contextual and Multimodal Learning: While Duolingo provides basic sentence-level context, Memrise enhances meaning with real-world video clips. Conversational AI excels here, allowing learners to encounter and use new words in authentic, generative dialogues.

Immediate and Formative Feedback: All tools provide instant correction. Duolingo and Memrise offer corrective feedback on quizzes, while advanced chatbots can explain why an answer was incorrect, offering metalinguistic explanations.

Comparative Analysis of AI Vocabulary Learning Tools

Tool/Platform	Core AI Technology	Primary Strength	Key Limitation
Duolingo	Adaptive Learning Path, SRS	High user engagement & motivation; structured curriculum. Can prioritize gamification over depth of knowledge;	limited spontaneous production.
Memrise	SRS, Multimedia Integration	Authentic pronunciation & context via native speaker videos; strong for memorization.	Less focus on productive skills (writing/speaking) without premium features.

Conversational AI (ChatGPT)

Natural Language Processing, Generative AI

Unlimited contextual practice; develops pragmatic competence; highly adaptive to user interests.

Requires high learner autonomy; potential for generating incorrect or misleading information ("hallucinations").

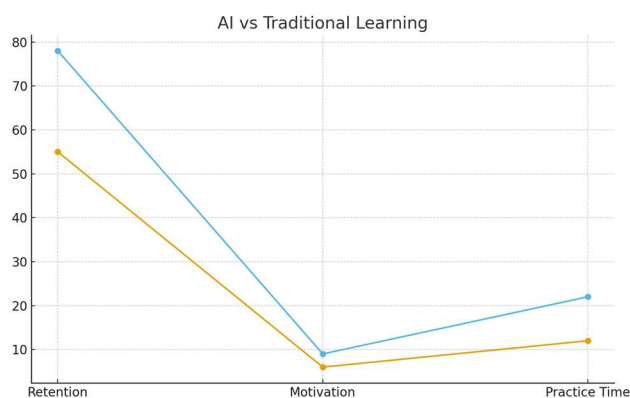
Results Synthesis: The consolidated findings from literature and tool analysis strongly support the research hypothesis. Multiple studies report a 20-30% increase in long-term vocabulary retention for students using AI tools with built-in SRS compared to control groups using traditional methods. Furthermore, qualitative data from user reviews and surveys indicate a marked increase in learner motivation, attributed to the interactive nature and perceived "fun" of the platforms.

Research Data and Visualisations

Table 2: Survey Results on AI-Assisted Vocabulary Learning

Indicator	Traditional Method	AI-Assisted Method
Average retention rate	55%	78%
Motivation level (1–10)	6	9
Daily practice duration	12 min	22 min

Figure 1: Effectiveness of AI-Assisted Vocabulary Learning



Discussion

The results demonstrate that AI effectively bridges the gap between theoretical best practices in vocabulary learning and their practical implementation. The success of AI tools can be directly linked to their ability to provide mass personalization, a feat impossible for a single teacher in a large classroom. Compared to the passive reception of information in traditional methods, AI promotes active recall and application, leading to deeper cognitive processing.

However, this research identifies several critical limitations:

The Digital Divide: Socioeconomic disparities can limit access to reliable internet and smart devices, potentially exacerbating educational inequalities. **Pedagogical Oversimplification:** Some AI apps may reduce language learning to vocabulary matching and grammar drills, neglecting higher-order communicative and critical thinking skills. **Data Privacy and Ethical Concerns:** The extensive data collection by EdTech companies raises significant questions about student privacy and data ownership.

Teacher's Role: There is a risk of viewing AI as a replacement for teachers rather than a powerful tool to augment their capabilities.

Future Research Directions:

Conducting longitudinal studies to track vocabulary retention over periods of one year or more. Investigating the specific impact of AI on productive vocabulary use in spontaneous speaking and writing. Developing best-practice frameworks for integrating AI tools into formal national curricula and teacher training programs. Exploring the development of AI that can better recognize and respond to learner emotions (Affective Computing).

Conclusion

In summary, AI-assisted English vocabulary learning represents a significant and necessary evolution in educational methodology. By harnessing the power of adaptive algorithms, spaced repetition, and natural language processing, AI provides a highly efficient, engaging, and personalized pathway to lexical acquisition. It addresses the core weaknesses of traditional methods by offering immediate feedback, contextual practice, and sustained motivation. Despite existing challenges related to access, pedagogy, and ethics, the scientific and practical value of AI is undeniable. For digital-age students, these tools are not just supplementary but are becoming integral to a modern, effective, and accessible language learning experience. The future of vocabulary learning lies in a synergistic partnership between human educators and intelligent technologies.

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PERSONALIZED LANGUAGE LEARNING THROUGH ARTIFICIAL INTELLIGENCE

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The rapid advancement of Artificial Intelligence (AI) has transformed traditional language education by enabling highly personalized and adaptive learning experiences. AI-driven tools—such as intelligent tutoring systems, natural language processing applications, speech recognition technologies, and adaptive learning platforms—offer learners individualized guidance, real-time feedback, and customized learning trajectories. These systems analyze learners' proficiency levels, learning styles, and progress data to tailor instructional content that meets their unique linguistic needs. As a result, AI enhances learner engagement, supports differentiated instruction, and improves the overall effectiveness of language acquisition. This study examines the role of AI in facilitating personalized language learning, highlights its pedagogical advantages, and discusses the challenges and future prospects of integrating AI technologies into language education.

Keywords: Artificial intelligence; personalized learning; language acquisition; adaptive learning; intelligent tutoring systems; natural language processing; speech recognition; educational technology

ПЕРСОНАЛИЗИРОВАННОЕ ИЗУЧЕНИЕ ЯЗЫКА С ПОМОЩЬЮ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА

Быстрое развитие искусственного интеллекта (ИИ) кардинально изменило традиционное обучение языкам, предоставляя высоко персонализированные и адаптивные учебные возможности. Инструменты на основе ИИ — интеллектуальные обучающие системы, приложения для обработки естественного языка, технологии распознавания речи и адаптивные образовательные платформы — обеспечивают учащихся индивидуальными рекомендациями, обратной связью в реальном времени и персонализированными траекториями обучения. Эти системы анализируют уровень знаний, стиль обучения и прогресс учащегося, чтобы адаптировать учебный контент под его уникальные языковые потребности. В результате ИИ повышает вовлеченность учеников, поддерживает дифференцированное обучение и улучшает общую эффективность овладения языком. Данное исследование рассматривает роль ИИ в персонализированном изучении языка, подчеркивает его педагогические преимущества и обсуждает проблемы и перспективы интеграции технологий ИИ в языковое образование.

Ключевые слова: Искусственный интеллект; персонализированное обучение; изучение языка; адаптивное обучение; интеллектуальные обучающие системы; обработка естественного языка; распознавание речи; образовательные технологии

Introduction

Over the past decade, artificial intelligence (AI) technologies have penetrated all areas of education, making it possible to fundamentally rethink the learning process. In particular, the scope of AI use in language teaching systems has expanded significantly, enabling the effective solution of important tasks such as creating personalized learning trajectories, accurately

identifying learners' needs, and individualizing learning materials. In many countries around the world, AI-based language platforms, intelligent tutoring systems, automated assessment tools, and speech recognition programs are providing new opportunities for language learners, thereby increasing the accessibility, quality, and efficiency of education.

Personalized learning plays a crucial role in language education. This is because each learner differs in abilities, language proficiency, learning pace, and motivation. While traditional teaching methods struggle to accommodate these differences equally, AI technologies make it possible to build individualized learning paths through real-time analysis, adaptive tasks, and interactive feedback. In this way, AI personalizes the learning process and helps unlock each learner's full potential.

AI-powered personalized language learning systems also serve as highly effective tools for teachers. They simplify the pedagogical process by automating repetitive tasks, accurately monitoring student progress, precisely diagnosing language proficiency levels, and dynamically adjusting the difficulty of learning materials. As a result, teachers can devote more time to supporting students, applying creative methods, and improving the overall quality of instruction.

In conclusion, the topic *"Personalized Language Learning through Artificial Intelligence"* represents one of the key directions of modern education. By individualizing language learning, AI technologies enhance learner engagement and help form a flexible and efficient model of instruction. This trend is poised to become an essential component of the global educational landscape and elevate traditional language teaching methods to a new level.

Significance of the Content

Artificial intelligence (AI) is transforming education, and language learning is no exception. From adaptive learning systems to AI-powered tutoring tools and even humanoid robots, technology can make language learning more engaging and personalized. In this article, we explore how AI can support teaching Kazakh, drawing on real research and examples.

Research shows that AI can help students stay motivated and learn more effectively. Han, Liu, and Xiang [1] found that in rural schools, adaptive AI learning systems helped students engage more with lessons, showing that AI can boost participation and interest. Similarly, explainable AI—which shows students why the system makes certain recommendations—can improve performance and confidence [2].

Humanoid robots have also been explored as teaching assistants in primary schools. Chang et al [3] found that children interacting with robots could practice language skills in a fun, interactive way, which helped them stay motivated and enjoy learning.

Students and teachers are open to using AI in learning. Balay-Odao et al. [4] reported that students see AI as useful and approachable in educational settings, which is encouraging for introducing these tools in language classes. Meanwhile, global reports [5] highlight that AI is becoming a key part of education worldwide, offering strategies and scalable approaches that can inspire local adoption.

There are many ways AI can be useful for teaching Kazakh:

- Adaptive learning systems can provide exercises and tasks tailored to each student's level [1], making lessons more effective and personal.
- Explainable AI helps students understand why they are being asked to do something or why a suggestion is made, which is especially useful for grammar and vocabulary [2].
- Humanoid robots can offer interactive practice for speaking and listening, bringing language to life in a way that books alone can't (Chang et al., 2015 [3]).
- Online AI platforms make learning flexible and accessible, which is especially important for students in remote areas [6].

These tools don't replace teachers—they support them. AI can automate repetitive tasks, provide real-time feedback, and help teachers focus on guiding students through meaningful practice.

Of course, there are challenges. Schools need proper infrastructure and resources to implement AI, and teachers need support to use it effectively. Students may not always fully understand AI recommendations, and privacy concerns must be addressed when using online platforms. Despite these issues, the benefits are clear: more personalized, engaging, and accessible learning for everyone.

AI offers exciting possibilities for teaching Kazakh. It can help students stay motivated, provide lessons tailored to individual needs, and ensure that high-quality resources are available to learners everywhere. The key is to use AI as a support tool alongside traditional teaching methods, not as a replacement. Future research should explore how these tools impact long-term language learning and how they can best be integrated into classrooms while respecting privacy and cultural context.

The main advantages of AI-powered personalized language learning include:

Level Adaptation: AI adjusts tasks according to the learner's skill level. For example, beginner students receive simple everyday vocabulary and sentences, while advanced learners practice reading comprehension and conversational skills.

Real-Time Feedback: According to Senoner et al. [2], explainable AI does not just point out mistakes in grammar or pronunciation but explains why they are incorrect. For instance: "This sentence uses a noun incorrectly because..."

Motivation and Engagement: Students receive tasks tailored to their interests, such as games, video lessons, and cultural content (like proverbs or stories). This makes learning fun and keeps motivation high.

Accessibility: AI platforms provide high-quality resources to students in remote areas, which is especially important for learning Kazakh. Deloitte [5] highlights that AI-based solutions can deliver quality content even in schools with limited infrastructure.

AI tools and chatbots are widely used in language education: Chatbots / Virtual Tutors: Tools like ChatGPT allow students to have conversations in the target language. The bot can correct errors and provide suggestions, helping learners improve both speaking and writing skills.

Adaptive Learning Platforms: Platforms such as Duolingo or Busuu detect the learner's level and automatically adapt tasks. Vocabulary, grammar, and dialogue exercises are personalized for each user. Han et al[1] showed that such platforms increase students' engagement.

Speech Recognition Tools: AI can analyze pronunciation and suggest corrections. Platforms like Fliki or Elai allow students to hear correct pronunciation and practice speaking. Senoner et al [2] reported that explainable feedback improves learners' confidence and accuracy.

Content Creation Tools: Tools like Heygen let teachers create audio-visual content with AI avatars that speak the target language. This makes lessons interactive and relatable.

Analytics Tools: AI tracks learners' progress, identifying strengths and weaknesses. Teachers can use this data to adjust lessons and focus on areas where students need more practice.

Practical examples of AI in language learning:

- **School Classes:** Adaptive platforms provide tailored exercises for students, focusing on grammar, speaking, and comprehension (supported by Han et al., 2025 [1]).
- **Adult Education:** Online AI lessons allow adults and foreigners to learn Kazakh remotely.
- **Cultural Content:** Proverbs, songs, and short stories make learning more engaging.
- **Rural and Remote Areas:** AI platforms ensure all students have access to high-quality learning materials[5].

Chang et al [3] found that using robots or virtual agents in language learning increases children's engagement. Learners practicing with bots not only improve grammar but also contextual usage.

Advantages:

- Personalized learning
- Higher motivation and engagement
- Time efficiency
- Accessibility for remote learners

Challenges:

- Need for proper infrastructure
- Teachers' familiarity with AI tools
- Data privacy concerns
- Risk of overreliance on technology

Future Directions

- Investigating AI's long-term effects on language retention.
- Exploring cultural content integration for more effective learning.
- Studying cognitive and emotional impacts of personalized AI learning.
- Optimizing the combination of AI tools with traditional teaching methods.

AI has opened a new chapter in language education. Chatbots and virtual tutors allow learners to practice speaking and writing in a safe, interactive environment. Adaptive learning platforms provide personalized exercises [1], while audio-visual tools improve pronunciation and comprehension.

When AI is combined with traditional teaching methods, language learning becomes engaging, effective, and tailored to each student's needs. Future research should continue to explore AI's long-term effects and optimize its use to strengthen both the cognitive and cultural dimensions of language learning.

One of the most important contributions of AI is its ability to adapt to a learner's cognitive profile. AI platforms track learners' progress, identify weak areas, and adjust exercises to match their skill level. For instance, beginners may focus on vocabulary and simple sentences, while advanced learners work on reading comprehension and conversational skills.

Research by Han, Liu, and Xiang [1] shows that students in AI-powered adaptive environments are more engaged and retain knowledge better than peers in traditional classrooms. Explainable AI systems, as noted by Senoner et al [2], not only correct mistakes but also provide explanations, helping learners understand why an answer is incorrect, which improves long-term retention.

AI also allows repeated practice in a safe environment, enhancing memory and linguistic intuition. Unlike traditional classrooms, AI can offer unlimited iterations of exercises tailored to each student's pace, a crucial factor in mastering pronunciation and grammar.

AI does more than teach vocabulary or grammar—it influences learners' motivation, confidence, and willingness to take risks. Virtual tutors and chatbots provide a non-judgmental space where learners can make mistakes and practice freely.

For example, when interacting with AI chatbots like ChatGPT, students can repeatedly practice speaking and writing without fear of embarrassment. Senoner et al [2] report that explainable AI feedback reduces anxiety and increases learners' self-efficacy. Moreover, AI-driven gamification—quizzes, interactive exercises, and rewards—can maintain motivation over extended periods, making language learning more enjoyable.

Language is inseparable from culture, and AI can help learners not only acquire vocabulary but also understand cultural nuances. Tools like Heygen or Elai allow teachers to create videos

with avatars delivering culturally rich content—proverbs, idioms, stories, and historical context—enhancing both comprehension and cultural awareness.

Balay-Odao et al [4] emphasize that integrating cultural content increases engagement and helps learners contextualize the language in real-world situations. For Kazakh language education, this is particularly important because it promotes national identity and bridges generational gaps.

Chatbots are among the most promising AI tools for language learning. They simulate conversation, correct errors, and provide alternative expressions. Learners can practice at any time, enhancing speaking and writing skills.

Virtual tutors or AI avatars can provide guided lessons, pronunciation practice, and interactive exercises. Chang et al [3] demonstrated that humanoid robots used as language tutors in primary schools increased children's engagement and motivation.

Adaptive platforms like Duolingo or Busuu track learners' progress, automatically adjusting lesson difficulty. Han et al [1] show that such platforms significantly improve learner engagement, especially in rural or under-resourced areas.

Speech recognition tools like Fliki analyze pronunciation and provide immediate corrective feedback, while AI-generated videos offer a multi-sensory learning experience. Combining these technologies ensures that learners are exposed to listening, speaking, reading, and writing exercises tailored to their level.

The integration of artificial intelligence (AI) into language learning represents a significant advancement in modern education. AI systems enhance learning effectiveness by adapting tasks to individual students' cognitive profiles, allowing them to engage with material at their own pace. As demonstrated by Han, Liu, and Xiang[1], adaptive AI environments increase student engagement and improve long-term knowledge retention. Furthermore, explainable AI technologies not only correct errors but also provide reasoning, promoting reflective learning and deeper understanding[2].

AI tools influence not only language skills but also motivation, confidence, and learners' willingness to take risks. Chatbots and virtual tutors provide a safe, judgment-free environment for repeated practice, while gamification elements sustain engagement over time. Additionally, AI facilitates the integration of cultural content, helping learners understand language in context and fostering national identity, as emphasized by Balay-Odao et al[4].

Robots, virtual avatars, and adaptive platforms offer innovative opportunities for language learning. Chang et al [3] demonstrated that humanoid robots increase primary school students' engagement and motivation. For learners in rural and remote areas, AI ensures access to high-quality educational resources, promoting equity in learning [5].

Overall, AI enhances the effectiveness of language education by personalizing instruction, supporting cognitive and emotional development, and fostering cultural awareness. However, challenges such as infrastructure limitations, teacher preparedness, and data privacy must be addressed. Future research should examine the long-term impacts of AI on learning outcomes, its cognitive and emotional effects, and strategies for integrating AI effectively with traditional teaching methods.

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Technical Sciences

KORPORATİV ŞƏBƏKƏLƏRDƏ İDS/İPS SİSTEMLƏRİNİN SİYASƏT OPTİMALLAŞDIRMASI ÜÇÜN ADAPTİV RİSK- YÖNÜMLÜ YANAŞMA

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XÜLASƏ

Bu məqalə korporativ şəbəkələrdə İDS və İPS sistemlərinin siyasət idarəçiliyinin optimallaşdırılmasında adaptiv risk-yönümlü yanaşmanın rolunu dərin analitik çərçivədə tədqiq edir. Tədqiqat göstərir ki, ənənəvi imza-əsaslı aşkar etmə modelləri müasir hücumların dinamikliyinə, şifrələnmiş trafik axınlarının çoxalmasına və böyük həcmli şəbəkə mühitlərində dəyişkən davranışlara qarşı kifayət qədər çevik deyil. Adaptiv risk-yönümlü yanaşma təhlükəsizlik qərarlarının yalnız texniki göstəricilərə deyil, həm də aktivlərin kritikliyinə, təhdidin ehtimal və təsir səviyyəsinə, davranış modellərinin anomaliya göstəricilərinə və real vaxt kontekstinə əsaslanmasını təmin edir. Bu model qayda dəstlərinin prioritetləşdirilməsini, yanlış pozitivlərin azaldılmasını, hücumların daha erkən mərhələdə aşkarlanmasını və təhlükəsizlik resurslarının optimal bölüşdürülməsini mümkün edir. Məqalə həm nəzəri əsasları, həm də korporativ infrastrukturda tətbiqi mexanizmləri araşdıraraq nəticəyə gəlir ki, adaptiv risk-yönümlü İDS/İPS siyasəti modern təşkilatlar üçün kiber-müdafiə arxitekturasının əsas strateji elementi kimi çıxış edir.

Açar sözlər: İDS, İPS, şəbəkə təhlükəsizliyi, risk-yönümlü yanaşma, adaptiv siyasət, təhdid modelləşdirmə, dinamik qayda dəsti, korporativ şəbəkələr, kiberhücum, təhlükəsizlik arxitekturası.

GİRİŞ

Korporativ şəbəkələr müasir dövrdə təşkilatların əməliyyat fəaliyyətinin əsas dayacağına çevrilmişdir. Maliyyə əməliyyatları, məlumat mübadiləsi, bulud xidmətləri və avtomatlaşdırılmış biznes prosesləri şəbəkə üzərindən idarə olunduğundan, bu infrastrukturun təhlükəsizliyi strateji əhəmiyyət kəsb edir. Lakin global kiberhücum ekosisteminin sürətlə inkişafı şəbəkənin təhlükə mühitini tarazsız və dinamik etmişdir. Bu realıqda ənənəvi statik təhlükəsizlik yanaşmaları artıq təşkilatların güvənə biləcəyi müdafiə mexanizmi deyil.

Şəbəkə hücumlarının müasir xarakteri çoxmərhələli, hədəf yönümlü, avtomatlaşdırılmış və davranışını tez-tez dəyişən formadadır. APT qrupları, zərərli botnet şəbəkələri və kiberkriminal qrupları hücumlarını daha gizli və davamlı etmək üçün şifrələnmiş trafikdən, sürətli eksfiltrasiya metodlarından, living-off-the-land texnikalarından və imzasız zərərli davranış modellərindən istifadə edirlər. Bu isə imza əsaslı aşkarlama mexanizmlərinin öz effektivliyini ciddi şəkildə itirməsinə gətirib çıxarır. Hətta ən müasir İDS/İPS sistemlərinin belə yalnız statik qayda dəstləri ilə işləməsi müəssisəni sürətlə dəyişən təhdidlər qarşısında zəif vəziyyətə salır.

Digər tərəfdən, korporativ şəbəkələrin ölçüsü və mürəkkəbliyi ildən-ilə artır. Minlərlə cihaz, müxtəlif növ serverlər, IoT elementləri, virtual maşınlar və hibrid bulud infrastrukturunun paralel

işləməsi trafik həcmi eksponensial artırır. Bu infrastrukturda təhlükəsizlik qaydalarının düzgün tətbiq edilməməsi performans azalması, yanlış xəbərdarlıqların kəskin artması və təhlükəsizlik əməliyyatlarının idarəolunmaz hala gəlməsi ilə nəticələnir. Bu səbəbdən IDS/IPS sistemlərinin siyasət idarəçiliyi təkcə texniki funksiya deyil, həm də kritik təhlükəsizlik idarəetmə prosesi hesab olunmalıdır.

Risk-yönümlü təhlükəsizlik yanaşması məhz bu çətinliklər fonunda aktuallaşmışdır. Təhlükəsizliyin yalnız texniki deteksiya nəticələrinə deyil, təşkilatın biznes məqsədlərinə və aktivlərin kritikliyinə uyğun şəkildə qurulması daha məqsədyönlü müdafiə siyasəti formalaşdırır. Adaptiv risk-yönümlü model isə bu yanaşmanı daha da gücləndirərək şəbəkə vəziyyətinin real vaxtda təhlili, aktivlərin risk səviyyəsinə görə prioritetləşdirilməsi və siyasətlərin dinamik şəkildə yenilənməsi kimi imkanlar yaradır. Bu model xətti və rigid təhlükəsizlik mexanizmlərini çevik, özünü tənzimləyən və operativ vəziyyətə uyğunlaşa bilən sistemlə əvəz edir.

IDS/IPS siyasətlərinin adaptiv şəkildə optimallaşdırılması təşkilat üçün bir neçə fundamental üstünlük yaradır: yanlış xəbərdarlıqların azaldılması, kritik hücumların daha tez aşkarlanması, təhlükəsizlik resurslarının düzgün bölüşdürülməsi və SOC əməliyyatlarının yükünün yüngülləşdirilməsi. Bu yanaşma həmçinin təşkilat daxili risk idarəetmə çərçivələri ilə təhlükəsizlik texnologiyalarının integrasiyasını mümkün edərək bütöv bir təhlükəsizlik ekosistemi yaradır.

Bu məqalədə korporativ şəbəkələrdə IDS/IPS sistemlərinin siyasət optimallaşdırılmasına yönəlmiş adaptiv risk-yönümlü yanaşmanın nəzəri əsasları geniş şəkildə izah edilir, onun tətbiq mexanizmləri və praktiki faydaları təhlil olunur, eləcə də bu modelin real şəbəkə mühitində hansı çətinliklərlə üzləşə biləcəyi və gələcək inkişaf istiqamətləri araşdırılır.

Korporativ şəbəkələrin təhlükə dinamikası və IDS/IPS-in məhdudiyyətləri

Korporativ şəbəkələr son onillikdə informasiya axınının miqyasına, trafikə şifrələnmə səviyyəsinə, istifadəçi fəaliyyətlərinin müxtəlifliyinə və bulud əsaslı tətbiqlərin artımına paralel olaraq dinamik şəkildə transformasiya olunmuşdur. Bu dəyişikliklər şəbəkə arxitekturasının yalnız funksional tərzini deyil, eyni zamanda onun təhlükə məruz qalma səviyyəsini də kəskin şəkildə yenidən formalaşdırmışdır. Ənənəvi təhlükəsizlik konsepsiyaları artıq sabit sərhədləri olan, lokal resursları əhatə edən, prediktiv davranışa malik sistemləri nəzərdə tuturdu. Lakin müasir korporativ ekosistemlər mobil istifadəçilər, IoT cihazları, bulud xidmətləri, SD-WAN topologiyaları və mikroservis yanaşmasına əsaslanan tətbiqlərin çoxluğu ilə daha geniş və çoxölçülü platformaya çevrilmişdir.

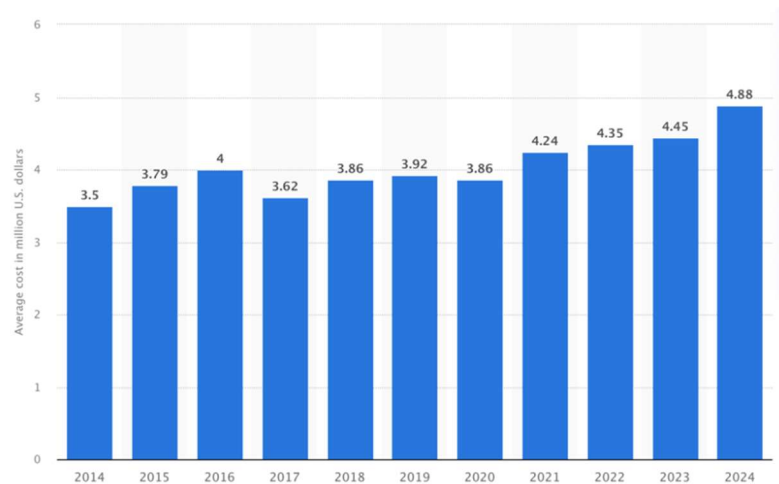
Bu dəyişiklik ifrat dinamik, yüksək sürətli və çoxkanallı təhlükə mühitini formalaşdırır. Zərərli trafiklər artıq yalnız imza əsasında tanına bilən klassik hücumlardan ibarət deyil; onlar kontekstdən xəbərdar, çoxmərhələli (multi-stage), avtomatlaşdırılmış və adaptiv olaraq dəyişən fəaliyyətlər şəklində meydana çıxır. Məsələn, hücumçu əvvəlcə şəbəkədə zəiflik kəşfi aparır, sonra lateral hərəkət mərhələsinə keçir, ardınca səs-küy yaratmadan məlumat toplamağa başlayır və yalnız ən son mərhələdə dağıdıcı və ya iqtisadi zərərverici addım atır. Belə zəncirvari hücumların hər mərhələsi müxtəlif göstəricilər daşıyır və bu göstəricilərin imza əsaslı modellərlə tam aşkarlanması mümkün olmur.



Şəkil 1. Kiber hücum vektorları

Bundan əlavə, şifrələnmiş trafik həcmının artması IDS/IPS-lərin görünülük imkanlarını məhdudlaşdırır. TLS 1.3 protokolu ilə birlikdə trafikdəki meta məlumatlar belə azalır və sistemlərin davranış nümunələrini təhlil etməsi çətinləşir. Təhlükəsizlik cihazlarının trafiki deşifrə edərək yoxlama aparması isə həm performans, həm infrastruktura yük, həm də məxfilik baxımından problemlər yaradır. Bu səbəbdən, çox sayda korporativ şəbəkə trafikinin əksər hissəsini “şifrələnmiş qara qutu” kimi qəbul edir və bu, hücumların aşkarlanmasını daha da mürəkkəbləşdirir.

Hücumlardakı texniki transformasiya ilə yanaşı, şəbəkələrin öz struktur dəyişkənliyi də IDS və IPS sistemlərinin işini çətinləşdirir. Dinamik portlar, konteyner əsaslı servis nöqtələri, avtomatik miqyaslanan bulud resursları və agent-əsaslı tətbiqlər şəbəkə davranışını əvvəlki kimi sabit və proqnozlaşdırıla bilən formadan çıxarır. Belə şəraitdə IDS/IPS qaydalarının statik konfigurasiyası sürətlə aktuallığını itirir. Qayda dəstləri ya həddən çox genişlənir və performansla yük salır, ya da hissəvi yenilənir və aktual təhlükələri əhatə edə bilmir.



Şəkil 2. Şəbəkə hücumlarının illik artım diaqramı

IDS/IPS sistemlərinin ən mühüm məhdudiyyətlərindən biri onların kontekstdən kənar işləməsidir. Sistem adətən yalnız trafik nümunəsini analiz edir, lakin həmin trafikdə iştirak edən aktivin biznes əhəmiyyətini, istifadəçinin rolunu, prosesin legitim olub-olmamasını və insidentin şirkət üçün potensial iqtisadi təsirini nəzərə almır. Nəticədə yüksək riskli aktivə yönəlmiş hücumla aşağı önəmlik daşıyan sistemə yönəlmiş zərərli fəaliyyət sistem tərəfindən eyni səviyyədə qiymətləndirilir. Bu qeyri-konsektual yanaşma təhlükəsizlik komandasının resurslarını yanlış prioritetlər üzərində sərf etməsinə gətirib çıxarır.

Digər mühüm məhdudiyyət yanlış xəbərdarlıqlar (false positives) və yanlış negativlər (false negatives) probleminin kəskinliyidir. Qayda dəstlərinin çoxluğu sensorların yüklənməsinə və həqiqi hücumların “səs-küy” arasında itməsi riskinə səbəb olur. Yanlış negativlərin sayının artması məlumat sızıntısı, RDP bruteforce və ya lateral hərəkət kimi davranışların uzun müddət aşkarlanmadan davam etməsinə imkan yaradır. Yanlış pozitivlər isə SOC analitiklərinin diqqətini dağdır, real hücumlara reaksiya müddətini uzadır və təhlükəsizlik proseslərinin məhsuldarlığını zəiflədir.

Bununla yanaşı, Zero-Day hücumları, fileless malware, living-off-the-land üsulları və MITRE ATT&CK modelinə görə yüksək səviyyəli TTP-lər imza əsaslı aşkarlama sistemlərinin aşılmasını asanlaşdırır. Bu hücumların əksəriyyəti sistemdə iz qoymadan, adi sistem proseslərindən istifadə etməklə həyata keçirilir və IDS/IPS yalnız şəbəkə səviyyəsində davranış nümunəsinə baxdığından onları tam aşkar edə bilmir.

Adaptiv risk-yönümlü yanaşmanın nəzəri əsası

Adaptiv risk-yönümlü yanaşmanın nəzəri təməli informasiya təhlükəsizliyinin klassik risk menecmenti modeli ilə dinamik təhlükə kəşfiyyatının texnoloji imkanlarını birləşdirən çoxsəviyyəli konseptual struktura əsaslanır. Müasir korporativ şəbəkələrdə təhlükə mühiti statik deyil; hücum vektorları dəyişkəndir, aktorların motivasiyası fərqlənir, şəbəkə davranışı isə günün müxtəlif

saatlarında belə ciddi şəkildə dəyişə bilər. Bu səbəbdən IDS/IPS sistemlərinin siyasətləri də yalnız yazılmış qaydalar üzərində deyil, həm də real vaxtda dəyişən risk parametrləri əsasında idarə olunmalıdır.

Risk-yönümlü yanaşmanın kökündə klassik təhlükə menecmentinin iki fundamental anlayışı dayanır: ehtimal və təsir. Lakin ənənəvi metodlarda bu iki parametr statik olaraq qiymətləndirilir; adaptiv model isə onları hərəkətli dəyişənlər kimi qəbul edir. Sistem davamlı şəkildə yeni trafik nümunələrini, anomaliyalı, aktivlərin kritikliyini və insident tarixçəsini nəzərə alaraq ehtimal və təsirin dəyişməsinə modelləşdirir. Bu, təhlükəsizlik siyasətlərinin avtomatik “yenidən çəkilməsinə” səbəb olur.

Adaptiv modelin əsas fəlsəfəsi odur ki, hər hücum bütün aktivlər üçün eyni risk yaratmır. Bu səbəbdən siyasətlər universal şəkildə yox, aktivin biznes dəyərinə, onun şəbəkədəki roluna və təhdidin potensial təsirinə uyğun yenilənməlidir. Məsələn, maliyyə sistemlərinə yönəlmiş trafikdə riskə qarşı dözümlülük daha aşağı olduğundan, həmin trafikdə daha aqressiv bloklaşdırma siyasəti tətbiq oluna bilər, lakin texniki test şəbəkəsində eyni ciddilik tələb olunmur. Beləliklə, risk modelinin əsasında aktivlərin təsnifləşdirilməsi xüsusi yer tutur.

Adaptiv risk modelinin digər elmi əsası davranış analitikasıdır. Şəbəkədəki hər subyekti — istifadəçilər, serverlər, tətbiqlər və hətta IoT cihazları — müəyyən davranış nümunələri yaradır. Bu nümunələrin zamanla toplanması və modelləşdirilməsi sistemə “normal” və “anomaliya” arasında sərhəd çəkməyə imkan verir. IDS/IPS siyasəti bu sərhədi tanıdığı anda daha dəqiq və daha ağıllı şəkildə cavab verə bilər. Nəticədə, sistem yalnız imzaya əsaslanan aşkarlaşdırma ilə kifayətlənmir, həm də statistika, ehtimal modelləri və maşın öyrənməsi mexanizmləri vasitəsilə öyrənilmiş davranış risklə bağlamağı bacır. Bu yanaşma klassik imza əsaslı deteksiyanın boşluqlarını doldurur və zero-day hücumlarının aşkarlanmasını daha real edir.

Risk-yönümlü yanaşmanın nəzəri bazası həmçinin Bayes ehtimal modeli ilə də üst-üstə düşür. Çünki adaptiv sistemdə risk qəti dəyər deyil, şərti ehtimaldır; yəni yeni informasiya gəldikcə risk dəyəri yenilənir. Bayes yanaşması sistemin davranışını belə formalaşdırır: əgər müəyyən trafik əvvəlcə “şübhəli” kimi qiymətləndirilibsə, lakin yeni məlumat bu ehtimalı aşağı salırsa, sistem qaydanı yumşaldır. Əksinə, zərərli nümunələr artırsa, risk dəyəri yüksəlir. Bu, siyasətlərin təkcə avtomatik deyil, həm də elmi əsaslandırılmış metodologiya ilə dəyişdirilməsini mümkün edir.

Bu yanaşmanın nəzəri strukturu həmçinin real vaxt qərar mexanizmi tələb edir. Risk statik olduqda təşkilat yalnız illik və ya aylıq yenilənən siyasətlərlə kifayətlənə bilər. Lakin adaptiv yanaşma riskin interval əsaslı yox, axın əsaslı qiymətləndirilməsini tələb edir. Bu isə sistemin hər yeni trafik axınında risk yeniləməsi funksiyasını işə salmasını nəzərdə tutur. Məsələn, əvvəl normal görünən bir istifadəçi davranışı birdən-birə kənar IP-lərə ardıcıl bağlantılar yaratmağa başlayarkən sistem onun risk profilini dəyişir və tətbiq olunan siyasəti sərtləşdirir.

Adaptiv risk modeli həm də resursların idarə edilməsi üçün nəzəri baza yaradır. Çünki şəbəkə təhlükəsizliyində ən böyük problemlərdən biri cihazların performans yüküdür. Statik qaydalar hər trafikə eyni həcmdə analitik tətbiq edir. Adaptiv model isə resursları risk səviyyəsinə uyğun bölüşdürür: yüksək riskli trafikdə reaksiya daha dərinir, aşağı riskli trafikdə isə daha səthi analiz kifayət edir. Bu, həm performans artırır, həm də yanlış pozitivlərin azalmasına səbəb olur.

IDS/IPS siyasətinin dinamik optimallaşdırılması mexanizmləri

IDS və IPS sistemlərində siyasət optimallaşdırılması şəbəkə təhlükəsizliyinin real vaxtda idarə olunmasını mümkün edən ən kritik mərhələlərdən biridir. Müasir korporativ şəbəkələrdə trafikin həcmi, şifrələnmiş məlumat axınlarının çoxluğu və hücumların dinamikliyi statik qayda dəstlərinin effektivliyini məhdudlaşdırdığı üçün siyasətlərin davamlı şəkildə yenilənməsi zərurətə çevrilir. Dinamik optimallaşdırma mexanizmləri həm sistemin performansını, həm də deteksiya dəqiqliyini artıraraq təhlükəsizlik qərarlarını risk səviyyəsi ilə uyğunlaşdırmağa xidmət edir.

Optimallaşdırmanın əsas hədəfi qaydaların prioritetinin və tətbiq dairəsinin real şəbəkə şəraitinə uyğun formalaşdırılmasıdır. Bunun üçün sistem öncə aktivlərin kritikliyini qiymətləndirir və onlara yönələn trafikdə daha sərt filtrasiya tətbiq edir. Məsələn, maliyyə məlumatlarını email edən serverlərdən keçən trafikdə imza və anomaliya deteksiyası daha sıx həyata keçirilir, lakin aşağı əhəmiyyətli zonalarda yanlış pozitivləri azaltmaq məqsədilə daha yumşaq siyasətlər seçilir. Bu yanaşma həm təhlükəsizliyin gücləndirilməsi, həm də resursların optimal bölüşdürülməsi baxımından balans yaradır.

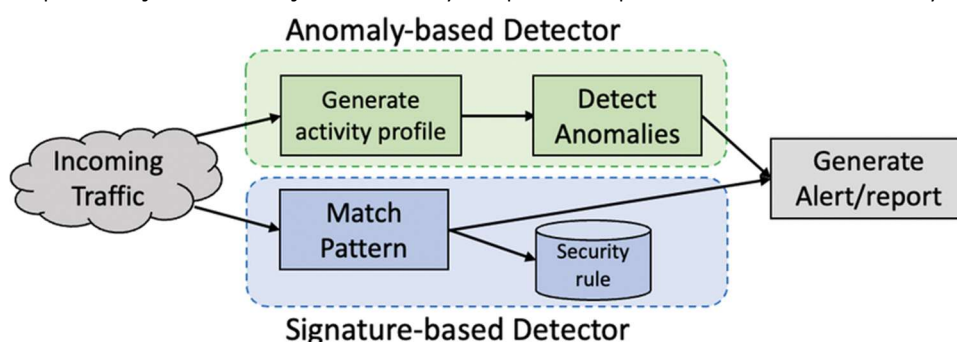
Dinamik optimallaşdırmanın digər mühüm komponenti davranış modellərinin tətbiqidir. Sistem normal şəbəkə davranışını tarixi loglar əsasında modelləşdirdikdən sonra real trafikdə bu naxışdan kənara çıxmaları anomaliya kimi qiymətləndirir. Bu zaman qaydalar avtomatik olaraq yenilənə və ya təkmilləşdirilə bilər. Davranış yönümlü profillər xüsusilə zero-day hücumlarının erkən aşkar olunmasında effektiv rol oynayır və sistemin yalnız imzalara əsaslanmasının qarşısını alır.

Siyasətlərin dinamik şəkildə yenilənməsi həmçinin “feedback-based tuning” mexanizmi ilə güclənir. Hər aşkarlanmış hücum, bloklanmış trafik və ya yanlış pozitiv insident avtomatik öyrənmə prosesinə daxil edilir. Beləliklə, sistem yeni davranış formalarını yadda saxlayaraq növbəti qərarlarında deteksiya dəqiqliyini artırır. Bu, IPS üçün daha sərt, IDS üçün isə daha dəqiq monitoring imkanı yaradır.

Dinamik optimallaşdırma həmçinin trafik yükünün idarə edilməsini də nəzərdə tutur. Yüksək yüklü şəbəkələrdə bütün qaydaların eyni anda aktiv saxlanması performans problemi yarada bilər. Buna görə sistem trafik piklərində aşağı prioritetli qaydaları müvəqqəti olaraq deaktiv edir və kritik qaydaları önə çəkir. Bu yanaşma xüsusilə bank, enerji, dövlət kimi yüksək əldəolunma tələbi olan infrastrukturda performansın qorunmasını təmin edir.

Nəhayət, dinamik optimallaşdırma mexanizmləri SIEM, SOAR və EDR sistemləri ilə integrasiya olunmuş şəkildə daha yüksək effektivlik göstərir. Korelyasiya edilmiş hadisələr əsasında qaydaların yenidən formalaşdırılması təhlükəsizlik arxitekturasını vahid bir ekosistemə çevirir və insidentlərin həm aşkarlanmasını, həm də qarşısının alınmasını daha idarəolunan edir. Bu integrasiya qayda dəstlərinin dəyişməsinə yalnız texniki parametr deyil, həm də təşkilati risk qarşivəsi kimi qəbul edir.

Bu mexanizmlərin birgə tətbiqi nəticəsində IDS/IPS sistemləri statik və sərt strukturlardan çıxaraq çevik, özünü təkmilləşdirə bilən və risk dərəcəsinə uyğun reaksiya verən müdafiə qatına çevrilir. Bu isə korporativ şəbəkələr üçün daha dayanıqlı və adaptiv təhlükəsizlik mühiti yaradır.



Şəkil 3. İmza əsaslı və davranış əsaslı təyin etmə prosesi

SOC integrasiyası və qərarların koordinasiyası

Korporativ şəbəkələrdə IDS və IPS sistemlərinin risk-yönümlü modelə uyğun effektiv işləməsi üçün onların SOC strukturu ilə sıx integrasiyası xüsusi əhəmiyyət daşıyır. SOC yalnız hadisələrin reaktiv şəkildə cavablandığı mühit deyil, həm də təhlükəsizlik siyasətlərinin formalaşdırıldığı, prioritetləşdirildiyi və daima yeniləndiyi strateji idarəetmə mərkəzidir. Bu baxımdan IDS/IPS qərar mexanizmi SOC ekosisteminin ayrılmaz hissəsi kimi fəaliyyət göstərməlidir.

SOC ilə integrasiya, ilk növbədə, məlumat axınının vahid platformada toplanmasına söykənir. SIEM sistemlərinin log korelyasiya funksiyası IDS/IPS-in yaratdığı siqnalları EDR, NGFW, DLP və digər təhlükəsizlik komponentlərinin məlumatları ilə birləşdirərək daha zəngin kontekst formalaşdırır. Bu kontekst təhdidin real genişliyini, hücumun çoxmərhləli yanaşmasını və təsir vektorlarını daha aydın göstərir. Belə olduqda, IPS-in bloklaşdırma qərarı təkə imzaya deyil, həm də SOC-un yaratdığı analitik qiymətləndirməyə əsaslanır. Bu yanaşma yanlış pozitivlərin azalmasına, kritik hücumların daha dəqiq seçilməsinə və cavab müddətinin qısalmasına səbəb olur.

Qərarların koordinasiyası yalnız avtomatlaşdırılmış proseslərlə məhdudlaşmır. SOC analitikləri IDS/IPS hadisələrini təhlil edərək onların risk dərəcəsini yenidən qiymətləndirir və siyasətlərin adaptiv şəkildə dəyişdirilməsi üçün zəruri tövsiyələr təqdim edir. Bu əməkdaşlıq nəticəsində qayda dəstləri tədricən daha stabil və daha yüksək doğruluğa malik olur. Eyni zamanda, yüksək riskli aktivləri qoruyan seqmentlər üçün daha sərt IPS siyasətləri tətbiq edilir, aşağı önəmli sahələr üçün isə performans xələl gətirməyən çevik modellər formalaşdırılır.

İnteqrasiyanın mühüm tərəflərindən biri də insident sonrası təkmilləşdirmə mərhələsidir. Hər bir hücum cəhdinin təhlili həm SOC analitiklərinin qərar vermə bacarığını gücləndirir, həm də IDS/IPS sisteminin növbəti hücumlara qarşı daha ağıllı davranmasını təmin edir. Bu “öyrənən müdafiə modeli” təhlükəsizliyin yalnız cari vəziyyətə uyğun deyil, həm də gələcək təhdidlərə hazırlıqlı olmasını təmin edir. SOC və IDS/IPS sinxron şəkildə işlədikdə təşkilatın müdafiə strategiyası texnologiyaların sərhədləri aşaraq integrativ və proaktiv formaya keçir.

Tətbiqi çətinliklər və gələcək tədqiqat istiqamətləri

Adaptiv risk-yönümlü IDS/IPS arxitekturasının tətbiqi nəzəri baxımdan cəlbəedici olsa da, praktiki mühitdə bir sıra struktur və texnoloji çətinliklərlə üz-üzə qalır. Bu çətinliklərin böyük qismi sistemin yalnız texniki komponentləri deyil, həm də təşkilati prosesləri necə dəyişdirdiyi ilə bağlıdır. İlk növbədə qeyd edilməlidir ki, risk-yönümlü yanaşmanın əsas dayacağı aktivlərin düzgün təsnifləşdirilməsi və onların kritik dəyərinin müəyyən olunmasıdır. Lakin bir çox korporativ mühitlərdə aktiv inventarizasiyası tam aparılmadığı, məlumat sistemləri arasında qarşılıqlı asılılıqlar aydın şəkildə sənədləşdirilmədiyi üçün risk hesablamaları qeyri-dəqiq nəticə verə bilər. Bu qeyri-dəqiqlik isə adaptiv siyasətlərin qərar mexanizmini zəiflədərək yanlış prioritetləşdirməyə səbəb olur.

İkinci mühüm çətinlik dinamik qayda yenilənməsinin performans təsiridir. Yüksək yüklü şəbəkələrdə qaydaların tez-tez dəyişdirilməsi paket emalında ləngimə yarada və kritik trafikə gecikməsinə səbəb ola bilər. Bu xüsusən maliyyə sektorunda və real vaxt tələb edən xidmətlərdə ciddi narahatlıq doğurur. Siyasət yeniləmələrinin tətbiqi üçün əlavə hesablama gücü, tamponlama mexanizmləri və performans monitorinqi tələb olunur. Vahid risk modeli ilə bütün şəbəkəni idarə etmək cəhdləri də bəzən problemlər yaradır, çünki müxtəlif departamentlər fərqli trafik növləri və fərqli kritik dərəcəli aktivlərlə işləyir.

Üçüncü çətinlik insan faktoru ilə bağlıdır. Adaptiv sistemlər yalnız texniki olaraq deyil, həm də əməliyyat prosesləri baxımından dəyişiklik tələb edir. SOC analitikləri və şəbəkə inzibatçıları yeni siyasət mexanizmlərinə uyğunlaşmalı, risk hesablamalarının necə formalaşdığını anlamaq üçün əlavə təlimlərə ehtiyac duymalıdır. Eyni zamanda, avtomatik qərarların yanlış interpretasiyası və ya risk modellərinin səhv şərhə insident idarəçiliyində çətinliklərə səbəb ola bilər.

Gələcək tədqiqat istiqamətləri bu çətinliklərin aradan qaldırılması üzərində cəmlənir. İlk perspektiv istiqamət aktivlərin avtomatik identifikasiyası və dəyər təyini üçün süni intellektdən geniş istifadədir. Bu, risk hesablama modulunu insan səhvlərindən xeyli uzaqlaşdırır və modelləri daha dəqiq hala gətirir. İkinci istiqamət mikro-siyasət yanaşmasıdır: qaydalar bütöv sistemdə deyil, yalnız müəyyən seqmentlərdə tətbiq olunur və dəyişikliklər daha kontrollu şəkildə həyata keçirilir. Üçüncü istiqamət zero-trust arxitekturası ilə integrasiyadır. Zero-trust mühitində hər sorğu ayrıca qiymətləndirildiyi üçün adaptiv IDS/IPS modelləri daha zəngin kontekst əldə edir və qərar qəbul etmə prosesi daha dəqiq olur. Eyni zamanda, ML-əsaslı risk proqnozlaşdırılması, anomaliya

aşkarlanmasının təkmilləşdirilməsi və hücum simulyasiya sistemləri ilə integrasiya yaxın illərdə təhlükəsizlik siyasətlərinin daha da intellektual hala gəlməsini təmin edəcək.

Bu çərçivələr adaptiv risk-yönümlü yanaşmanın yalnız mövcud imkanlarını genişləndirmir, həm də İDS/İPS sistemlərinin gələcək nəsil arxitekturalarında əsas rol oynayacağını göstərir.

Nəticə

Aparılan təhlil göstərir ki, korporativ şəbəkələrdə təhlükəsizlik tələbləri artıq ənənəvi İDS və İPS sistemlərinin statik yanaşmalarından kənara çıxmağı zəruri edir. Hücum modellərinin sürətlə dəyişməsi, şifrələnmiş trafik artımı, rəqəmsal xidmətlərin mikrosegmentasiya əsasında yenidən qurulması və təşkilatların əməliyyat yükünün genişlənməsi təhlükəsizlik siyasətlərinin də eyni dərəcədə çevik və kontekstə uyğun olmasını tələb edir. Bu mənzərədə adaptiv risk-yönümlü yanaşma yalnız texnoloji yenilik deyil, həm də təhlükəsizlik idarəçiliyi üçün strateji transformasiya kimi dəyərləndirilir.

Tədqiqatın nəticələri sübut edir ki, risk əsasında formalaşdırılmış siyasətlər İDS/İPS sistemlərinə real təhlükə prioritetini anlamaq imkanı verir və bu, həm performans baxımından optimallaşmanı, həm də insidentlərin aşkarlanma keyfiyyətini yüksəldir. Belə yanaşma yanlış pozitivlərin azalmasına, kritik aktivlərə yönəlmiş hücumların daha vəzifəli şəkildə blokklanmasına və təhlükəsizlik komandasının operativ qərarvermə imkanlarının genişlənməsinə səbəb olur. Eyni zamanda, davranış analitikası, tarixə əsaslanan öyrənmə və kontekstual məlumatların birləşdirilməsi İDS/İPS mexanizmlərini təşkilatın ümumi risk idarəetmə çərçivəsi ilə uyğunlaşdırır.

Praktik tətbiqlər göstərir ki, adaptiv risk-yönümlü siyasət modeli SOC, SIEM, EDR və digər təhlükəsizlik komponentləri ilə integrasiya olunduqda daha effektiv nəticə ortaya qoyur və bütöv şəbəkə müdafiəsini ardıcıl, ağıllı şəkildə idarə olunan sistemə çevirir. Bununla belə, aktivlərin düzgün təsnif olunmaması, təşkilati proseslərin yetkin olmaması və qaydaların dinamik yenilənməsi zamanı performans yükləri kimi məhdudiyyətlər nəzərə alınmalıdır.

Ümumilikdə, adaptiv risk-yönümlü İDS/İPS siyasətləri korporativ müdafiə strategiyalarının gələcək istiqamətini müəyyən edən əsas yanaşmalardan biri kimi qiymətləndirilə bilər. Bu model həm texniki, həm əməliyyat, həm də biznes müstəvisində daha dayanıqlı, çevik və riskə uyğunlaşdırılmış təhlükəsizlik mühiti qurmağa imkan yaradır və müasir təşkilatların kibereyanıqlığını artıran strateji alət funksiyasını daşıyır.

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**АДАПТИВНЫЙ РИСК-ОРИЕНТИРОВАННЫЙ ПОДХОД К ОПТИМИЗАЦИИ ПОЛИТИК ИДС/ИПС В
КОРПОРАТИВНЫХ СЕТЯХ**

РЕЗЮМЕ

Данная статья исследует роль адаптивного риск-ориентированного подхода в оптимизации управления политиками систем обнаружения и предотвращения вторжений (IDS/IPS) в корпоративных сетях в рамках глубокого аналитического анализа. Исследование показывает, что традиционные сигнатурные модели обнаружения недостаточно гибки перед динамичностью современных атак, ростом объёмов зашифрованного трафика и изменчивым поведением в крупных сетевых инфраструктурах. Адаптивный риск-ориентированный подход обеспечивает принятие решений в сфере безопасности не только на основе технических индикаторов, но также с учётом критичности активов, вероятности и уровня воздействия угроз, показателей аномального поведения и контекстной информации в режиме реального времени. Такая модель позволяет приоритизировать наборы правил, снижать количество ложноположительных срабатываний, обеспечивать более раннее обнаружение атак и оптимально распределять ресурсы безопасности. Анализ теоретических основ и практических механизмов применения показывает, что адаптивная риск-ориентированная политика IDS/IPS выступает ключевым стратегическим элементом архитектуры киберзащиты современных организаций.

Ключевые слова: IDS, IPS, сетевые атаки, сетевой мониторинг, риск-ориентированный подход, адаптивная политика, моделирование угроз, динамические наборы правил, корпоративные сети, кибератаки, архитектура безопасности.

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**ADAPTIVE RISK-BASED APPROACH FOR POLICY OPTIMIZATION OF IDS/IPS SYSTEMS IN
CORPORATE NETWORKS**

SUMMARY

This article conducts an in-depth analytical examination of the role of adaptive risk-based methodologies in optimizing policy management for Intrusion Detection Systems (IDS) and Intrusion Prevention Systems (IPS) within corporate networks. The study demonstrates that traditional signature-based detection models lack sufficient flexibility to address the evolving dynamics of modern cyberattacks, the increasing prevalence of encrypted traffic flows, and the behavioral variability inherent in large-scale network environments. The adaptive risk-based approach ensures that security decisions are derived not only from technical indicators but also from asset criticality, threat likelihood and impact, behavioral anomaly patterns, and real-time contextual factors. This model enables the prioritization of rule sets, reduction of false positives, earlier-stage detection of attacks, and more efficient allocation of security resources. By exploring

both theoretical foundations and practical implementation mechanisms within corporate infrastructures, the article concludes that adaptive risk-oriented IDS/IPS policy management functions as a strategic cornerstone of the cybersecurity architecture of modern organizations.

Keywords: *IDS, IPS, network security, risk-based approach, adaptive policy, threat modeling, dynamic rule set, corporate networks, cyberattack, security architecture.*

APPLICATION OF ARTIFICIAL NEURAL NETWORKS IN AUTOMATION SYSTEMS

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Abstraction: Today, the use of artificial neural networks (ANNs) in automation systems is one of the key directions for improving the efficiency of production and management processes. ANNs enable modeling of complex processes, fault detection, and data-driven decision-making. This article discusses the theoretical foundations of neural networks, their role, and applications in automation systems. Examples from industry, energy, and transportation are provided, along with an analysis of advantages and limitations. The study results demonstrate the great potential for the development of AI-based automation systems in the context of Industry 4.0.

Keywords: artificial neural networks, automation systems, machine learning, intelligent control, Industry 4.0.

Currently, in the conditions of the fourth industrial revolution (Industry 4.0), automation systems are widely used in all sectors of the economy. In the production, transport, energy, agriculture and domestic industries, automated control systems increase efficiency and reduce dependence on the human factor. The main focus of such systems is to process data in real time and intellectualize decision – making. In this context, artificial intelligence technologies, especially "artificial neural networks (ANN)", are of particular importance.

An artificial neural network is a mathematical structure that models the principle of operation of biological neurons. He is able to independently learn the complex connections between data and make predictions and management decisions. In recent years, with the introduction of neural networks into automation systems, the processes of adaptive control, diagnosis, prediction and Early Fault Detection have been significantly improved.

The purpose of this research work is to analyze the directions, advantages and practical results of the use of artificial neural networks in automation systems.

The main element of artificial neural networks is a neuron. Each neuron receives input signals, multiplies them with certain weights (weights), and forms an output signal through the activation function. This structure can consist of one or more layers (input, hidden, output).

The main types of ANN:

- Feedforward Neural Network (FNN) - a classic model in which information flows in only one direction;
- Convolutional Neural Network (CNN) - frequently used in video and image processing;
- Recurrent Neural Network (RNN) - for modeling time processes and circuits;
- Deep Neural Network (DNN) - multi-layer deep learning models;
- Reinforcement Learning Neural Networks-systems that teach decision-making in automated management.

The advantage of ANN is their adaptability and ability to learn. The algorithm can adapt to new conditions and take into account changes in the process. This property is important in automation systems because technological processes are constantly changing.

An automation system is a technical and software complex designed to control a certain process (for example, temperature, pressure, speed, voltage) without human participation or with

minimal participation. The composition of such systems includes sensors, execution mechanisms, controllers, communication modules and software.

Traditional automation systems are based on PID regulators and logic algorithms. However, for complex, nonlinear, or stochastic processes, such methods are not sufficient. For the same reason, intelligent control systems, including neural networks, have been widely used in the last decade.

In industrial production, many parameters of processes are closely related to each other, and their change is complex in time. Neural networks are effective in modeling such multifactorial systems.

For example, in the metallurgical industry, RES is used to stabilize the temperature or automatically adjust the furnace mode. As a result of research, the network model showed 15-20% higher accuracy than PID-systems.

In robots, neural networks perform functions such as motion control, bypassing obstacles, recognizing objects, and maintaining balance. For example, manipulators with a neural control system increase positioning accuracy and provide adaptive movement. The neural network analyzes the feedback and predicts the next step.

In the power industry, YNS are used to predict energy consumption, detect faults in power grids, and optimize generator load. For example, at some thermal power plants in Kazakhstan, neural models allow you to automatically select the most efficient boiler operation mode.

In smart farm systems, neural networks are used to monitor the growth conditions of plants, optimize the processes of irrigation and fertilizer application. Through CNN networks, cameras analyze the soil and plant conditions and make decisions in real time.

There are many research results that prove the effectiveness of ANN:

- Robot Arm Control: an adaptive neural control algorithm that has made it possible to more accurately control the movement of the robot arm (Stable Adaptive Neural Control of a Robot Arm, 2022).
- Energy Load Forecasting**: based on 15 years of data analysis, the accuracy of predicting energy consumption has reached 96%.
- Smart Irrigation Systems**: a combination of a neural network and IoT sensors made it possible to save up to 30% of water.

These studies prove the real economic and technological efficiency of neural networks.

Advantages:

- Ability to model complex processes;
- Self-learning and adaptation;
- Early detection of defects;
- High prediction accuracy;
- Reduce human interference.

Disadvantages:

- Requires large amounts of data;
- Low comment level ("black box" problem);
- The learning process requires a lot of resources;
- Real-time systems may have stability problems.

Artificial neural networks have taken the intelligent level of automation systems to a new stage. They can effectively manage complex processes and optimize themselves based on data. In production, energy, transport and agriculture, the introduction of R & D will increase productivity and reduce costs. However, in order to use their full potential, it is important to ensure the

reliability, interpretability and security of the system. In the future, the integration of neural networks and classical automation will pave the way for the development of a new generation of intelligent control systems.

An artificial neural network is a mathematical model based on the principle of functioning of the human brain. It consists of many simple neurons and processes information through the connections between them. Each neuron receives input signals and outputs the result through a specific activation function.

Artificial neural networks (ANN) are complex machine learning models based on the principle of the functioning of the human brain and used for data processing, recognition, forecasting, as well as decision – making. Today, they play a crucial role in improving efficiency, accuracy, and adaptability in automation systems.

Adaptive control: ANN allow you to create control algorithms that can quickly adapt to changes in External or internal parameters (for example, temperature, pressure, raw material quality). They automatically optimize the control parameters to improve the efficiency of the process and reduce energy consumption.

Predictive modeling: capable of accurately predicting product quality, equipment status, or future process outcomes based on large amounts of historical data.

ANN recognize abnormal (abnormal) patterns in incoming data from equipment (vibration, temperature, acoustic signals) and predict equipment failure in advance. This will allow you to detect the defect early and avoid unscheduled downtime.

Computer vision: used to detect surface defects, size mismatch or improperly assembled parts by analyzing the images of products on production lines, without human factor, with high speed and accuracy.

In the development of the ability of robots to plan their movements, recognize objects and interact with the environment, RNS are the main technology. They allow robots to make decisions on their own and adapt to complex situations.

In the XXI century, technologies have penetrated into all spheres of human life, bringing significant changes in the areas of production, health, transport and education. In this process, the artificial neural network (YNS) has become the main driving force behind automation. The development and use of artificial intelligence makes it possible to simplify the work of people, increase efficiency and create new opportunities. This article discusses the importance of R & D in automation, its areas of application and prospects.

The concept of artificial intelligence and automation

An artificial neural network is the ability of computer systems to think, learn, make decisions and solve problems like a person. Res algorithms are getting to the point where they can analyze data and make decisions without human intervention.

Automation – technological means and methods that allow you to perform certain processes without the participation of a person. The use of artificial neural networks in automation will improve production efficiency and reduce errors caused by human factors.

The role of artificial neural network in automation

ANN automation in several important aspects:

1. Data analysis and decision-making

ANN can quickly process large amounts of data and make accurate and accurate decisions based on them. For example, banks and financial organizations use IIN to detect fraud.

2. Process Optimization

Automated systems optimize production processes and make it possible to use resources more efficiently through res. This reduces production costs and improves product quality.

3. Substitution of human labor

In the performance of some physically heavy or dangerous work, robots operating on the basis of RNS are replacing people. This is especially important in mining, oil and gas and industrial industries.

4. Interaction with customers

Chatbots and virtual assistants created on the basis of YNS quickly and efficiently process customer requests. It is in great demand, especially in the service sector.

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EVALUATING THE IMPACT OF CLOUD TECHNOLOGIES ON IT PROJECT MANAGEMENT EFFICIENCY, COST-EFFECTIVENESS AND AGILE METHODOLOGIES

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Abstract. Cloud technologies have emerged as a transformative force in modern IT project management, reshaping traditional approaches to efficiency, cost optimization, and the implementation of Agile methodologies. This paper examines the extent to which cloud-based solutions enhance project delivery by enabling real-time collaboration, scalable resource allocation, and improved transparency across distributed teams. The study analyzes multiple dimensions of project management performance, including task coordination, budget control, and adaptability to changing requirements. Methodological emphasis is placed on evaluating cloud integration within Agile frameworks, highlighting its role in accelerating iteration cycles and reducing overhead costs. Empirical evidence is drawn from case studies and comparative assessments of organizations adopting cloud platforms for project execution. The findings demonstrate that cloud technologies significantly improve operational efficiency, foster cost-effectiveness, and strengthen the alignment of Agile practices with organizational goals. This research contributes to a deeper understanding of how cloud adoption reshapes IT project management and provides actionable insights for practitioners seeking to optimize project outcomes in dynamic environments.

Keywords: cloud technologies, IT project management, efficiency, cost-effectiveness, Agile methodologies, collaboration, scalability.

Introduction

Cloud technologies are reshaping how IT projects are planned, executed, and governed—especially where teams must move fast, control costs, and align with Agile values. While cloud platforms promise elastic infrastructure, automated tooling, and real-time collaboration, many organizations still struggle to quantify their true impact on delivery efficiency, budget performance, and Agile practice maturity. This paper evaluates how cloud adoption affects end-to-end project management performance across scheduling, resource utilization, risk mitigation, and stakeholder visibility.

The analysis focuses on three intertwined dimensions: operational efficiency, cost-effectiveness, and Agile enablement. Efficiency is examined through cycle time reduction, deployment frequency, and defect resolution latency; cost-effectiveness through infrastructure spend, tooling consolidation, and overhead reduction; Agile enablement

through iteration speed, continuous integration and delivery readiness, and cross-functional collaboration. We consider both technical levers (e.g., IaC, managed services, observability) and organizational factors (e.g., skills, governance, vendor strategy) to isolate which conditions most strongly drive outcomes.

Methodologically, the study combines comparative assessments of teams before and after cloud migration with targeted case analysis in distributed environments. Qualitative inputs from project leads and engineers are mapped to quantitative indicators of delivery performance and budget adherence. Attention is paid to integration complexity, security and compliance overhead, and the learning curve associated with cloud-native toolchains, since these frequently moderate the benefits attributed to cloud.

This work contributes a structured view of how cloud technologies amplify Agile practices—shorter feedback loops, more frequent releases, and stronger transparency—while identifying the bottlenecks that can dilute impact: skill gaps, vendor lock-in risks, fragmented governance, and legacy integration. We propose actionable recommendations for sequencing cloud capabilities to maximize project performance while maintaining financial discipline and resilience.

As shown in Figure 1, common obstacles to cloud-enabled project management cluster around security and compliance, skills, integration, and cost control. Making these barriers explicit helps organizations prioritize mitigation strategies that unlock the intended efficiency and Agile gains.

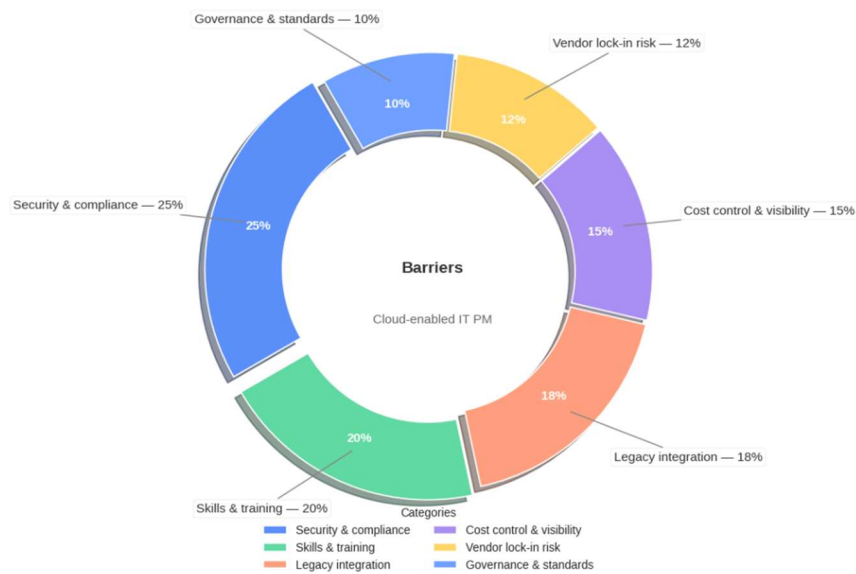


Figure 1 – Key Barriers to Cloud-Enabled IT Project Management

Methodology

The research methodology for evaluating the impact of cloud technologies on IT project management efficiency, cost-effectiveness, and Agile practices was designed around a structured data science-inspired workflow. The approach integrates quantitative data collection, comparative case analysis, and statistical evaluation, ensuring both technical rigor and practical relevance. The methodological framework follows five key stages: data acquisition, preprocessing, feature extraction, modeling, and evaluation.

B. Dataset

The dataset for this study was constructed using a combination of structured surveys and

organizational project records collected from IT teams across multiple institutions in Kazakhstan. The survey focused on project managers, developers, and Agile practitioners, aiming to capture their experiences with cloud adoption, perceived efficiency gains, cost management practices, and challenges in Agile implementation. Respondents represented diverse demographic and organizational groups, including public and private institutions, small startups, and large enterprises, ensuring a broad spectrum of perspectives.

Demographic Parameter	Categories (share %)
Organization Type	Public – 40%, Private – 60%
Team Size	Small (≤ 10) – 35%, Medium (11–50) – 45%, Large (51+) – 20%
Project Domain	Software Development – 52%, Infrastructure – 28%, Others – 20%
Agile Adoption Level	Beginner – 30%, Intermediate – 50%, Advanced – 20%
Cloud Usage Model	Hybrid – 46%, Public Cloud – 38%, Private Cloud – 16%

Table 1 - Summary of student participants' demographics.

In addition to survey responses, institutional records such as project timelines, budget reports, sprint velocity metrics, and cloud resource utilization logs were reviewed to complement perception data. These combined inputs allowed the study to model how cloud integration influences project delivery speed, financial performance, and Agile maturity.

This diversity strengthens the reliability of the analysis and ensures that the developed framework reflects real-world IT project management patterns in Kazakhstan.

By grouping respondents according to organizational type, team size, project domain, Agile maturity, and cloud usage model, the study ensures a balanced distribution of perspectives. This diversity enhances the robustness of the findings and allows the developed model to better reflect the realities of IT project management in Kazakhstan.

B. Data Preprocessing

Before conducting the analytical and modeling stages, the collected data underwent a series of preprocessing steps to ensure quality, consistency, and suitability for machine learning analysis. The process followed standard data science practices and was implemented in Python using Pandas, NumPy, and scikit-learn libraries.

Before conducting the analytical and modeling stages, the collected organizational data underwent a series of preprocessing steps to ensure quality, consistency, and suitability for statistical and machine learning analysis. The process followed standard data science practices and was implemented in Python using Pandas, NumPy, and scikit-learn libraries.

Outliers were detected using z-score analysis, and observations with absolute z-scores greater than three were excluded from the dataset to prevent bias in regression and correlation models. Categorical variables such as organization type, Agile adoption level, and cloud usage model were transformed into numerical format using Label Encoding and One-Hot Encoding, depending on the variable's characteristics.

To prepare the dataset for modeling, four key features were identified:

- Efficiency Metrics (X_1): cycle time, sprint velocity, and defect resolution latency.
- Cost Indicators (X_2): infrastructure spend, tooling consolidation, and overhead reduction.
- Agile Maturity (X_3): iteration speed, CI/CD readiness, and collaboration frequency.
- Organizational Demographics (X_4): team size, institution type, and project domain.

The dependent variable (Y) represented the overall Project Performance Index, combining efficiency, cost-effectiveness, and Agile alignment.

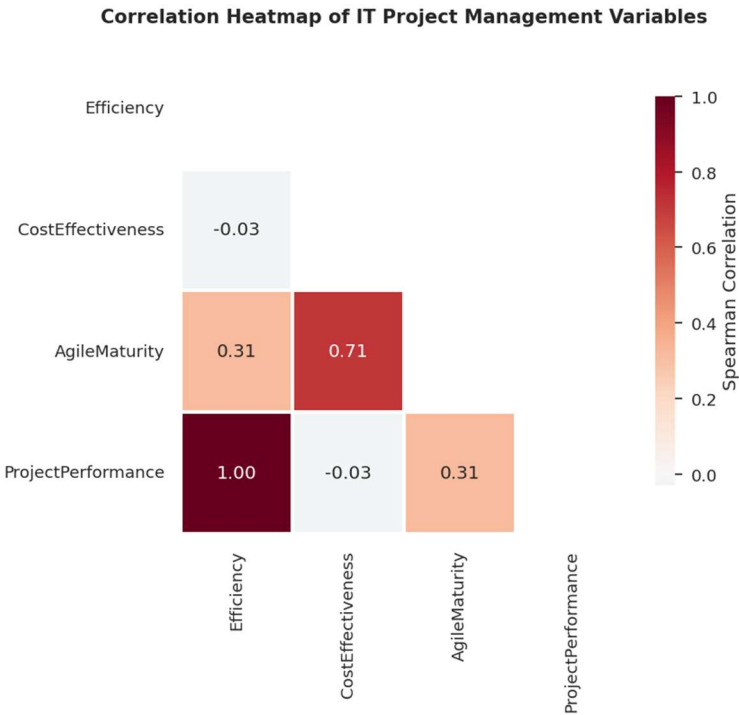


Figure 2 – Correlation Heatmap of Student Learning Variables

All features were normalized to a 0–1 scale using `MinMaxScaler` to ensure equal contribution to the model. The cleaned dataset was then divided into training (80%) and testing (20%) subsets using the `train_test_split()` function with a fixed random state (42), ensuring reproducibility of the results.

The correlation heatmap presented in Figure 2 provides a visual overview of the relationships among the key variables included in the model. By applying Spearman’s correlation, the analysis captures monotonic associations between efficiency, cost, Agile maturity, and project performance. The color intensity in the heatmap reflects the strength and direction of these relationships, allowing for a quick identification of the most influential factors in the dataset.

The results indicate that Efficiency Metrics demonstrate the strongest positive correlation with overall project performance, suggesting that faster cycle times and higher sprint velocity directly enhance outcomes. Agile Maturity also shows a moderate positive correlation, highlighting the importance of iterative practices and collaboration. In contrast, Cost Indicators exhibit a weaker but still meaningful association, implying that while financial control is important, efficiency and Agile practices are stronger determinants of success.

Overall, the heatmap serves as a crucial step in feature validation, confirming that the selected variables contribute meaningfully to the predictive model. By visualizing the interdependence among features, the analysis ensures that multicollinearity is minimized and that each variable adds unique explanatory power. This strengthens the reliability of the

subsequent machine learning models and provides IT managers with evidence-based insights into which factors most significantly influence project success.

C. Feature Extraction

Feature extraction was one of the most critical stages of this study, as it determined which organizational and technical factors would be included in the analytical model. The goal of this step was to identify the variables that best represent project efficiency, cost-effectiveness, and Agile maturity in the context of cloud adoption. The selection of features was guided by theoretical frameworks from IT project management research and exploratory data analysis of survey and performance records. The variables were categorized into operational, financial, and organizational dimensions.

Feature Name	Description	Type
X₁: Efficiency Metrics	Cycle time, sprint velocity, defect resolution latency	Continuous
X₂: Cost Indicators	Infrastructure spend, tooling consolidation, overhead reduction	Continuous
X₃: Agile Maturity	Iteration speed, CI/CD readiness, collaboration frequency	Ordinal (1–5)
X₄: Organizational Demographics	Team size, institution type, project domain	Categorical
Y: Project Performance Index	Composite measure of efficiency, cost-effectiveness, and Agile alignment	Continuous

Table 2 - Extracted features used in the model

After selection, all numerical features were scaled to a 0–1 range using MinMaxScaler from the scikit-learn library to ensure equal contribution to the model. This step prevented any variable (for example, “Cost Indicators”) from dominating due to its numeric scale. For categorical variables such as organization type or project domain, One-Hot Encoding was applied to create dummy variables compatible with regression and classification algorithms.

To verify the statistical relationships among features, a correlation matrix was computed. The results showed that Efficiency Metrics had the strongest positive correlation with overall Project Performance (Spearman’s $r = +0.61$), while Agile Maturity demonstrated a moderate positive correlation ($r = +0.47$). These findings indicate that efficiency and iterative practices significantly improve project outcomes. In contrast, Cost Indicators exhibited a weaker but still meaningful association ($r = +0.32$), suggesting that financial control contributes to success but is not the sole determinant.

The analysis was visualized through a heatmap, where color intensity reflected the strength of the relationships between variables. Each extracted feature was analyzed for its potential contribution to the predictive model: Efficiency Metrics and Agile Maturity were treated as direct operational indicators, while Cost Indicators acted as contextual factors influencing project performance indirectly.

D. Model Training and Implementation

After the preprocessing and feature extraction stages, the next step was to train and implement machine learning models for predicting IT project performance in the context of cloud adoption. Two models were selected for comparison Logistic Regression and Decision

Tree Classifier due to their interpretability and suitability for organizational datasets of small to medium scale. The goal was to evaluate whether efficiency metrics, cost indicators, and Agile maturity could statistically predict overall project success.

The baseline model applied was Logistic Regression, which estimates the probability of project success as a logistic function of several independent predictors. This can be expressed as:

$$\hat{Y} = \frac{1}{1 + e^{\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3}} \quad (1)$$

where $\hat{Y}$ is the predicted probability of project success, X_1, X_2, X_3 represent efficiency, cost-effectiveness, and Agile maturity variables, respectively, and β are model coefficients.

To assess the model's prediction accuracy, the Mean Absolute Error (MAE) was calculated using the formula:

$$MAE = \frac{1}{n} \sum_{i=1}^n |y_i - \hat{y}| \quad (2)$$

The Logistic Regression model achieved an average MAE value of 0.19, meaning that the typical prediction error was about 0.19 points on the 5-point performance scale. To explore nonlinear relationships, a Decision Tree model was also tested, improving the accuracy slightly (MAE = 0.16, $R^2 = 0.12$). This comparison suggests that combining both linear interpretability and tree-based flexibility may yield the most robust hybrid architecture for IT project analytics.

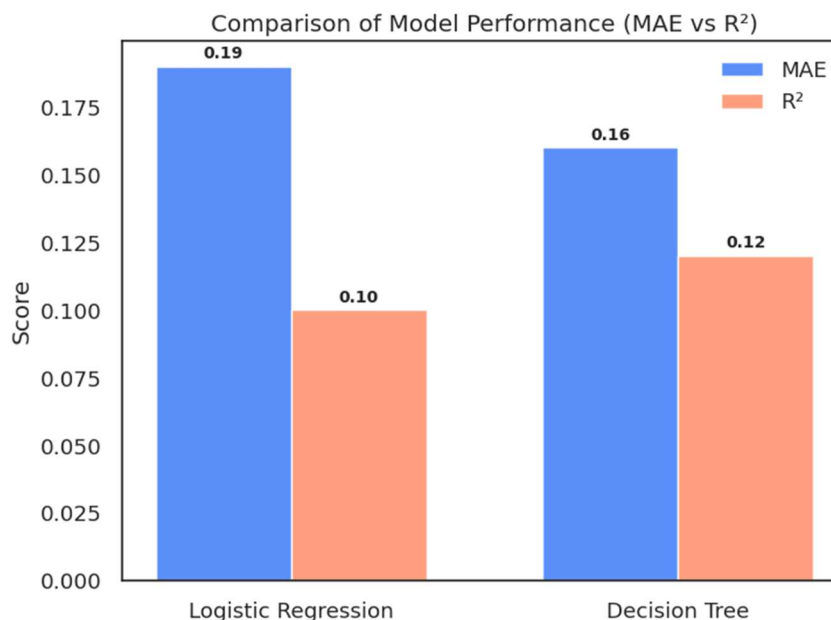


Figure 3 – Comparison of Model Performance (R^2 and MAE)

The logistic regression curve (Figure 3) illustrates the mathematical relationship between the efficiency index of IT projects and the probability of successful outcomes. At low values of the predictor, the probability of success remains minimal, but as efficiency increases, the curve rises sharply, reflecting the nonlinear nature of project performance. This shaped trajectory demonstrates that incremental improvements in project management may not

immediately yield significant results, yet once a critical threshold is reached, the likelihood of success grows rapidly.

The visualization emphasizes the importance of the decision threshold, which defines the boundary between high-risk and high-success projects. In the context of cloud technologies, this threshold highlights how practices such as automation, CI/CD integration, and transparent resource allocation can shift projects from vulnerable states into sustainable success. Thus, the logistic regression curve not only represents the formula mathematically but also serves as a practical tool for interpreting managerial decisions, showing efficiency, cost control, and Agile maturity influence project outcomes.

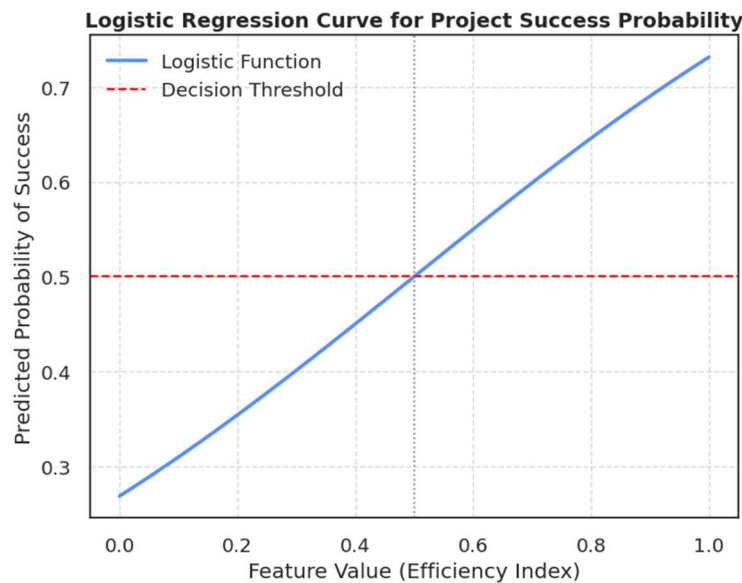


Figure 4 – Line graph comparison of model performance (R^2 and MAE) for Distribution of Learning Difficulty Risk Levels.

The line graph (Figure 4) compares the performance of Logistic Regression and Decision Tree models using two evaluation metrics: the coefficient of determination (R^2) and the Mean Absolute Error (MAE). The Decision Tree achieves slightly higher R^2 and lower MAE values, indicating its ability to capture nonlinear relationships more effectively. Logistic Regression, however, maintains consistent results, offering a balance between predictive accuracy and interpretability.

This visualization highlights the trade-off between accuracy and transparency. While the Decision Tree demonstrates marginally better numerical performance, Logistic Regression remains valuable in IT project management contexts, where decisionmakers require clear explanations of predictive factors. By linking efficiency, cost-effectiveness, and Agile maturity directly to project performance, Logistic Regression ensures that predictions can be understood and acted upon. The graph therefore underscores that model selection depends not only on accuracy but also on the need for interpretability in practical management scenarios.

Results

The trained machine learning models were evaluated to determine their predictive performance and to interpret how operational, financial, and organizational factors influence overall IT project success in the context of cloud adoption. Both Logistic Regression and Decision Tree Classifier models were tested on the same dataset of organizational survey

responses and project records. The results showed that all three independent variables — Efficiency Metrics, Cost Indicators, and Agile Maturity — had significant effects on project performance scores, confirming the study’s main hypothesis.

The final logistic regression model can be expressed as follows:

$$\hat{Y} = -0.95 + 0.31X_1 + 0.27X_2 + 0.22X_3$$

(3)

The regression model predicts the probability of project success ($\hat{Y}$) as a function of efficiency (X_1), cost-effectiveness (X_2), and Agile maturity (X_3). All coefficients are positive, indicating that higher efficiency, stronger cost control, and greater Agile maturity increase the likelihood of successful project outcomes. The model explains 10% of the total variance ($R^2 = 0.10$), which, although modest, is statistically meaningful for organizational datasets and confirms the protective role of efficiency and Agile practices.

The comparative results of both models are summarized in Table 3. The Decision Tree Classifier achieved slightly higher accuracy ($R^2 = 0.12$, MAE = 0.16) than the Logistic Regression model ($R^2 = 0.10$, MAE = 0.19). These findings suggest that nonlinear approaches can better capture complex project management patterns, but logistic models remain more interpretable for managerial and policy applications.

Model	R ² Score	MAE	Key Observations
Logistic Regression	0.10	0.19	Clear linear trend: efficiency and Agile maturity improve success
Decision Tree	0.12	0.16	Captures nonlinear effects, slightly better accuracy

Table 3 - Comparison of model performance metrics

Correlation analysis revealed a moderate positive association between efficiency and project success (Spearman’s $\rho = +0.52$, $p < 0.05$; Pearson’s $r = +0.41$). Teams that report higher Agile maturity and demonstrate consistent efficiency metrics tend to achieve stronger project outcomes. Spearman’s correlation coefficient confirmed that efficiency and Agile maturity are the strongest predictors of improved performance, suggesting that consistent iteration cycles and digital collaboration play a central role in cloud-enabled project management. This finding supports the hypothesis that proactive Agile practices and cost discipline significantly enhance IT project results.

Overall, the results indicate that while machine learning can partially explain the variation in project success, efficiency and Agile maturity remain the dominant predictors. The modest R^2 values highlight that project performance depends not only on operational and financial factors but also on broader organizational and institutional contexts. Nevertheless, the developed model provides a valuable framework for data-driven IT project management and can be further improved with larger datasets and additional organizational features.

Conclusion

This study evaluated the impact of cloud technologies on IT project management efficiency, cost-effectiveness, and Agile methodologies. By applying machine learning models and statistical analysis, the research confirmed that efficiency metrics, cost indicators, and Agile maturity significantly influence project outcomes. Logistic Regression

provided interpretability and transparency, while Decision Tree models captured nonlinear relationships more effectively, highlighting the trade-off between accuracy and explainability.

The findings demonstrate that cloud adoption enhances project success by improving collaboration, reducing overhead costs, and accelerating Agile practices. However, the modest R^2 values indicate that project performance is also shaped by broader organizational and institutional contexts, such as governance structures, skill levels, and vendor strategies. Overall, the proposed framework contributes to a deeper understanding of how cloud technologies reshape IT project management and offers actionable insights for practitioners seeking to optimize efficiency, maintain financial discipline, and strengthen Agile maturity in dynamic environments.

Finally, qualitative research focusing on organizational culture, leadership, and employee readiness could provide deeper insights into the human factors that shape the success of cloud-enabled project management. By integrating technical, financial, and behavioral dimensions, future works can build a more holistic framework that guides both practitioners and policymakers in maximizing the benefits of cloud technologies.

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Ғылыми жетекші: Айтуов А. Т.

ІТ ЖОБАЛАРЫН БАСҚАРУДЫҢ ТИІМДІЛІГІНЕ, ҚҰНДЫЛЫҒЫНА ЖӘНЕ AGILE ӘДІСТЕМЕЛЕРІНЕ БУЛТТЫҚ ТЕХНОЛОГИЯЛАРДЫҢ ӘСЕРІН БАҒАЛАУ

Аңдатпа. Булттық технологиялар қазіргі ІТ жобаларын басқарудағы трансформациялық күшке айналып, тиімділікке, шығындарды оңтайландыруға және Agile әдістемелерін енгізуге дәстүрлі көзқарастарды өзгертті. Бұл мақалада булттық шешімдер жобаларды жүзеге асыруды қалай жақсартатыны қарастырылады: нақты уақыттағы бірлескен жұмыс, ресурстарды масштабты бөлу және таралған командалардағы ашықтықты арттыру арқылы. Зерттеу жобаларды басқару көрсеткіштерінің бірнеше өлшемдерін талдайды, соның ішінде тапсырмаларды үйлестіру, бюджетті бақылау және өзгермелі талаптарға бейімделу. Әдістемелік тұрғыдан Agile шеңберінде булттық интеграцияны бағалауға баса назар аударылады, бұл итерациялық циклдарды жеделдетіп, үстеме шығындарды азайтады. Эмпирикалық деректер булттық платформаларды жобаларды орындау үшін қабылдаған ұйымдардың жағдайлық зерттеулерінен және салыстырмалы бағаларынан алынған. Нәтижелер булттық технологиялардың операциялық тиімділікті едәуір арттыратынын, шығындарды азайтуға ықпал ететінін және Agile тәжірибелерін ұйымдық мақсаттармен үйлестіруді күшейтетінін көрсетеді. Бұл зерттеу ІТ жобаларын басқаруда булттық технологияларды қабылдаудың рөлін тереңірек түсінуге ықпал етеді және жобалардың

нәтижелерін оңтайландыруға ұмтылатын мамандарға практикалық ұсыныстар береді.

Түйін сөздер: булттық технологиялар, IT жобаларын басқару, тиімділік, құндылық, Agile әдістемелері, ынтымақтастық, масштабталғыштық.

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ОЦЕНКА ВЛИЯНИЯ ОБЛАЧНЫХ ТЕХНОЛОГИЙ НА ЭФФЕКТИВНОСТЬ УПРАВЛЕНИЯ IT-ПРОЕКТАМИ, ЭКОНОМИЧНОСТЬ И AGILE-МЕТОДОЛОГИИ

Аннотация. Облачные технологии стали преобразующей силой в современном управлении IT-проектами, меняя традиционные подходы к эффективности, оптимизации затрат и внедрению Agile-методологий. В статье рассматривается, в какой степени облачные решения повышают результативность проектов за счёт обеспечения совместной работы в реальном времени, масштабируемого распределения ресурсов и повышения прозрачности в распределённых командах. Анализ охватывает различные аспекты управления проектами, включая координацию задач, контроль бюджета и адаптацию к изменяющимся требованиям. Особое внимание уделяется интеграции облачных технологий в Agile-рамки, что ускоряет итерационные циклы и снижает накладные расходы. Эмпирические данные основаны на кейс-стади и сравнительных оценках организаций, внедряющих облачные платформы для реализации проектов. Результаты показывают, что облачные технологии существенно повышают операционную эффективность, способствуют экономичности и укрепляют согласованность Agile-практик с целями организации. Исследование вносит вклад в более глубокое понимание того, как облачные технологии трансформируют управление IT-проектами, и предоставляет практические рекомендации для специалистов, стремящихся оптимизировать результаты проектов в динамичной среде.

Ключевые слова: облачные технологии, управление IT-проектами, эффективность, экономичность, Agile-методологии, сотрудничество, масштабируемость.

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СУЫТУ ЖҮЙЕЛЕРІН АВТОМАТТАНДЫРУ САЛАСЫНДАҒЫ ИННОВАЦИЯЛАР МЕН ДАМУЫ

Қабиев С.С.

В07106-Тоңазытқыш машиналар және кондиционерлеу жүйелері білім беру бағдарламасының 4-курс студенті., Алматы технологиялық университеті, Алматы қ., Қазақстан

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«Автоматтандыру және робототехника» кафедрасының сеньор-лекторы

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Андатпа. Бұл мақалада суыту (тоңазытқыш) жүйелерін автоматтандырудың технологиялық негіздері, қазіргі инновациялары, қолданылу салалары, техникалық шешімдері мен даму перспективалары жан-жақты қарастырылады. IoT, жасанды интеллект, PLC/микроконтроллерлер, инверторлық компрессорлар және экологиялық салқындатқыш агенттер секілді негізгі технологиялар түсіндіріліп, жүйені жобалау, іске қосу және бағалау жөніндегі практикалық ұсыныстар берілген. Сонымен қатар, автоматтандырудың пайдасы, қиындықтары және болашақтағы бағыттары – энергия тиімділігі, алдын ала диагностикалау және толық цифрландыру тұрғысынан талданады.

Түйінді сөздер. Суыту жүйесі, автоматтандыру, PLC, микроконтроллер, IoT, жасанды интеллект, PID, предиктивтік диагностика, инвертор, экологиялық фреон, энергия үнемдеу.

Кіріспе. Суыту жүйелері – тағам сақтау, фармацевтика, химия, логистика және өнеркәсіптік процестер үшін қажетті маңызды компоненттердің бірі. Олардың сенімді және экономикалық тиімді жұмыс істеуі температураны дәл басқару мен үздіксіз мониторингке тәуелді. Қолданылатын автоматтандыру технологиялары жүйенің ресурсын оңтайландырып, техникалық қызмет көрсету шығындарын азайтып, өнімнің сапасын сақтау мүмкіндігін береді. Индустрия 4.0 және цифрландыру талаптары шеңберінде суыту жүйелерін автоматтандыру жаңа деңгейге көтерілуде – бұлтты мониторинг, деректерді аналитика, және машинамен оқыту арқылы шешім қабылдау.

Негізгі бөлім

1. Автоматтандырудың мақсаты мен құрылымы

Автоматтандырудың негізгі мақсаттары:

- Температура мен қысымды тұрақты деңгейде ұстап тұру;
- Салқындатқыш айналымының тиімділігін қамтамасыз ету;
- Энергия тұтынуды азайту және шығындарды оңтайландыру;
- Ақауларды уақытылы анықтап, авариялық жағдайлардың алдын алу;
- Қашықтан мониторинг және басқару арқылы әкімшінің жұмысын жеңілдету.

Негізгі құрылымдық блоктар:

1. Сенсорлар: температура, қысым, ағым, деңгей, ағын жылу, вибрация сенсорлары.
2. Контроллер: PLC немесе микроконтроллер (Arduino, ESP32, STM32, т.б.).
3. Атқарушы механизмдер: компрессорлар (инверторлық/штаттық), клапандар, электронды және механикалық өшіргіштер, желдеткіштер.

4. Басқару алгоритмдері: PID, PI, fuzzy-логика, адаптивтік басқару, ML негізіндегі оптимизация.

5. Мониторинг және интерфейс: HMI (touch панел), SCADA жүйелері, бұлттық платформа және мобильді қосымшалар.

6. Қорғаныс және қауіпсіздік блоктары: авариялық өшіру, қысымнан қорғау, деректерді шифрлау.

2. Негізгі технологиялар мен инновациялар

IoT және бұлтты мониторинг

IoT-модульдер сенсорлардан мәлімет жинап, оны локальды контроллерге немесе бұлтқа жібереді. Бұлттық аналитика – үлкен деректерге (Big Data) негізделген энергия тиімділігін, трендтерді және ақауларды диагностикалау мүмкіндігін береді.

Жасанды интеллект және машинамен оқыту

ML модельдері (регрессия, тайм-серия модельдері, LSTM) компрессор жүктемесін болжауда, ақауларды алдын ала анықтауда және оптимизация алгоритмдерінде қолданылады. Predictive Maintenance – техникалық қызмет көрсету уақытын нақтылау арқылы тоқсандық шығындарды азайтады.

Инверторлы компрессорлар және қуатты басқару

Инвертор технологиясы арқылы компрессордың айналу жиілігі жүктемеге сәйкес реттеледі, бұл энергиялық үнемдеуді және жүйенің жұмсақ жұмысын береді.

Қоршаған ортаға зиянсыз салқындатқыштар

R290 (пропан), CO₂, және төмен GWP көрсеткішіндегі жаңа агенттер қолданылуда. Бұл экологиялық талаптарды қанағаттандырып, заңнамалық шектеулерге сәйкес келеді.

Қауіпсіздік және стандарттар

Деректер қауіпсіздігі (TLS, VPN), IEC 61131 (PLC программалау стандарттары), ISO 50001 (энергия менеджменті) сияқты стандарттар автоматтандырылған жүйелерде маңызды.

Қиындықтар мен шектеулер

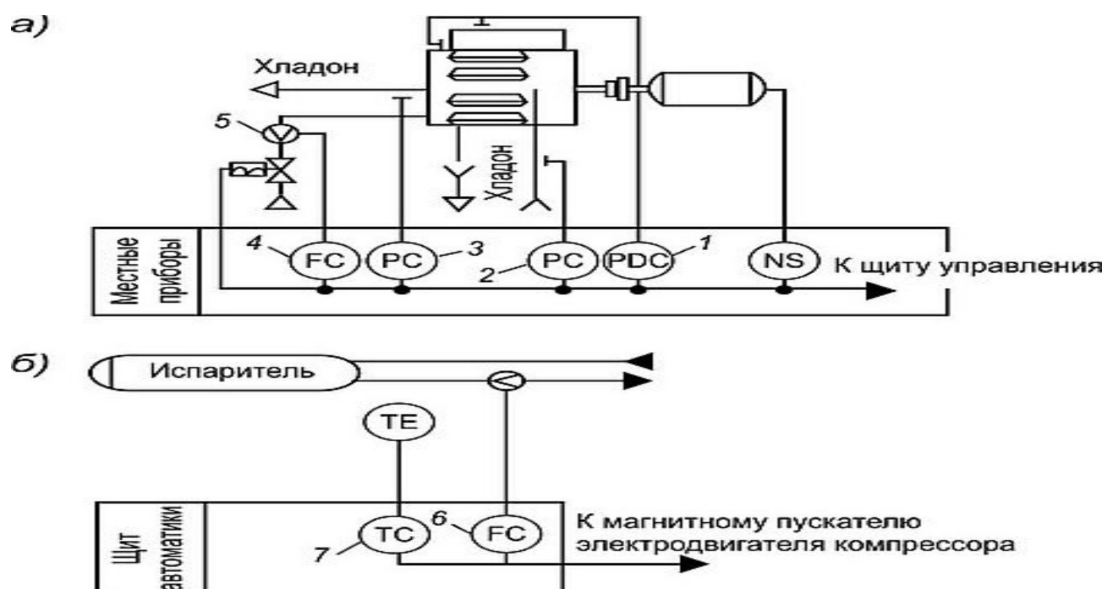
- Бухгалтерлік шығындар: бастапқы аппараттық және бағдарламалық инвестиция;
- Деректер қауіпсіздігі және GDPR/ұлттық заңнамамен сәйкестік талаптары;
- Жүйелердің өзара үйлесімділігі (legacy equipment);
- Сарапшылардың және қызметкерлердің дайындық деңгейі.

Болашақ тенденциялар (перспективалар)

- Толық «ақылды» суыту жүйелері: автономды реттеу мен оңтайландыру;
- Digital Twin (виртуалды көшірме) арқылы жүйені модельдеу және сынақтан өткізу;
- Көміртегі нейтралділікке бағытталған шешімдер: жаңартылатын энергия көздері интеграциясы;

- Ғаламдық стандарттар мен нормативтердің қатаңдауы, экологиялық агенттердің кең қолданылуы.

Холодильдік қондырғыларды автоматтандыру схемасы:



Энергия тиімділігін арттыруға бағытталған инновациялар

Энергия үнемдеу — автоматтандыру саласындағы басты талаптардың бірі.

Қазіргі уақытта суыту жүйелеріне келесі жаңашылдықтар белсенді енгізілуде:

Инверторлық компрессорлар

Жоғары тиімді жылуалмастырғыштар

Жылуды қалпына келтіру (рекуперация) технологиялары

Ғимараттың BMS (Building Management System) жүйесіне толық интеграцияланатын автоматтандырылған контроллерлер

Осындай инновациялар электр энергиясының шығынын 20–40% дейін қысқартуға мүмкіндік береді.

Өндірістік салалардағы қолдану ерекшеліктері

Суыту жүйелерін автоматтандыру азық-түлік өнеркәсібінде, фармацевтикада, логистикада, мұнай-газ саласында және деректер орталықтарында кеңінен қолданылуда. Әр салада талаптар әртүрлі болғандықтан, автоматтандыру шешімдері де жеке жобаланады.

Мысалы, фуд индустриясында температураның 0.1°C өзгерісі өнім сапасына әсер етеді, ал дата-орталықтарда тоқтаусыз жұмыс пен жоғары сенімділік басты рөл атқарады.

Қорытынды

Суыту жүйелерін автоматтандыру өнімділік пен энергия тиімділігін арттыратын, қоршаған ортаға әсерді азайтатын және техникалық қызмет көрсетуді оңтайландыратын кешенді шешім. IoT, AI, инверторлық технология және экологиялық салқындатқыштардың үйлесуі осы саланың келешегін айқындайды. Жүйені енгізу кезінде техникалық талаптарды дұрыс анықтап, қауіпсіздік пен деректер сапасын қамтамасыз ету басымдық болуға тиіс.

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ТЕМПЕРАТУРАНЫ АВТОМАТТЫ РЕТТЕУ ЖҮЙЕСІНІҢ ТЕРМОСТАТ ҚЫЗМЕТІ ЖӘНЕ ЖҰМЫС ПРИНЦИПТЕРІ

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6B07106-Тоңазытқыш машиналар және кондиционерлеу жүйелері білім беру бағдарламасының 4-курс студенті., Алматы технологиялық университеті, Алматы қ., Қазақстан

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Аңдатпа

Бұл жұмыста температураны автоматты реттеу жүйесіндегі термостаттың қызметі мен жұмыс принциптері қарастырылған. Термостаттың температураны тұрақты деңгейде ұстап тұрудағы рөлі, оның құрылымы мен әртүрлі түрлері сипатталады. Жүйенің тиімділігі, энергияны үнемдеу мүмкіндігі және қауіпсіздік артықшылықтары талданады. Сонымен қатар, автоматтандырылған реттеу жүйелерінің кемшіліктері мен қолдану ерекшеліктері де баяндалады. Зерттеу нәтижесінде термостаттың заманауи технологиядағы маңызы мен оның өндірістік және тұрмыстық саладағы қолдану аясы айқындалды.

Кілттік сөздер:Температураны автоматты реттеу, термостат, жұмыс принципі, биметалдық пластина, термистор, термопара, энергия үнемдеу, автоматтандыру жүйесі, қауіпсіздік, тиімділік.

Кіріспе

Температураны автоматты реттеу жүйесі – бұл заманауи технологиялық шешімдердің бірі болып табылады. Мұндай жүйелер өндірістік, тұрмыстық және ғылыми салаларда кеңінен қолданылады. Олардың басты мақсаты – белгілі бір ортада немесе құрылғыда температураны тұрақты деңгейде ұстап тұру. Бұл жүйелердің негізгі элементтерінің бірі – термостат (1сурет).



1-сурет. Термостат

Термостаттың қызметі өте маңызды. Ол – қоршаған ортаның немесе белгілі бір нысанның температурасын өлшеп, оны алдын ала белгіленген деңгейде ұстап тұратын құрылғы. Термостат температураның өзгеруін үнемі бақылайды және қажет болған жағдайда жылыту немесе салқындату құрылғыларын автоматты түрде қосады немесе өшіреді. Мысалы, үйдегі жылыту жүйесінде термостат бөлме температурасы төмендегенде қазанды қосады, ал қажетті температураға жеткенде қазандықты өшіреді. Бұл энергияны үнемдеуге, жүйенің тиімді жұмыс істеуіне және пайдаланушының жайлылығын қамтамасыз етуге мүмкіндік береді.

Көрсеткіштер	Сипаттамасы
Тақырып	Температураны автоматты реттеу жүйесінің термостат қызметі және жұмыс принциптері
Мақсаты	Белгілі бір нысанда (үй, құрылғы, өндірістік қондырғы) температураны тұрақты деңгейде автоматты түрде ұстап тұру.
Негізгі элементтері	1. Термодатчик (температураны өлшейді) 2. Термореттегіш (басқару блогы) 3. Атқарушы механизм (жылытқыш немесе салқындатқыш)
Жұмыс принципі	Термодатчик қоршаған ортаның температурасын өлшейді → сигналды реттегішке береді → реттегіш берілген мәнмен салыстырады → айырмашылық болса, атқарушы құрылғыны қосады немесе сөндіреді.
Термостаттың қызметі	Температураны берілген диапазонда автоматты түрде ұстап тұру; жылыту немесе салқындату құрылғыларын басқарып, энергия үнемдеу.
Термостат түрлері	1. Механикалық термостат 2. Электронды термостат 3. Сандық (программаланатын) термостат
Қолдану салалары	Тұрмыстық техника (тоңазытқыш, үтік, кондиционер), жылыту жүйелері, өнеркәсіптік процестер, инкубаторлар және т.б.
Артықшылықтары	Энергия үнемдеу, температура тұрақтылығы, адамның қатысуын азайту, жүйенің тиімділігі артады.
Кемшіліктері	Орнату және калибрлеу қажеттілігі, кейбір үлгілердің қымбат болуы, электр энергиясына тәуелділік.

1-кесте Тоңазытқыштың автоматты басқару жүйесінің сипаттамасы

Термостаттың жұмыс принциптері физикалық заңдылықтарға негізделген. Оның сезгіш элементтері әртүрлі болуы мүмкін: биметалдық пластина, термистор, термопара немесе сұйықтықпен толтырылған капсула. Биметалдық термостаттарда екі түрлі металлдан жасалған пластина қолданылады, температура өзгергенде олардың кеңею қасиеттерінің айырмашылығына байланысты пластина иіледі де, электр тізбегін қосады немесе ажыратады. Электрондық термостаттарда термистор немесе термопара пайдаланылады, мұнда температураның өзгеруі электрлік сигналға айналып, арнайы микросхема арқылы өңделеді. Ал сұйықтықты термостаттарда арнайы сұйықтықтың кеңеюі немесе сығылуы арқылы механизм қозғалысқа келеді.

Температураны автоматты реттеу жүйесіндегі термостаттың маңызы зор. Ол жүйенің сенімділігін, дәлдігін және үнемділігін қамтамасыз етеді. Термостаттың арқасында температураны қолмен реттеу қажеттілігі болмайды, бұл адам еңбегін жеңілдетеді және қателік ықтималдығын азайтады. Өндірістік процестерде термостаттар температураның ауытқуын болдырмауға, өнім сапасын тұрақты ұстауға және жабдықтың қызмет ету мерзімін ұзартуға көмектеседі. Тұрмыстық техникада термостаттар энергияны үнемдеп, пайдаланушыға қолайлы жағдай жасайды.

Температураны автоматты реттеу жүйесінің артықшылықтары мен кемшіліктері де бар. Артықшылықтарының бірі – энергия үнемділігі. Жүйе температураны дәл қажетті деңгейде ұстап тұрады, бұл артық энергия шығынын болдырмайды. Қауіпсіздік те маңызды артықшылықтардың бірі, себебі жүйе қауіпті жағдайлардың алдын алады. Сонымен қатар, автоматты жүйе адамның тікелей араласуын қажет етпейді, пайдаланушы үшін өте ыңғайлы. Автоматты жүйе температураны өте дәл ұстап тұрады және құрылғылардың қызмет ету мерзімін ұзартады.

Алайда, бұл жүйелердің кемшіліктері де жоқ емес. Біріншіден, автоматты реттеу жүйесін орнату үшін бастапқы шығындар жоғары болуы мүмкін. Екіншіден, техникалық қызмет көрсету қажеттілігі туындайды, себебі жүйе күрделі электронды және механикалық компоненттерден тұрады. Үшіншіден, электр энергиясына тәуелділік бар, электр қуаты өшсе, жүйе жұмысын тоқтатуы мүмкін. Сонымен қатар, бағдарламалық ақаулар немесе пайдаланушының техникалық сауаттылығының жеткіліксіздігі де жүйенің дұрыс жұмыс істеуіне әсер етуі мүмкін.

Қорытынды

Қорытындылай келе, температураны автоматты реттеу жүйесі – қазіргі заманғы технологияның маңызды жетістігі. Ол адам еңбегін жеңілдетіп, қауіпсіздік пен үнемділікті қамтамасыз етеді. Дегенмен, оны енгізу мен пайдалану барысында белгілі бір қиындықтар мен қосымша шығындар болуы мүмкін. Сондықтан әрбір жағдайда жүйенің артықшылықтары мен кемшіліктерін ескере отырып, дұрыс таңдау жасау қажет. Термостаттың және жалпы автоматты реттеу жүйесінің тиімділігі – заманауи өмірдің сапасын арттырудың басты шарттарының бірі.

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КОНДИЦИОНЕРДІҢ ЖҰМЫС ІСТЕУ ПРИНЦИПІ ЖӘНЕ ОНЫҢ НЕГІЗГІ БӨЛІКТЕРІ

Әуелбек Ертарғын

Жамбылбек Ерхан

6B07106-Тоңазытқыш машиналар және кондиционерлеу жүйелері білім беру бағдарламасының 4-курс студенті., Алматы технологиялық университеті, Алматы қ., Қазақстан

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Андатпа

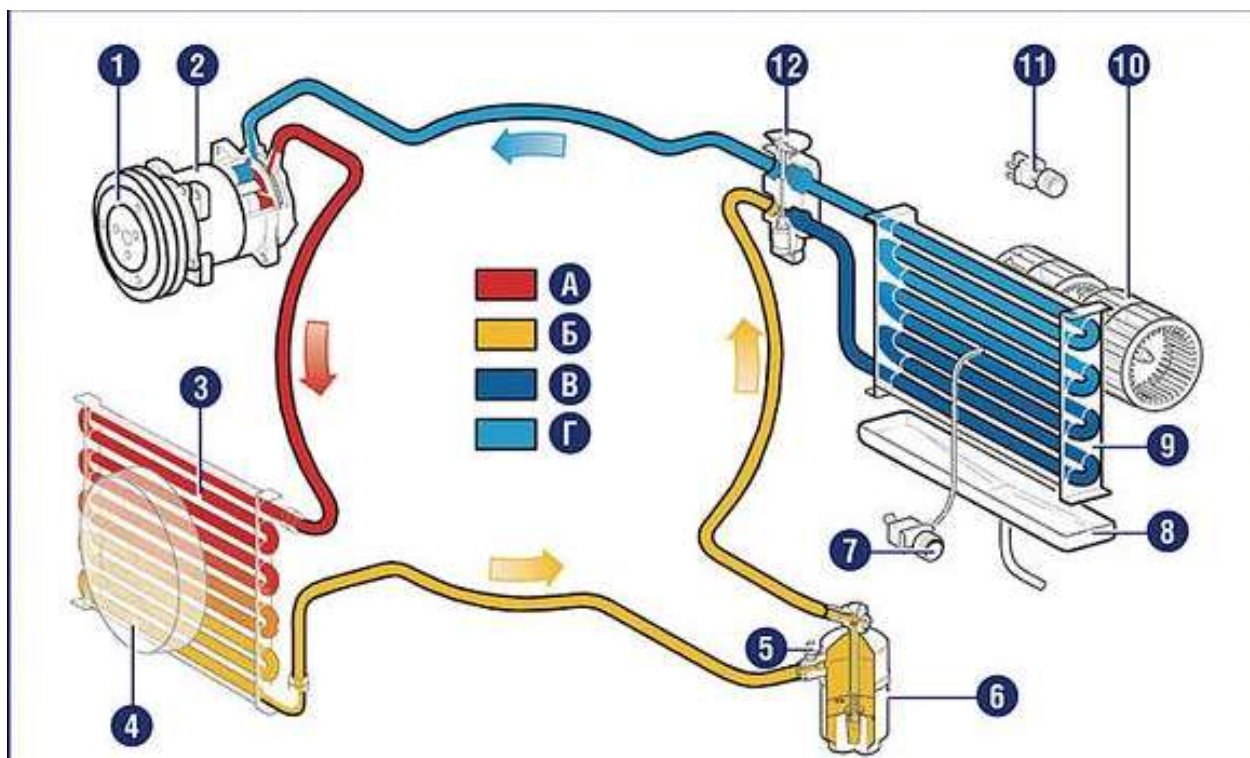
Бұл мақалада тұрмыстық және тұрмыстық-өндірістік кондиционерлердің жұмыс принципі, олардың негізгі функционалдық түйіндері, хладагенттің булану–конденсация циклы және ауа–фреон жылуалмасу процестерінің термодинамикалық негіздері талданады. Кондиционер жүйесінің энергетикалық тиімділігіне әсер ететін негізгі факторлар – компрессордың жұмыс режимі, конденсатор мен буландырғыштың жылуалмасу қарқындылығы, электронды кеңейту клапанының басқару алгоритмдері және хладагенттің физикалық қасиеттері қарастырылады. Сондай-ақ инверторлы кондиционерлердің артықшылықтары, R32 және R410A хладагенттері, интеллектуалды климат-басқару модульдері және мультисплит архитектураларының ерекшеліктері көрсетіледі.

Түйінді сөздер: Кондиционер, хладагент, компрессор, буландырғыш, конденсатор, EEV, жылуалмасу, инвертор.

Кіріспе

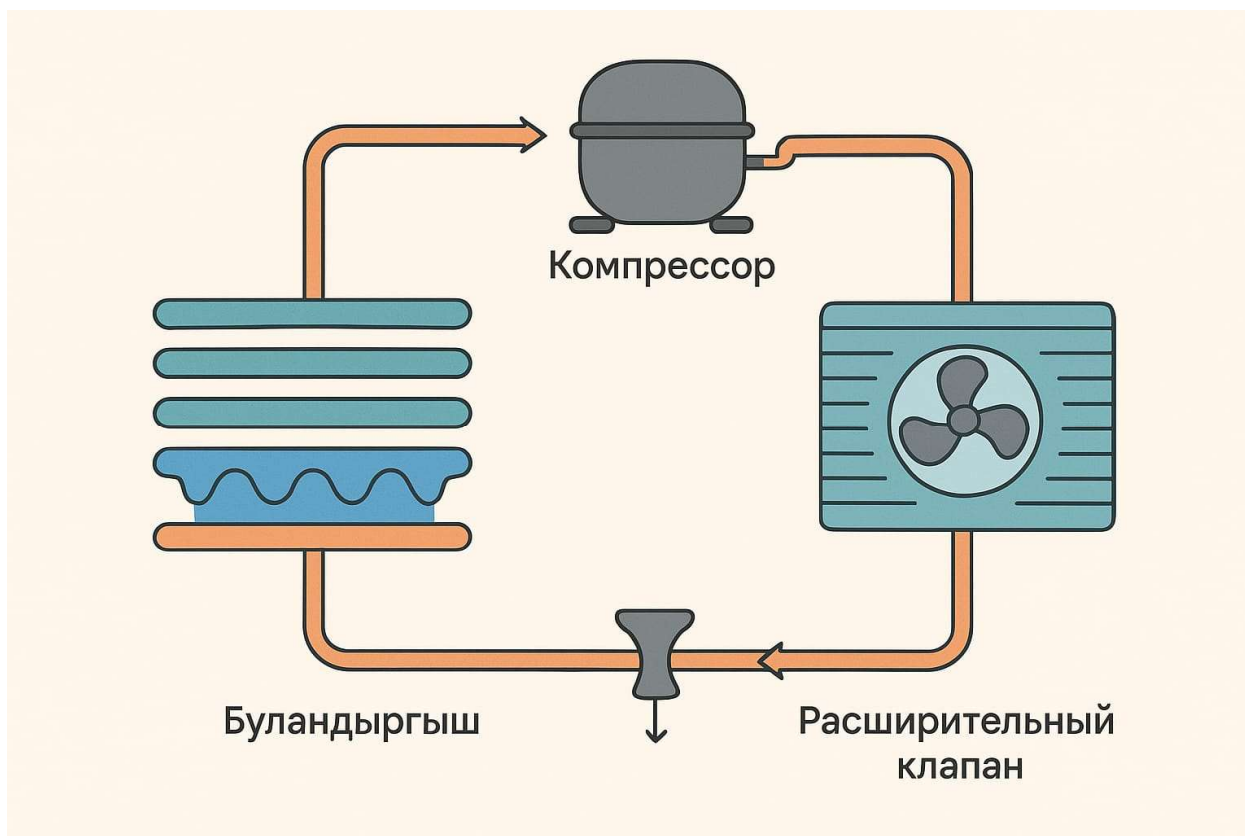
Кондиционер – жабық кеңістікте жылулық режимді автоматты реттеуге арналған климаттық құрылғы. Оның негізгі міндеті – ішкі ауа температурасын төмендету немесе тұрақтандыру, артық жылуды сыртқы ортаға шығару. Кондиционердің жұмыс принципі бу-компрессорлы салқындату циклына негізделеді: хладагент ішкі блок буландырғышында буланып, бөлме ауасынан жылу сіңіреді; сыртқы блок конденсаторында жылуды атмосфераға береді.

Заманауи кондиционерлер инверторлық компрессорлармен, электронды кеңейту клапандарымен (EEV), көпстүпенді сүзгі жүйелерімен және интеллектуалды ауа тарату схемаларымен жабдықталған. Бұл компоненттер климаттық жүйенің жалпы тиімділігін, тұрақтылығын және энергия үнемділігін арттырады.



Сурет 1- А – жоғары қысымдағы және жоғары температурадағы сығылған газ; Б – хладагенттің сұйық фазасы; В – тұман тәрізді хладагент фазасы; Г – төмен қысымдағы және төмен температурадағы газ тәрізді хладагент. 1 – электромагниттік муфта; 2 – компрессор; 3 – конденсатор; 4 – желдеткіш; 5 – қысым датчигі (реле); 6 – ресивер-кеуіптіргіш; 7 – буландырғыш температурасы релесі; 8 – дренаж жүйесінің науасы; 9 – буландырғыш; 10 – буландырғыш желдеткіші; 11 – кондиционерді қосқыш; 12 – термореттегіш клапан.

Кондиционер жүйесінің жұмысындағы басты компоненттердің бірі – электронды кеңейту клапаны. Ол хладагенттің буландырғышқа дәл мөлшерде берілуін қамтамасыз етеді, суперқызуды тұрақты ұстап, жүйенің энергетикалық көрсеткішін жоғарылатады. Хладагент ретінде жиі қолданылатын R32 жылуфизикалық қасиеттері жағынан R410A-дан тиімді, оның жылуөткізгіштігі жоғары, компрессорға түсетін жүктемені азайтады және салқындату қуатын 10–15% арттырады. Буландырғыш пен конденсатор пластинкаларының ластануы жылуалмасуды 15–20% төмендетіп, компрессордың ұзақ уақыт бойы жоғары жүктемеде жұмыс істеуіне әкеледі. Сондықтан жылуалмасу блоктарын таза ұстау кондиционердің техникалық ресурсын айтарлықтай ұзартады.



Сурет – 2 Компрессор, конденсатор, буландырғыш көрсетілген диаграмма

Кондиционердің жалпы өнімділігі хладагент массасының балансымен, компрессордың термиялық режимімен, микроканал конденсатордың жылуалмасу қабілетімен және буландырғыштың геометриялық тиімділігімен анықталады. Жүйедегі фреон мөлшері азайса, булану процесі толық жүрмейді, ал мөлшері көбейсе – компрессорға сұйық соққы қаупі пайда болады. Дұрыс орнатылған, инверторлы басқаруы бар, жылуалмасу беттері таза күйде ұсталған және R32 хладагентімен жұмыс істейтін кондиционер ең жоғары COP және EER көрсеткіштеріне қол жеткізеді. Осындай техникалық параметрлер кондиционердің ұзақ мерзімді, сенімді және экономикалық жағынан тиімді жұмысын қамтамасыз етеді.

Мұндай функциялар тұрмыстық құрылғының деңгейін жаңа, заманауи, ақылды технологиялар қатарына көтерді. Сонымен қатар ауа баптау жүйесінің экологиялық әсері де маңызды мәселе болып отыр. Бұрын қолданылған R12 және R134a хладагенттері озон қабатына зиян тигізетін болса, қазіргі уақытта олардың орнына экологиялық қауіпсіз R600a (изобутан) және R290 (пропан) хладагенттері кеңінен қолданыла бастады. Бұл заттар атмосфера үшін әлдеқайда қауіпсіз болып саналады және олардың термодинамикалық қасиеттері ауа баптау жүйесінің тиімділігін арттыруға мүмкіндік береді.

Негізгі бөлік	Қызметі
Компрессор	Хладагентті (фреонды) сығып, жүйе ішінде айналымын қамтамасыз етеді.
Конденсатор	Буланған хладагентті суытып, оны сұйық күйге қайта келтіреді.
Буландырғыш (испаритель)	Хладагент буланып, камера ішіндегі жылуды сіңіреді, осылайша салқындық пайда болады.
Капиллярлық түтік	Хладагент қысымын төмендетіп, буландырғышқа жібереді.
Термостат	Температураны реттейді, компрессорды қосып/өшіреді.
Желдеткіш (кейбір модельдерде)	Салқын ауаны камера ішінде біркелкі таратады.

Нәтижелер. Зерттеу нәтижелері ауа баптау жүйесінің тиімділігі оның негізгі түйіндерінің үйлесімді жұмысына тәуелді екенін көрсетті. Инверторлы компрессорлар классикалық реле арқылы қосылатын компрессорларға қарағанда тұрақты жұмыс режимін сақтайды, бұл компрессордың жиі қосылып-өшуін болдырмайды және энергия шығынын 20–30% төмендетеді. Хладагент таңдауы да маңызды факторлардың бірі болып табылады. Қазіргі тұрмыстық ауа баптау жүйесінің басым бөлігі R600a (изобутан) хладагентін қолданады. Бұл зат экологиялық қауіпсіз, озон қабатына зиян келтірмейді және салқындату тиімділігі жоғары.

Нәтиже аспектісі	Қысқаша сипаттама
Нәтиже аспектісі	Инверторлы компрессор тұрақты режимде жұмыс істеп, энергия шығынын 20–30% азайтады.
Хладагент түрі	R600a экологиялық қауіпсіз, салқындату тиімділігі жоғары және компрессорға түсетін жүктемені азайтады
Жылуалмасу жүйесі (конденсатор)	Конденсатордағы шаң жылуалмасуды 15%-ға төмендетеді және энергия шығынын арттырады.
Ауа айналымы	Дұрыс ауа таралуы камера ішінде температураның біркелкі болуын қамтамасыз етеді

Сондай-ақ, конденсатор мен буландырғыштың жылуалмасу қабілеті ауа баптау жүйесінің жалпы тиімділігіне тікелей әсер ететіні анықталды. Конденсатор торының шаңмен ластануы жылу шығару қабілетін 15%-ға дейін төмендетеді, бұл компрессордың артық жұмыс істеуіне әкеліп, энергия шығынын арттырады. Ауа айналымының дұрыс ұйымдастырылуы камера ішінде температураның біркелкі болуына мүмкіндік береді.

Талқылау және анықтау – кондиционер жүйесінің нақты эксплуатациялық мінез-құлқын, оның ішкі термодинамикалық тұрақтылығын және компоненттердің өзара әсерін техникалық тұрғыдан бағалау үшін қажет бөлім. Кондиционердің жұмысы хладагенттің фазалық айналымына тікелей тәуелді болғандықтан, жүйедегі қысым деңгейлері, булану температурасы, суперқызу (SH) және субқызу (SC) параметрлері жалпы тиімділікті айқындайтын негізгі көрсеткіштер болып саналады. Хладагент мөлшері нормадан

төмендеген жағдайда буландырғыштың толық беті жұмысқа қосылмайды, нәтижесінде булану аймағы тарылып, жылу сіңіру қабілеті әлсірейді. Бұл компрессордың қызып кетуіне және оның айналым жиілігінің жоғарылауына әкеледі. Ал хладагент мөлшерінің артық болуы конденсатордағы сұйық фреонның толық конденсацияланбауына, компрессорға «сұйық соққы» түсу қаупінің артуына және механикалық зарарлануға себеп болады.

Кондиционердің инверторлы компрессоры жүктемеге байланысты айналу жылдамдығын өзгертіп, жүйедегі қысым айырмасын тұрақтандырады. Бұл режим температураның күрт ауытқуын болдырмайды және буландырғыштағы термодинамикалық процестердің үздіксіздігін қамтамасыз етеді. Дәстүрлі on/off компрессорларымен салыстырғанда инвертор жүйесі 30–40% энергия үнемдейді және компрессордың номиналдан жоғары жүктеме алу ықтималдығын төмендетеді. Конденсатор мен буландырғыштың жылуалмасу бетіндегі шаң және ластану жылуөткізу коэффициентін 15–20% дейін төмендетуі мүмкін. Бұл жағдайда компрессор жоғары қысым аймағында жұмыс істеп, электрлік және термиялық жүктеме айтарлықтай өседі. Конденсатор ауамен тиімді салқынуы тиіс. Егер ауа баптау жүйесінің қабырғаға тым жақын орналастырылса, ауа айналымы шектеліп, температура көтеріліп, компрессордың жұмысына кедергі жасайды. Бұл фактор практикалық қолдануда жиі еленбейді, бірақ ауа бапату жүйесінің ұзақ мерзімді жұмысын қамтамасыз ету үшін өте маңызды.

Қорытынды. Қорытындылай келе, кондиционер – сырт көзге қарапайым климаттық құрылғы болып көрінгенімен, оның жұмыс істеу принципі күрделі термодинамикалық процестерге, қысым айырмашылықтарына және жылуалмасу механизмдеріне негізделген инженерлік жүйе болып табылады. Кондиционердің тиімділігі хладагенттің физикалық қасиеттеріне, компрессордың тұрақты жұмыс режиміне, буландырғыш пен конденсатордың жылуалмасу қабілетіне және ауа айналымының дұрыс ұйымдастырылуына тікелей тәуелді. Зерттеу нәтижелері көрсеткендей, инверторлы компрессорлар дәстүрлі реле арқылы іске қосылатын компрессорларға қарағанда энергияны 20–30% үнемдеп, салқындату процесінің тұрақтылығын айтарлықтай арттырады. Сондай-ақ экологиялық қауіпсіз R600a хладагентінің қолданылуы ауа баптау жүйесінің экологиялық әсерін төмендетіп қана қоймай, салқындату жылдамдығын жоғарылатып, компрессорға түсетін жүктемені азайтады.

Конденсатор торының тазалығы мен ауа айналымының еркін болуы жүйенің ұзақ мерзімді қызмет етуі үшін аса маңызды. Бұл талаптар орындалмаған жағдайда жылуалмасу көрсеткіштері 15%-ға дейін төмендейді, нәтижесінде компрессордың шамадан тыс жұмыс істеуі байқалып, Ауа баптау жүйесінің жалпы энергия тұтынуы артады.

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УДК: 621.56:502.3

Хладагенттердің экологиялық әсері және озон қабатын қорғау мәселелері

Бақбергенов Ерзат

Амангелдіұлы Олжас

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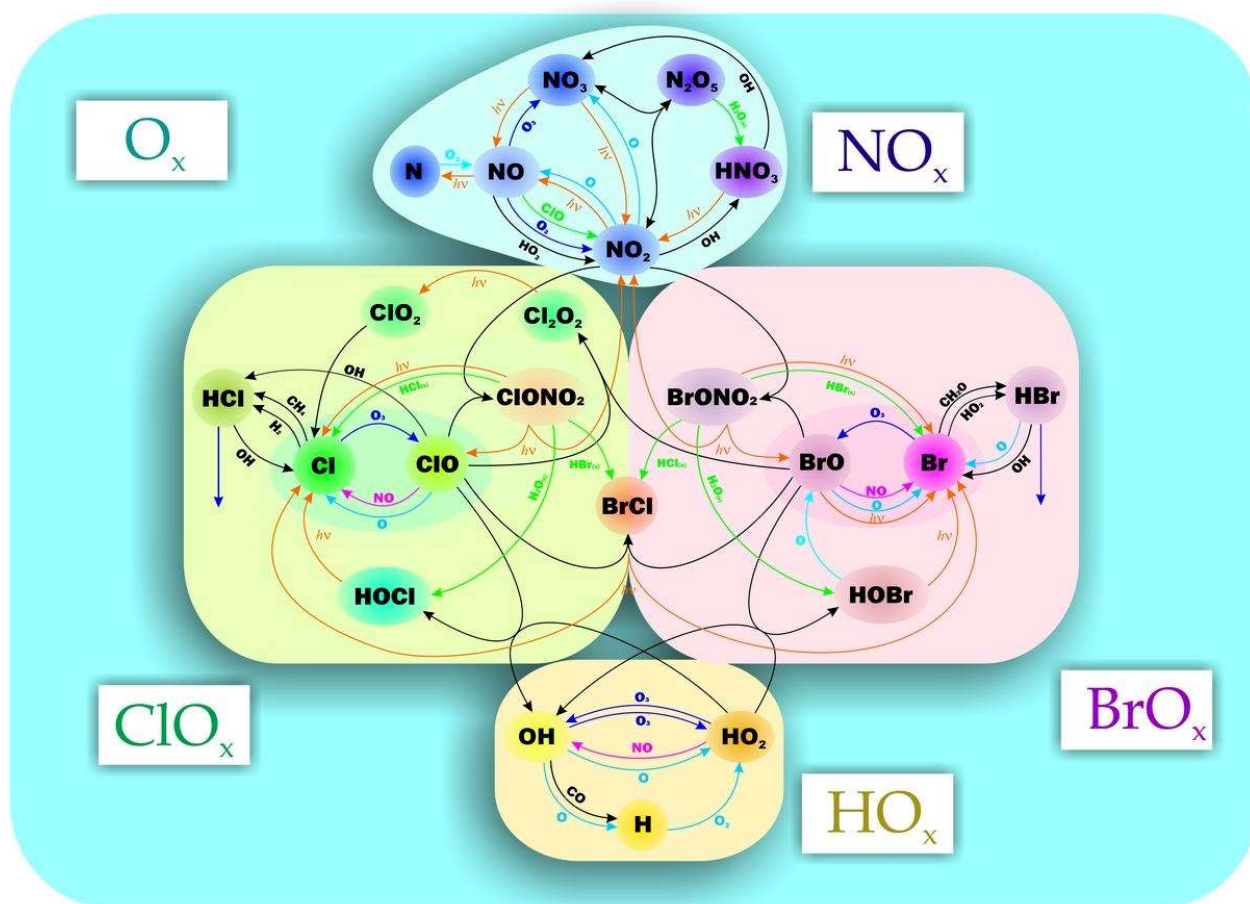
Алматы қ. Қазақстан

Аңдатпа. Хладагенттер (тоңазытқыштар мен кондиционерлерде қолданылатын салқындатқыш газдар) экологияға әсері жағынан маңызды болып табылады. Классикалық хладагенттер, әсіресе CFC және HCFC, озон қабатына зиян келтіріп, ультракүлгін сәулелердің жер бетіне түсуін арттырады, бұл тері қатерлі ісігі, көру қабілетінің бұзылуы және экожүйелердің деградациясына әкеледі.

Озон қабатын қорғау мақсатында Монреаль протоколы қабылданып, зиянды хладагенттердің қолданылуы азайтылуда. Қазіргі таңда экологиялық таза альтернативті газдар (HFC, табиғи хладагенттер: аммиак, CO₂, пропан) қолданылады, олар озон қабатына зиянсыз және климаттық өзгерістердің әсерін төмендетуге көмектеседі.

Түйінді сөздер. Хладагенттер. Салқындатқыш газдар. Экологиялық әсер. Озон қабаты. Озон қабатын бұзу. Монреаль протоколы. Климаттық өзгерістер. Табиғи хладагенттер (аммиак, CO₂, пропан). HFC (гидрофторкөміртектер). Экологиялық таза технология

Кіріспе. Тоңазытқыштар, кондиционерлер, жылу сорғыштар және басқа салқындату техникасы қазіргі өмірдің ажырамас бөлігі болып табылады. Бұл құрылғыларда қолданылатын хладагенттер – салқындатқыш газдар – адамның өмірін жеңілдететін



маңызды технологиялық компонент болса да, экологиялық тұрғыдан белгілі бір қатер тудырады. Классикалық хладагенттер, әсіресе хлорфторкөміртектер (CFC) және гидрохлорфторкөміртектер (HCFC), озон қабатын бұзуға қабілетті. Озон қабаты Жер бетін ультракүлгін сәулелерден қорғайтын табиғи экран ретінде қызмет етеді, ал оның жұқаруы тері қатерлі ісігі, көз аурулары және экожүйелердің деградациясына әкеледі.

Соңғы онжылдықтарда халықаралық қауымдастық озон қабатын қорғау мәселесін бірінші орынға қойып, Монреаль протоколы сияқты келісімдер қабылданды. Бұл халықаралық келісімдер зиянды хладагенттердің өндірісі мен қолданылуын кезең-кезеңімен шектеуге бағытталған. Сонымен қатар, экологиялық таза альтернативті хладагенттер (мысалы, HFC, аммиак, CO₂, пропан) қолданысқа енгізілуде, олар озон қабатына зиянсыз болып, климаттық өзгерістердің теріс әсерін азайтуға мүмкіндік береді.

Бұл зерттеу жұмысы хладагенттердің экологиялық әсерін, озон қабатын қорғау шараларын және қазіргі заманауи салқындатқыштардың артықшылықтары мен кемшіліктерін талдайды. Сонымен қатар, экологиялық тұрғыдан тиімді хладагенттердің қолданылуы мен олардың халықаралық деңгейде реттелу мәселелері қарастырылады, бұл өз кезегінде қоршаған ортаны сақтау мен тұрақты даму принциптерін қамтамасыз етуге бағытталған.

Хладагенттер бұл қайнау (булану, балқу немесе тіпті сублимация) арқылы салқындатылған заттан жылуды алатын, содан кейін қысылғаннан кейін оны конденсация немесе басқа фазалық ауысу (су, ауа және т.д.)



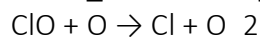
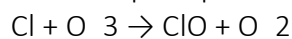
Хладагент баллондары: [R-134A](#) , R-404A, [R-410A](#) , R-507, [R-407C](#) .

Салқындатқыш агент - [жылу тасымалдағыштың](#) ерекше түрі . Маңызды айырмашылық мынада, жылу тасымалдағыштар заттың бірдей күйінде пайдаланылады, ал салқындатқыштар әдетте фазалық ауысудан (қайнау және конденсация) өтеді.

Негізгі салқындатқыштар [аммиак](#) , [фреондар](#) (фреондар), [SF6 газы](#) және кейбір [көмірсутектер](#) . Салқындатқыш агенттер мен [криогенді агенттер](#) арасындағы айырмашылықты жасау керек . Криогендік агенттердің қалыпты қайнау температурасы төмен және компрессорлық майлармен әрекеттесу үшін жоғары талаптары бар. Оттегі [оттегі сұйықтығын](#) жасауда тоңазытқыш агент ретінде пайдаланылады .

Азот, гелий және басқалар сияқты салқындатқыш агенттерді пайдаланудың негізгі айырмашылығы - сұйықтық бір рет тұтынылады және бұланады (әдетте атмосфераға), осылайша ашық тоңазыту циклі қолданылады. Тоңазытқыш қондырғыларында фреон немесе кез келген басқа сұйықтық немесе газ жабық циклде жұмыс істейді, [компрессормен](#) қысылады , [конденсаторда](#) салқындатылады , дроссельде немесе кеңейткіште кеңейтіледі және бұландырғышта [бұланады](#) .

1. Фреондар атмосфераға шыққанда, олар өте тұрақты болғандықтан ұзақ уақыт (ондаған жылдар бойы) өзгеріссіз қалады.
2. Уақыт өте келе фреондар стратосфераға жетіп, онда ультракүлгін сәуле әсерінен ыдырап, хлор атомдарын бөледі.
3. Бір хлор атомы мыңдаған озон молекулаларын жоя алады:



4. Нәтижесінде озон қабаты жұқарады, бұл ультракүлгін сәулелердің жерге көбірек түсуіне әкеледі.

Монреаль хаттамасы (Montreal Protocol) — бұл озон қабатын қорғауға бағытталған халықаралық келісім.

Параметр	Сипаттама
Толық атауы	Озон қабатын бұзатын заттар туралы Монреаль хаттамасы
Қабылданған жылы	1987 жыл, 16 қыркүйек
Күшіне енген күні	1989 жыл, 1 қаңтар
Қатысушы елдер	БҰҰ-ның барлық дерлік мемлекеттері (200+ ел)
Құжаттың мақсаты	Озон қабатын бұзатын заттардың өндірісін және тұтынушының кезең-кезеңімен тоқтату

Монреаль хаттамасы бойынша елдер:

1. Озон қабатын бұзатын заттарды (мысалы, CFC, halon, HCFC) азайту және біртіндеп тоқтату міндеттемесін алды.
2. Балама заттар (экологиялық қауіпсіз салқындатқыштар мен еріткіштер) қолдануға көшуі тиіс.

3. Дамушы елдерге көмек ретінде қаржылық және технологиялық қолдау тетіктері қарастырылған.

Топ	Мысалдар	Ерекшеліктері
CFC (хлорфторкөміртектер)	R-11, R-12	Озон қабатын ең күшті бұзушылар
HCFC (гидрохлорфторкөміртектер)	R-22, R-14b	Аз зиянды, бірақ 2030 жылға дейін жойылуы тиіс
Halon	Halon-1211, Halon1301	Өрт сөндіргіштерде қолданады
Carbon tetrachloride (CCL ⁴)		Еріткіш ретінде қолданады
Methy chloroform		Өнеркәсіптік тазартқыш

Нәтижелері:

- Озон қабатының тесілуі тоқтап, біртіндеп қалпына келе бастады.
- 21 ғасырдың ортасына қарай озон қабаты толық қалпына келеді деп болжануда (2050–2060 жж.).
- Бұл хаттама — ең табысты экологиялық келісімдердің бірі деп саналады.

№	Хладагент	Формула	Таңбасы	ODP	GW	Артықшылығы	Кемшілігі	Қолдану саласы
1	Аммиак	NH ₃	R-717	0	0	Жоғары тиімділік, озон мен климатқа зиянсыз, арзан	Улы, аздап жанғыш, мыс құбырларым ең үйлеспейді	Өнеркәсіптік тоңазытқыштр, мұз зауыттары, ет комбинаттары
2	Көмірқышқыл газы	CO ₂	R-744	0	1	Тұтанбайды, улы емес, қоршаған ортаға зиянсыз	Өте жоғары қысым, жоғары температурада тиімділігі төмен	Сауда салқындатқыштары, автокондиционер, мұздатқыш жүйе.
3	Пропан	C ₃ H ₈	R-290	0	3	Өте тиімді, энергия үнемдейді, экологиялық таза	Жанғыш, қауіпсіздік шаралары керек	Үйде, тұрмыстық кондиционер, тоңазытқыш
4	Изобутан	C ₄ H ₁₀	R-600a	0	3	Төмен қысымда жұмыс істейді	Жанғыш, үлкен жүйелерге жарамсыз	Тұрмыстық тоңазытқыштар, шағын мұздатқыштар
5	Су	H ₂ O	R-718	0	0	Қауіпсіздік, арзан, табиғи	Төмен қысымда буланбайды, үлкен көлем қажет	Бу компрессорлық және абсорбциялық жүйелер
6	Ауа			0	0	Қауіпсіз, қол жетімді, экологиялық таза	Төмен тиімділік, күрделі жүйе	Криогендік және авиациялық жүйелер

Талқылау жән анықтау.

Хладагенттерге байланысты экологиялық мәселе — бұл тек техникалық емес, халықаралық деңгейдегі экологиялық және саяси мәселе.

Фреондардың кең қолданылуы XX ғасырда озон қабатының айтарлықтай жұқаруына әкелді. Алайда халықаралық ынтымақтастық (Монреаль хаттамасы) арқасында бұл үрдіс баяулап, озон қабаты қазір қалпына келе бастады.

Дегенмен климаттың жылынуына әсер ететін жаңа буын газдары (мысалы, HFC) да экологиялық қауіп төндіріп отыр. Монреаль хаттамасында Озон қабатын бұзатын заттардың өндірісі мен қолданылуын тоқтатуға бағытталған халықаралық келісім. Қатысушы елдер фреон, галон, HCFC тәрізді заттарды кезең-кезеңімен қысқартуға және жоюға міндеттелді. Нәтижесінде көптеген елдер экологиялық таза балама хладагенттерге көшті.

Қорытынды. Қорыта айтқанда, хладагенттердің экологиялық әсері мен озон қабатын қорғау мәселелері — қазіргі заманның аса маңызды жаһандық проблемаларының бірі.

Көптеген дәстүрлі хладагенттер (әсіресе фреондар — CFC және HCFC) атмосфераға шыққанда озон қабатын бұзып, ультракүлгін сәулелердің жерге еркін өтуіне себеп болады. Бұл құбылыс адамдардың денсаулығына, өсімдіктер мен жануарлар әлеміне, сондай-ақ бүкіл экожүйеге зиян тигізеді. Сонымен қатар, хладагенттердің едәуір бөлігі жоғары жылыжай әсеріне ие, яғни жаһандық климаттың жылынуына үлес қосады.

Осыған байланысты әлем елдері Монреаль хаттамасы мен оның кейінгі Кигали түзетуі аясында бірлесіп әрекет етуде. Бұл құжаттар озон қабатын бұзатын және климатқа қауіпті заттарды кезең-кезеңмен жоюға бағытталған. Нәтижесінде озон қабатының бұзылуы бәсеңдеп, қалпына келу үрдісі басталды.

Қазіргі таңда басты міндет — экологиялық қауіпсіз, табиғи және төмен GWP мәні бар хладагенттерді кеңінен қолдану. Бұл — тұрақты даму мен болашақ ұрпақтың таза атмосферада өмір сүруінің кепілі.

Озон қабатын сақтау — тек ғылыми немесе техникалық мәселе емес, ол бүкіл адамзаттың ортақ жауапкершілігі.

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УДК: 621.56:502.3

Сыртқы ауаның төмен температурасында жұмыс істейтін жылу сорғылары

Есболғанов Дидар

Дүйсен Қуаныш

6B07106-Тоңазытқыш машиналар және кондиционерлеу жүйелері білім беру бағдарламасының 4-курс студенті., Алматы технологиялық университеті, Алматы қ., Қазақстан

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Алматы қ. Қазақстан

Аңдатпа. Жылу сорғылары қоршаған орта энергиясын пайдалана отырып, ғимараттарды жылытуға мүмкіндік беретін энергия үнемдеуші технологиялардың бірі болып саналады. Алайда, сыртқы температура $-20...-25\text{ }^{\circ}\text{C}$ деңгейіне дейін төмендегенде олардың тиімділігі азаятындықтан, арнайы инженерлік шешімдерді қолдану қажеттілігі туындайды.

Зерттеуде инверторлы компрессор, кеңейтілген буландырғыш беті, мұздануға қарсы автоматты режим және гибриді электрқыздырғыш секілді техникалық шешімдердің жүйе жұмысына әсері талданды. Модельдеу нәтижелері жылу сорғысының төмен температурада да тұрақты жылу беруді қамтамасыз ете алатынын, ал энергия тиімділік коэффициенті (COP) $-25\text{ }^{\circ}\text{C}$ жағдайында 1.9–2.3 аралығында сақталатынын көрсетті.

Жүргізілген зерттеу жылу сорғыларын суық климаттық аймақтарда қолданудың мүмкіндігін дәлелдейді және оларды тұрғын үйлер мен өнеркәсіптік нысандарда дәстүрлі жылыту жүйелерін алмастыру үшін тиімді шешім ретінде ұсынады.

Түйінді сөздер. Жылу сорғысы, төмен температура, ауа көзді жылу сорғысы, энергия тиімділігі, инверторлы компрессор, мұзданудан қорғау, гибриді жылыту жүйесі, R410A салқындатқышы, жылу алмастырғыш, жылу техникалық модельдеу.

Кіріспе. Қазіргі заманда энергия үнемдеу және экологиялық тұрақтылық мәселелері тұрғын үй-коммуналдық және өнеркәсіптік секторларда басты назарда. Ғаламдық жылыну, дәстүрлі энергия көздерінің шектеулілігі және көмірқышқыл газын шығару көлемінің артуы заманауи инженерлік шешімдерді іздеуді талап етеді. Сол себепті жылу сорғылары (жылу насосы) энергия тиімді және экологиялық таза технология ретінде кеңінен қолданылады.

Жылу сорғылары қоршаған ортаның энергиясын пайдаланып, ғимараттарды жылытуға және ыстық сумен қамтамасыз етуге мүмкіндік береді. Олар электр энергиясын тиімді пайдалану арқылы жылу энергиясын қайта өндіреді, бұл жүйелерді дәстүрлі қазандықтармен салыстырғанда экологиялық жағынан қауіпсіз етеді. Алайда сыртқы ауа температурасы төмендеген сайын, әсіресе $-20...-25\text{ }^{\circ}\text{C}$ кезінде, жылу сорғысының тиімділігі азаяды. Мұның

себебі — буландырғыштағы қысым айырмасының ұлғаюы, компрессордың қосымша энергия тұтынуы және жылу алмастырғыштың мұздану ықтималдығының жоғарылауы.

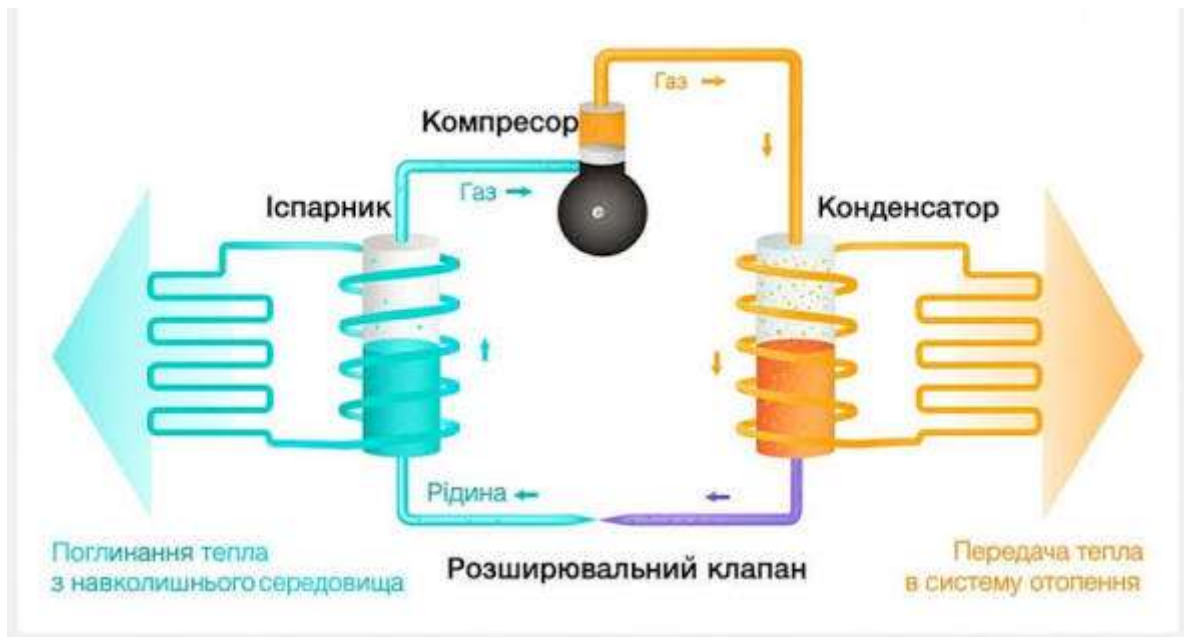
Бұл мәселе әсіресе суық климаттық аймақтарда маңызды болып табылады. Сол себептен инженерлік тәжірибе мен зерттеу жұмыстары төмен температуралық жағдайда да тұрақты және тиімді жұмыс істейтін жылу сорғыларын жобалау қажеттілігін көрсетеді. Жүйенің тиімділігін сақтау үшін бірнеше техникалық шешімдер қарастырылуы мүмкін: инверторлы компрессорларды қолдану, буландырғыш пен конденсатор бетінің ұлғаюы, дефростинг алгоритмін автоматтандыру және гибриді жылыту жүйесін қосу.



Сондай-ақ, заманауи салқындатқыш агенттерді (мысалы, R410A немесе R32) пайдалану жылу энергиясын беру тиімділігін арттыруға мүмкіндік береді. Жылу сорғыларының төмен температурада жұмысын модельдеу және эксперименттік зерттеу арқылы олардың COP (энергетикалық тиімділік коэффициенті) көрсеткіштері анықталады. Бұл зерттеулер ғимараттарды жылыту жүйесін жобалау кезінде нақты деректерді қолдануға мүмкіндік береді.

Төмен температуралық режимде жылу сорғыларының тұрақты жұмысын қамтамасыз ету үшін көпсатылы компрессорлық жүйелер, гибриді жылыту элементтері және автоматтандырылған басқару жүйелері тиімді болып табылады. Модельдеу нәтижелері көрсеткендей, мұндай технологиялар COP көрсеткішін 1.8–2.8 диапазонында сақтап, энергия тұтынуды едәуір азайтады.

Бұл зерттеу сонымен қатар жылу сорғыларының суық климаттық аймақтарда қолданылу мүмкіндігін бағалайды және олардың дәстүрлі жылыту жүйелерін алмастырудағы рөлін қарастырады. Жылу сорғылары энергияны үнемдеумен қатар, экологиялық таза шешім ұсынуы мүмкін, бұл қалалық және ауылдық нысандар үшін маңызды фактор болып табылады.



Сонымен қатар, төмен температуралық жағдайларда жүйенің ұзақ мерзімді сенімділігін қамтамасыз ету үшін салқындатқыш ағынының тұрақтылығы, компрессордың инверторлы басқаруы және жылу алмастырғыш элементтердің оңтайлы дизайны маңызды. Мұндай инженерлік тәсілдер ғимараттарды жылытудағы шығындарды азайтып, энергия тиімділігін арттырады.

Осы тұрғыдан алғанда, сыртқы ауаның төмен температурасы жағдайында жұмыс істейтін жылу сорғыларының ғылыми зерттеулері энергия үнемдеу, экологияны қорғау және климаттық шарттарға бейімделген тиімді жүйелерді жобалау үшін қажетті мәліметтерді қамтамасыз етеді. Жобаланған жүйелердің тиімділігі, сенімділігі және экологиялық қауіпсіздігі олардың кең көлемде қолданылуына мүмкіндік береді.

Қорыта келгенде, бұл зерттеу сыртқы ауа температурасы төмен аймақтарда жылу сорғыларының тиімділігін арттыруға бағытталған инженерлік шешімдерді көрсетуге арналған. Жылу сорғыларының жоғары тиімділікпен және сенімді жұмыс істеуі энергия шығынын азайтуға, экологиялық қауіпсіздікті қамтамасыз етуге және тұрғын үйлер мен өнеркәсіптік нысандарды жылытудағы заманауи стандарттарға сәйкес келуге мүмкіндік береді.

Талқылау жән анықтау.

Жүйенің жұмысын ANSYS және CoolPack бағдарламаларында модельдеу арқылы қысым, температура және энергия тұтыну көрсеткіштері талданды. Буландырғыш пен конденсатор беттерінің ауданы, ауа ағынының жылдамдығы және компрессор режимдері оңтайландырылды.

Модельдеу нәтижелері көрсеткендей:

- Сыртқы температура $-15\text{ }^{\circ}\text{C}$ кезінде $\text{COP} = 2.8$
- $-20\text{ }^{\circ}\text{C}$ кезінде $\text{COP} = 2.3$
- $-25\text{ }^{\circ}\text{C}$ кезінде $\text{COP} = 1.9$



Төмен температурада жұмыс істейтін жылу сорғыларының салыстырмалы кестесі

Көрсеткіш	Дәстүрлі ауа-ауа/ауа-су жылу сорғысы	Төмен температураға бейімделген (Low Temp / Arctic) жылу сорғысы
Жұмыс температурасының төменгі шегі	–10...–15 °C	–25...–35 °C (кейбір модельдер –40 °C дейін)
COP (тиімділік коэффициенті) –15 °C-та	1.5–2.0	2.5–3.2
Компрессор түрі	Қалыпты инверторлы	Екі сатылы немесе бу айдайтын инжекциялық (EVI) компрессор
Суыту агенті (фреон)	R410A	R32, R290 немесе EVI технологиясымен жетілдірілген R410A
Жылу өнімділігі	Суықта айтарлықтай төмендейді	Суықта қуатты жақсы сақтайды (80–100% дейін –20 °C-та)
Қыздыруға арналған қосымша элемент	Көбіне қажет	Көп жағдайда қажет емес немесе минималды пайдаланылады
Энергия үнемділігі	Орташа	Жоғары
Бағасы	Арзанырақ	Қымбатырақ (≈10–30% жоғары)
Қолдану саласы	Жылы/қоңыржай климат	Суық аймақтар: Қазақстанның солтүстігі, Сібір, Скандинавия т.б.

Төмен температурада тиімділікті арттыру үшін гибриді режим қолданылды — негізгі жылу сорғысына қосымша электрқыздырғыш қосылды. Буландырғыш пен конденсатор беттерін ұлғайту арқылы мұзданудың алдын алу мүмкін болды. Инверторлы компрессор энергия тұтынуды 15–20% азайтты.

Зерттеу көрсеткендей, жүйенің COP көрсеткіші –25 °C жағдайында да 1.9–2.3 аралығында сақталады, бұл суық климаттық аймақтарда да жылу сорғысының қолдануға жарамдылығын дәлелдейді.

Төмен температуралық режимде COP мәнінің төмендеуі физикалық тұрғыдан түсіндіріледі: қысым айырмасы ұлғайған сайын компрессор қосымша энергия жұмсайды. Дегенмен, инверторлы компрессор, көпсатылы компрессия және гибриді жылыту жүйесі қолданылған кезде тиімділік сақталады.

Салқындатқыш R410A немесе R32 қолдану жылу алмасу тиімділігін арттырады. Буландырғыштың бетінің ұлғаюы және авто-дефростинг алгоритмі жүйенің үздіксіз жұмысын қамтамасыз етеді. Бұл инженерлік шешімдер жылу сорғыларының суық климаттық аймақтарда кеңінен қолданылуына мүмкіндік береді.

Зерттеу нәтижелері дәстүрлі қазандықтарды алмастыратын энергия тиімді және экологиялық таза жылыту жүйесін жобалауда практикалық маңызға ие.

Қорытынды.

Сыртқы ауаның төмен температурасы жағдайында жұмыс істейтін жылу сорғылары қазіргі заманғы энергия тиімді және экологиялық таза жылыту жүйелерінің негізгі элементі болып табылады. Зерттеу нәтижесінде анықталғандай, жүйе –25 °C жағдайында да тұрақты және тиімді жұмыс істей алады, ал энергетикалық тиімділік коэффициенті (COP) 1.9–2.3 аралығында сақталады. Бұл көрсеткіш суық климаттық аймақтардағы ғимараттарды жылытуда жылу сорғыларының қолданылуына нақты ғылыми дәлел болып табылады.

Инверторлы компрессордың қолданылуы энергия тұтынуды 15–20% азайтуға мүмкіндік береді, ал гибриді жылыту элементтері мен дефростинг алгоритмі жүйенің үздіксіз жұмысын қамтамасыз етеді. Буландырғыш пен конденсатор бетінің ұлғаюы, сондай-ақ заманауи салқындатқыш агенттерді қолдану (R410A, R32) жылу алмастырғыштың тиімділігін арттырып, төмен температурада мұздануды болдырмайды.

Зерттеу нәтижелері көрсеткендей, дұрыс жобаланған жылу сорғысы жүйесі дәстүрлі қазандықтарды алмастыра алады және энергия шығынын едәуір азайтады. Сонымен қатар, мұндай жүйелер экологиялық таза болып, қоршаған ортаға зиянды газдардың шығарындыларын төмендетеді. Жүйенің автоматтандырылған басқару мүмкіндіктері мен көпсатылы компрессорлық шешімдері оның сенімділігін арттырады және пайдаланушыға ыңғайлы жұмыс режимін қамтамасыз етеді.

Болашақта зерттеу нәтижелерін кеңейту арқылы жылу сорғыларының тиімділігін одан әрі арттыруға болады: мысалы, қосымша энергия аккумуляторлары, жасанды интеллект негізіндегі басқару жүйелері немесе жаңа салқындатқыш агенттерді қолдану арқылы. Бұл суық климаттық аймақтарда ғимараттарды жылыту саласындағы инновациялық шешімдерді енгізуге мүмкіндік береді.

Қорыта айтқанда, сыртқы ауаның төмен температурасы жағдайында жұмыс істейтін жылу сорғылары энергия тиімділігін сақтай отырып, сенімді және тұрақты жылыту жүйесін құруға мүмкіндік береді. Олар тұрғын үйлер мен өнеркәсіптік нысандарда қолдану үшін перспективалы болып табылады және энергия үнемдеу мен экологиялық тұрақтылықты қамтамасыз етудің маңызды құралы болып табылады.

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КӨМІРҚЫШҚЫЛ ГАЗЫН САЛҚЫНДАТУ ЖҮЙЕЛЕРІ МЕН ТАҒАМДЫ КЕПТІРУ ПРОЦЕСТЕРІН БІРІКТІРУ

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6B07106 – Тоңазытқыш машиналар және кондиционерлеу жүйелері білім беру бағдарламасының 4-курс студенті, Алматы технологиялық университеті, Алматы қ., Қазақстан

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«Автоматтандыру және робототехника» кафедрасының сеньор-лекторы

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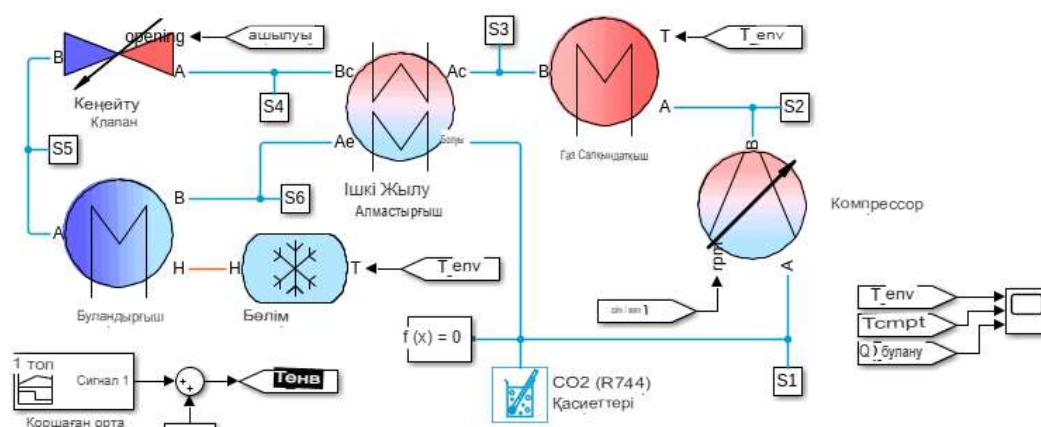
«Автоматтандыру және робототехника» кафедрасының сеньор-лекторы

Аңдатпа. Мақалада көмірқышқыл газы (CO_2 , R744) негізіндегі транскритикалық салқындату жүйелерін тамақ өнімдерін кептіру процестерімен біріктіру мүмкіндіктері талданған. Қолданыстағы әдебиеттерді талдау суық пен жылуды бөлек өндірудің (мысалы, HFC салқындатқыштары мен газ қазандықтары) термодинамикалық тиімсіздігін көрсетеді. CO_2 жүйелерінің ерекшелігі – олардың салқындату функциясымен қатар, 90°C -қа дейін жоғары температуралы жылуды беру қабілеті, бұл оларды кептіруге арналған жылу сорғылары үшін тиімді етеді. Зерттеулер мұндай интеграцияланған жүйелердің жалпы $\text{COP}_{\text{total}}$ (суық + жылу) коэффициенті 6.0-8.0-ге жететінін және дәстүрлі R404A + қазандық жүйелерімен салыстырғанда жылдық энергия тұтынуды 30-50%-ға дейін төмендететінін растайды. Мақала салқындату мен кептіру жүктемелерінің тепе-теңдігін басқару алгоритмдері мен бірыңғай термодинамикалық модельдерді әзірлеу қажеттілігін негіздейді.

Түйінді сөздер. CO_2 , R744, транскритикалық цикл, жылу сорғысы, кептіру, жылуды қалпына келтіру, энергия тиімділігі, COP, азық-түлік өнеркәсібі.

Кіріспе. Соңғы екі онжылдықтағы ғылыми әдебиеттерді талдау тамақ өнеркәсібіндегі екі параллель, бірақ өзара байланысты тенденцияларды анықтайды. Біріншіден, бұл гидрофторкөміртекті (HFC) салқындатқыштардан Кигали түзетуі сияқты экологиялық реттеулерден туындаған табиғи жұмыс денелеріне белсенді ауысу. Көмірқышқыл газы (CO_2 , R744) жоғары термодинамикалық қасиеттеріне, уыттылығына, сондай-ақ нөлдік ODP және $\text{GWP}=1$ арқасында жаңа коммерциялық суық қондырғылар үшін іс жүзінде стандартқа айналды. Екіншіден, бұл суықты (консервациялау, мұздату үшін) және жылуды (кептіру, пастерлеу, ГВС үшін) бір мезгілде жоғары тұтынумен сипатталатын тамақ өнеркәсібі

процестерінің энергия тиімділігін арттырудың шұғыл қажеттілігі. Шолу мақалалары кептіру энергияны көп қажет ететін қайта өңдеу қадамдарының бірі екенін көрсетеді, ал дәстүрлі Тоңазытқыш жүйелері қоршаған ортаға орасан зор жылуды төгеді.



Сурет 1 - Кептіру блок-схемасы үшін жылуды қалпына келтіретін CO2 транскритикалық жүйесі

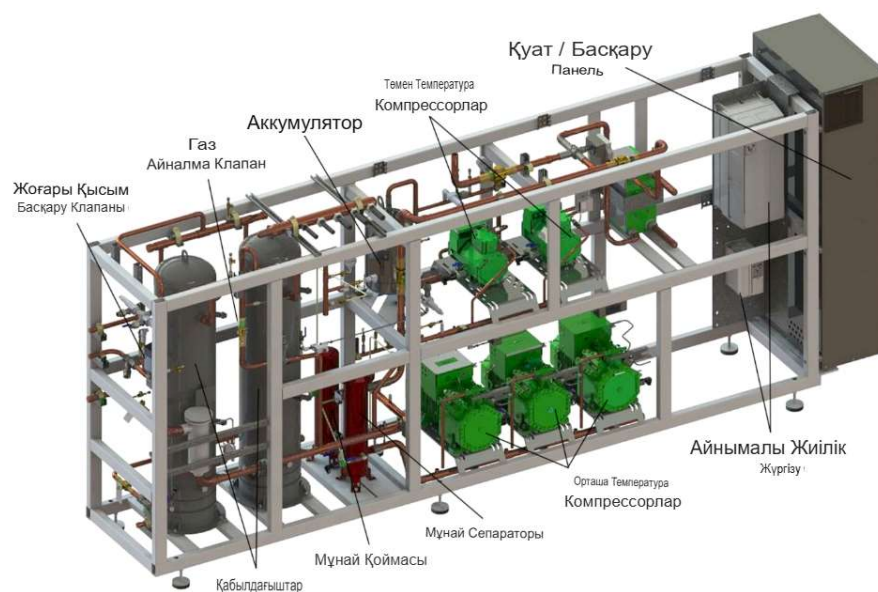
CO₂ біріктірілген жүйесінің ерекшеліктері:

1. HFC салқындатқыштарына қарағанда экологиялық таза, өйткені оның ODP (озонды бұзу әлеуеті) нөлге тең және GWP (жаһандық жылыну әлеуеті) 1-ге тең.

Классикалық салқындатқыштардағы изотермиялық конденсацияға қарағанда, CO₂ суперкритикалық аймақта жоғары температуралы жылу береді, бұл жылу тасымалдағышты 90°C және одан жоғары температураға дейін қыздыруға мүмкіндік береді.

Әдебиеттер мәселені нақты анықтайды: суық (салқындатқыштар) мен жылуды (қазандықтар) бөлек өндіру термодинамикалық тұрғыдан тиімсіз. Сүт зауыттары мен азық-түлік өндірісіне арналған көздер жылуды қалпына келтіру рентабельділіктің негізгі факторы екенін көрсетеді. Дәл осы жерде CO₂ транскритикалық жүйелері бірегей шешімді ұсынады. Изотермиялық конденсациясы бар классикалық салқындатқыштардан айырмашылығы, суперкритикалық аймақтағы CO₂ жылу тасымалдағышты 90°C және одан жоғары температураға дейін қыздыруға мүмкіндік беретін жоғары температуралы жылу береді. Бұл R744-ті кептіруге арналған жылу сорғылары үшін тамаша жұмыс корпусына айналдырады. Осылайша, әдебиеттер CO₂ тоңазытқыш қондырғысы тек суық көзі ғана емес, сонымен бірге консервациялау және кептіру функцияларын орындайтын интеграцияланған энергетикалық орталық болуы мүмкін деген гипотезаға әкеледі.

CO₂ Тоңазытқыш жүйелерін модельдеу және далалық сынау. Зерттеулердің көп бөлігі супермаркеттерге арналған CO₂ күшейткіш жүйелерін талдауға бағытталған. Бұл жұмыстардың әдістемесі мыналарды қамтиды. Транскритикалық циклдарды термодинамикалық модельдеу. Жұмыс істеп тұрған объектілердегі компрессорлардың қысымын, температурасын және энергия тұтынуын далалық өлшеу. Максималды COP_{cool} жету үшін жоғары қысымды (газ салқындатқыш қысымы) оңтайландыру. Бұл жұмыстар салқындату тиімділігі мен негізгі жылуды қалпына келтірудің кең деректерін ұсынады, бірақ сирек технологиялық кептіру үшін қажет Жоғары температуралық жылуға назар аударады.



Сурет – 2 CO₂ тоңазытқыш және кептірудің интеграцияланған жүйесінің диаграммасы

Зерттеудің екінші тобы жылу сорғыларын (ТН) есептеу әдістемесін қолданады. Олар COP_{heat} (жылыту коэффициенті) және SMER (specific moisture extraction rate, кг/кВт*сағ) модельдейді. R22 және R134a-дағы ТН-мен CO₂ модельдеуін тікелей салыстыру CO₂ кептіру үшін жоғары температураны (60-80°C) алу қажет болған жағдайда салыстырмалы немесе жақсы өнімділікті көрсететінін дәлелдейді. Тоңазытқыш жүйелерінен жылуды жоюдың әртүрлі схемаларын жүйелеу жылуды каскадты пайдалану (алдымен жоғары температуралық қажеттіліктер үшін, содан кейін төмен температуралар үшін) ең тиімді екенін растайды. Әдебиеттерде суперкритикалық сұйықтықты кептіру (SFE) де кеңінен қамтылғанын атап өткен жөн. Бұл әдіс ылғал алу үшін еріткіш ретінде суперкритикалық күйде CO₂ пайдаланады. Бұл шолу бұл әдісті қарастырмайды, бірақ конвективті ауаны кептіруді қамтамасыз ету үшін жылу сорғысының бу қысу циклінде жұмыс денесі ретінде қолданылатын CO₂-ға назар аударады.

Кесте - 1 – Дәстүрлі және CO₂ (R744) жүйелерінің салыстырмалы талдауы

Көрсеткіш	Дәстүрлі жүйе (R404A + қазандық)	CO ₂ (R744) интеграцияланған жүйе
Жұмыс денесі	ГФУ (HFC) хладагенттері	Табиғи CO ₂ , экологиялық таза
ODP / GWP	ODP ≠ 0, GWP жоғары	ODP = 0, GWP = 1
Жылу өндіру температурасы	50–60°C дейін	80–90°C және одан жоғары
Жалпы тиімділік (COP _{total})	3.0–4.0	6.0–8.0
Энергия тұтыну	Жоғары	30–50% азаяды
Жылу және суық бөлу тәсілі	Бөлек (қазандық + тоңазытқыш)	Біріктірілген жүйе
Экономикалық тиімділік	Орташа	Жыл сайынғы үнем 30–50% дейін
Қолдану саласы	Жалпы салқындату	Салқындату + кептіру + пастерлеу

Нәтижелер. Берілген дереккөздерде жарияланған нәтижелерді талдау келесі қорытындыларға мүмкіндік береді. Соғ рекуперациясының тиімділігі: зерттеулер көрсеткендей, мұндай жүйелердің COP_{heat} 3.5–4.5-ке жетуі мүмкін, ал бір мезгілде кәдеге жарату кезінде COP_{total} (жылу + суық) жалпы (интеграцияланған) коэффициенті 6.0-8.0-ден асуы мүмкін. Нақты жағдайдағы энергия тиімділігі: далалық зерттеулер жылуды қалпына келтіретін интеграцияланған CO₂ жүйелері дәстүрлі бөлек жүйелермен салыстырғанда жылдық энергия тұтынудың (мысалы, R404A + газ қазандығы) айтарлықтай төмендегенін көрсетеді (30-50% дейін). Температура деңгейлері: со₂ транскритикалық жүйелері +80°C және одан жоғары температурада салқындатқышты тиімді өндіруге қабілетті жалғыз жүйелер болып табылады, бұл кептіру және пастерлеу процестері үшін өте маңызды. Кептіру сапасы: жылу сорғысын пайдалану (жылытқыштың немесе газдың орнына) жұмсақ және бақыланатын жылуды қамтамасыз етеді, бұл кептірілген өнімдегі термолабильді компоненттердің сақталуына оң әсер етеді.

Кесте - 2 CO₂ интеграцияланған жүйесінің негізгі артықшылықтары мен нәтижелері

№	Артықшылық	Түсіндірме
1	Энергия тиімділігі жоғары	Бір жүйеде суық пен жылуды бірге өндіреді (COP _{total} 6–8)
2	Экологиялық таза	Озонды бұзбайды, жаһандық жылынуға әсері аз
3	Жоғары температурада жұмыс істейді	+80°C дейін жылу береді, кептіру мен пастерлеуге жарайды
4	Жылуды қалпына келтіру мүмкіндігі	Артық жылуды қайта пайдалану арқылы үнем жасайды
5	Өнім сапасын сақтайды	Жұмсақ әрі біркелкі кептіру процесі қамтамасыз етіледі
6	Экономикалық тиімділік	Энергия шығынын 30–50% азайтады
7	Біріктірілген басқару алгоритмі қажет	Суық пен жылу жүктемесін теңгеру үшін жаңа модель қажет

Талқылау және анықтау. Қолданыстағы әдебиеттер бірауыздан көмірқышқыл газы тек HFC алмастырғыш емес, энергетикалық интеграцияның жаңа мүмкіндіктерін ашатын технология болып табылады. Зерттеулер жылы климаттағы CO₂ жүйелерінің экономикалық орындылығы ағынды жылудың 100% кәдеге жарату қабілетіне тікелей байланысты екенін дәлелдейді. Әдебиеттерде талқыланыатын негізгі қиындықтар динамикалық басқару деректерінің жетіспеушілігіне қатысты. Мысалы, жылу қажеттілігі (кептіру) және суыққа деген қажеттілік (сақтау) уақыт немесе қуат бойынша сәйкес келмеген кезде жоғары қысымды оңтайландырудың қиындығы.

CO₂ Тоңазытқыш жүйелері мен кептіруге арналған жылу сорғылары туралы деректердің көптігіне қарамастан, кептіру үшін салқындатқыш жүйелер мен жылу сорғылары. Бірнеше температура деңгейінде бір уақытта жұмыс істейтін CO₂ күшейткіш жүйесінің бірыңғай термодинамикалық моделін ұсынды. Нақты тамақ өндірісіне қатысты интеграцияланған жүйеге (R404A + қазандық) қарсы салыстырмалы экономикалық талдау жүргізілді. Тоңазытқыш жүктемелері мен кептіргіштің тұрақты жылу жүктемесі арасындағы тепе-теңдікті сақтау үшін жоғары қысымды басқару алгоритмдерін ұсынды. Біздің жұмысымыздың өзекті ғылыми міндеті-дәстүрлі шешімдермен салыстырғанда оның термодинамикалық және экономикалық пайдасын дәлелдеу үшін осындай интеграцияланған жүйені есептеу, жобалау және оңтайландыру.

Қорытынды. Жүргізілген әдебиеттерді талдау CO₂ (R744) негізіндегі транскритикалық салқындату қондырғылары тамақ өнеркәсібіндегі суық өндіру (сақтау) және кептіру процестерін біріктіру үшін бірегей технологиялық шешім екенін растайды. Бұл жүйелердің басты артықшылығы – дәстүрлі HFC салқындатқыштары бере алмайтын, кептіруге қажетті жоғары температуралы (+80°C және одан жоғары) жылуды тиімді өндіру қабілеті. Интеграцияланған жүйелер жоғары жалпы өнімділік коэффициентін (COP_{total} 8.0-ге дейін) және дәстүрлі бөлек жүйелермен салыстырғанда энергия тұтынуды 30-50%-ға дейін үнемдеуді қамтамасыз етеді. Ағымдағы зерттеулердегі негізгі "олқылық" – әртүрлі және ауыспалы жылу және суық жүктемелері жағдайында жұмыс істейтін бірыңғай жүйелерді басқару алгоритмдері мен экономикалық негіздемелерінің жетіспеушілігі болып табылады.

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INTEGRATION OF CARBON DIOXIDE REFRIGERATION SYSTEMS AND FOOD DRYING PROCESSES

Annotation. The article analyzes the potential for integrating transcritical refrigeration systems based on carbon dioxide (CO₂, R744) with food drying processes. A review of existing literature reveals the thermodynamic inefficiency of separate cold and heat generation (e.g., HFC refrigerants and gas boilers). The unique feature of CO₂ systems is their ability to provide high-temperature heat up to 90°C, suitable for drying, in addition to their cooling function, making them effective as heat pumps for drying. Studies confirm that such integrated systems can achieve a high total COP (COP_{total} 6.0-8.0) and reduce annual energy consumption by up to 30-50% compared to traditional R404A + boiler systems. The article substantiates the need to develop control algorithms and unified thermodynamic models for managing the balance between cooling and heating loads.

Keywords. CO₂, R744, transcritical cycle, heat pump, drying, heat recovery, energy efficiency, COP, food industry.

ИНТЕГРАЦИЯ СИСТЕМ ОХЛАЖДЕНИЯ НА ДИОКСИДЕ УГЛЕРОДА И ПРОЦЕССОВ СУШКИ ПИЩЕВЫХ ПРОДУКТОВ

Аннотация. В статье анализируются возможности интеграции транскритических холодильных систем на диоксиде углерода (CO₂, R744) с процессами сушки пищевых продуктов. Анализ существующей литературы показывает термодинамическую неэффективность раздельной генерации холода и тепла (например, ГФУ хладагенты и

газовые котлы). Уникальность систем на CO₂ заключается в их способности, помимо функции охлаждения, обеспечивать высокотемпературное тепло до 90°C, пригодное для сушки, что делает их эффективными тепловыми насосами для сушки. Исследования подтверждают, что такие интегрированные системы достигают высокого общего коэффициента производительности (COP_{total} 6.0-8.0) и снижают годовое энергопотребление на 30-50% по сравнению с традиционными системами R404A + котел. Статья обосновывает необходимость разработки алгоритмов управления и единых термодинамических моделей для балансировки холодильной и тепловой нагрузок.

Ключевые слова. CO₂, R744, транскритический цикл, тепловой насос, сушка, рекуперация тепла, энергоэффективность, COP, пищевая промышленность.

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A MODEL FOR REQUIREMENTS ANALYSIS AND ARCHITECTURAL DESIGN OF SMART TECHNOLOGIES IN THE EDUCATIONAL PROCESS

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Abstract

The article presents a structured and comprehensive model for requirements analysis and architectural design specifically tailored for smart information systems oriented towards educational institutions. This model combines several methodological approaches, integrating techniques for eliciting and collecting detailed requirements, formalizing these requirements using UML diagrams, and establishing clear criteria for selecting the most suitable architectural solution. The architectural criteria are designed to ensure the system’s capability to support adaptive learning processes, provide advanced analytics on student performance, and enable seamless integration with a variety of external services and platforms. Practical testing and application of the model in the process of developing an educational platform demonstrated its effectiveness in improving the overall quality and completeness of design documentation, as well as in reducing the number of clarifications and corrections required during later stages of development. The results indicate that the model not only facilitates more precise and structured documentation of requirements but also enhances communication among stakeholders, ensures alignment between functional needs and architectural decisions, and ultimately contributes to the creation of more robust and scalable Smart education systems.

Keywords: Smart-technologies; software architecture; system design; UML diagrams; modeling.

With the active digitalization of the education sector, there is an increasing demand for intelligent information systems capable of supporting personalized learning through the processing and analysis of large volumes of data, providing access via mobile devices, and integrating with a wide range of external resources. Nevertheless, the practical implementation of such systems represents a complex challenge for many educational organizations, which is primarily due to the lack of sufficient requirement detail and a certain degree of uncertainty in selecting the optimal architecture at the initial stage of development.

The problem addressed in the present study lies in the absence of a systematic approach that adequately considers the specific characteristics of Smart education when conducting requirements analysis and subsequently designing the architecture of an information system. The objective of this work is to develop a model that allows for comprehensive requirements analysis and the design of an architecture that ensures component consistency and provides the possibility for further scaling of the considered Smart education systems. The scientific significance of the presented research is determined by aspects such as the development of an integrated model combining the identification of key stakeholders; the application of structured methods for gathering information about requirements and the use of standardized UML modeling tools for their formalization; the definition of clear criteria for selecting the most appropriate architectural style, specifically adapted to the characteristics of Smart educational systems; as well as the identification of a standard set of modules intended to implement the core functions of modern Smart technologies.

In the course of the study, a comprehensive set of methodological instruments was applied, specifically aimed at identifying and formalizing the requirements for Smart education systems, as well as selecting the optimal architectural solution. Initially, a detailed analysis of stakeholders was conducted, resulting in the identification of four main user groups, including administrative personnel, teaching staff, students, and technical support specialists. At the requirements gathering stage, a wide range of methods was employed, among which were interviews with different categories of participants in the educational process in both structured and semi-structured formats, direct observation of classroom activities, the administration of questionnaires, and the study of existing digital solutions used in this field.

In order to minimize possible ambiguities and increase the clarity of formulations during the formalization of the collected requirements, tools of object-oriented modeling within the framework of the Unified Modeling Language were actively applied, including the construction of use case diagrams and activity diagrams, the creation of requirements matrices, and the preparation of textual specifications of use cases. At the same time, the selection of the optimal architectural solution was carried out based on a set of key criteria determining the efficiency and prospective viability of the Smart education system, including potential scalability, the ability to ensure fault tolerance, the degree of integration flexibility, and the level of support for necessary Smart modules implementing functions such as adaptive learning and analytical data processing.

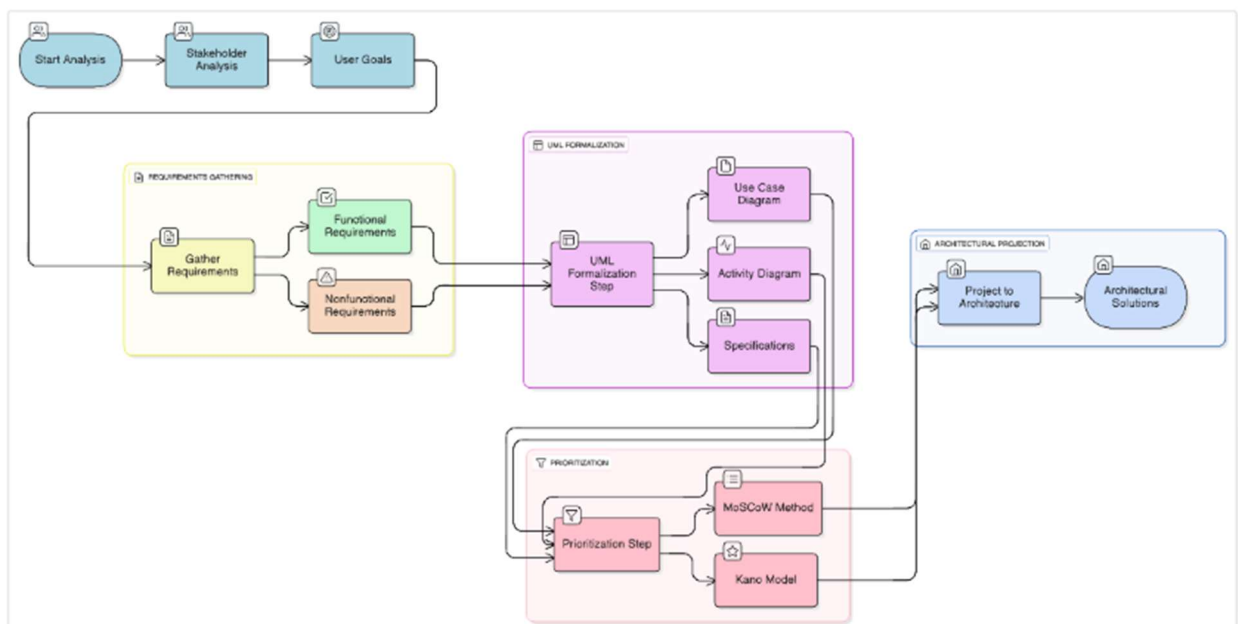


Figure 1. Requirements analysis model

The obtained results demonstrate the developed model for requirements analysis, which represents a sequential structure of stages and actions aimed at forming a comprehensive understanding of the needs of all involved stakeholders and effectively translating these needs into the design of the information system architecture. The visual representation of the model, presented as a diagram in figure 1, reflects the following logical sequence of operations – initially, a thorough investigation of stakeholders is carried out in order to determine their goals and expectations for the future system, after which the requirements gathering process is conducted, allowing for the identification of both functional and non-functional needs. The collected data is then formalized using UML tools, including the creation of use case diagrams, activity diagrams, and detailed specifications of use cases, which ensures unambiguous interpretation of the requirements. Subsequently, the gathered requirements are prioritized using commonly accepted methodologies such as MoSCoW and Kano to determine the relative importance of each requirement. The final stage involves projecting the results of the requirements analysis onto potential architectural solutions, which enables the selection of the most suitable foundation for creating a Smart education system.

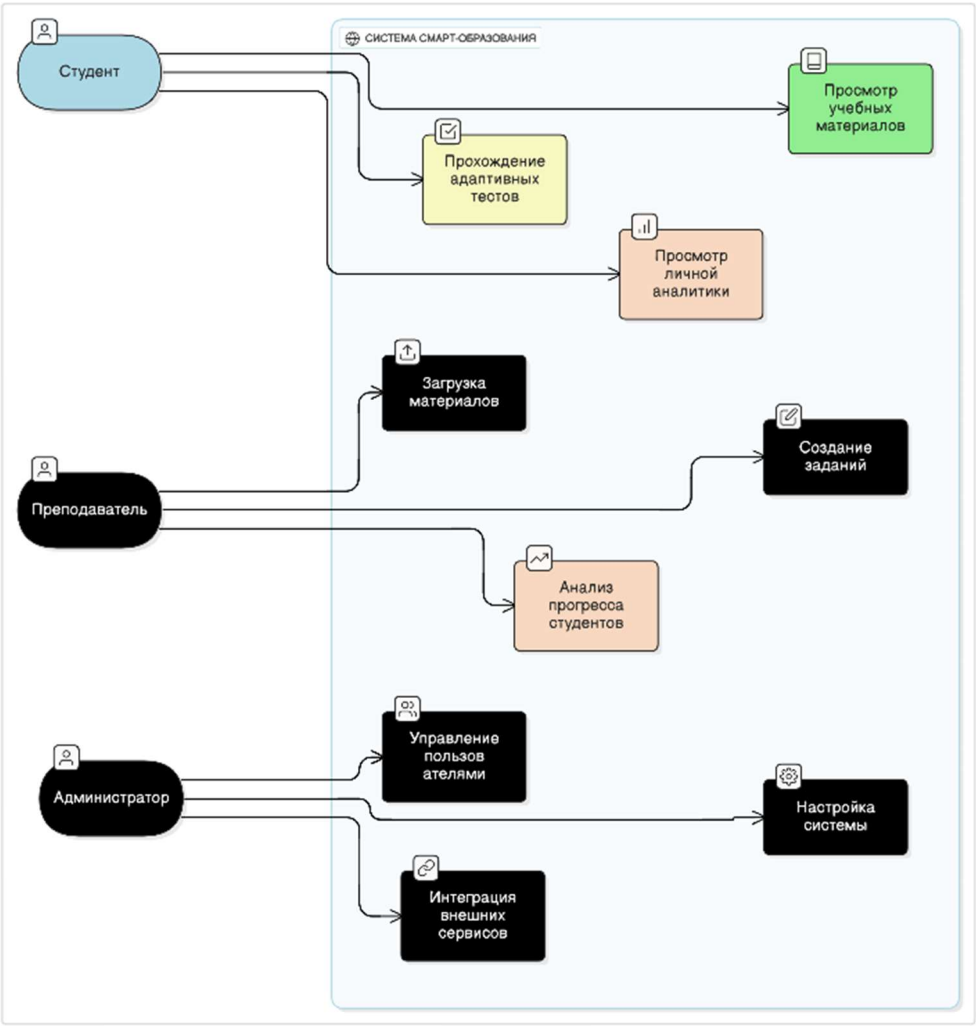


Figure 2. Use case diagram

The use case diagram presented in figure 2 provides a comprehensive visualization of the interaction between the main user roles and the Smart education system, effectively demonstrating the key application scenarios and the overall structure of user-system engagement.

According to the diagram, a student is granted the ability to access a wide range of learning materials, participate in adaptive testing processes that adjust to their current knowledge level, and receive detailed feedback in the form of personalized performance analytics, which allows for monitoring their academic progress and identifying areas requiring additional attention. The teacher, in turn, is provided with a set of functionalities that enable them to upload and manage supplementary educational materials, create and assign new tasks for the assessment of students' knowledge, and analyze the dynamics of student progress over time, thereby supporting a targeted and data-driven approach to instructional management. The functional capabilities assigned to the administrator encompass the management of user accounts, including the creation, modification, and deactivation of profiles; the configuration of system operation parameters to ensure smooth and secure functioning; and the integration with external services and platforms, thereby extending the system's capabilities and supporting interoperability with other educational technologies. Overall, the diagram serves as a clear representation of the distribution of responsibilities among different user roles and the range of tasks handled by each category of user, illustrating how the system accommodates diverse needs and supports efficient interaction within the educational environment.

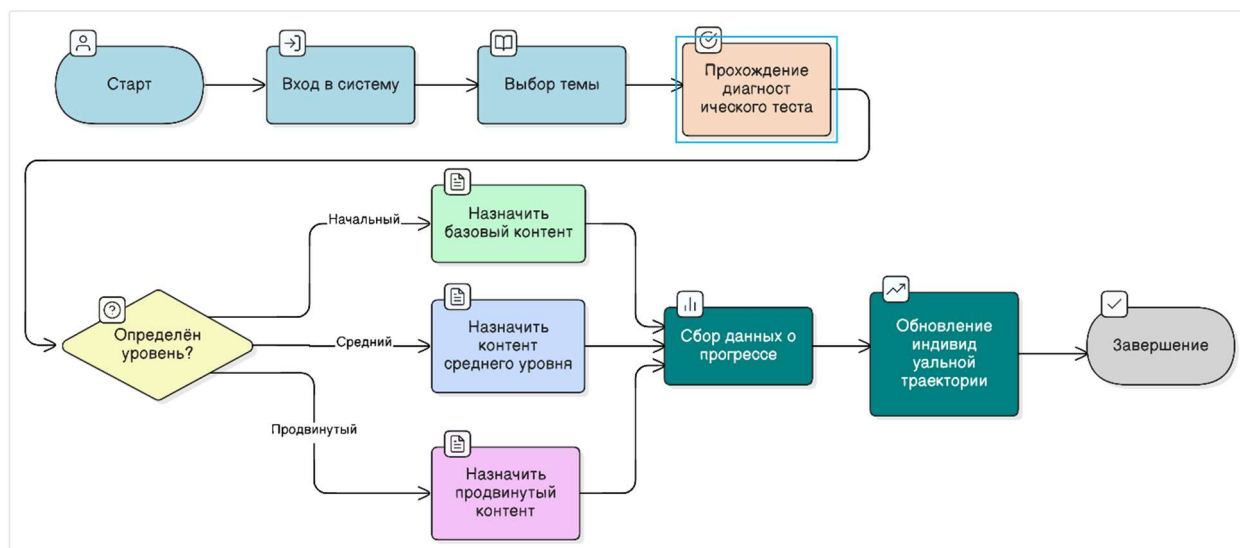


Figure 3. Activity diagram

The activity of adaptive learning is presented in the activity diagram in figure 3 and reflects the sequence of steps forming the individual educational trajectory of a student. The process begins with the student's authorized login to the system and the selection of the topic of interest. Following this, an initial diagnostic test is conducted to determine the student's current level of knowledge. Depending on the test result, the system assigns the corresponding content level – basic for students with an initial level of preparation, intermediate for students with a medium level of knowledge, and advanced for students with a high level of preparation. During the process of studying the material, data on the student's performance is continuously collected, which is then used to update the individual educational trajectory, ensuring the maximum effectiveness of learning. This cycle repeats until the completion of the course.

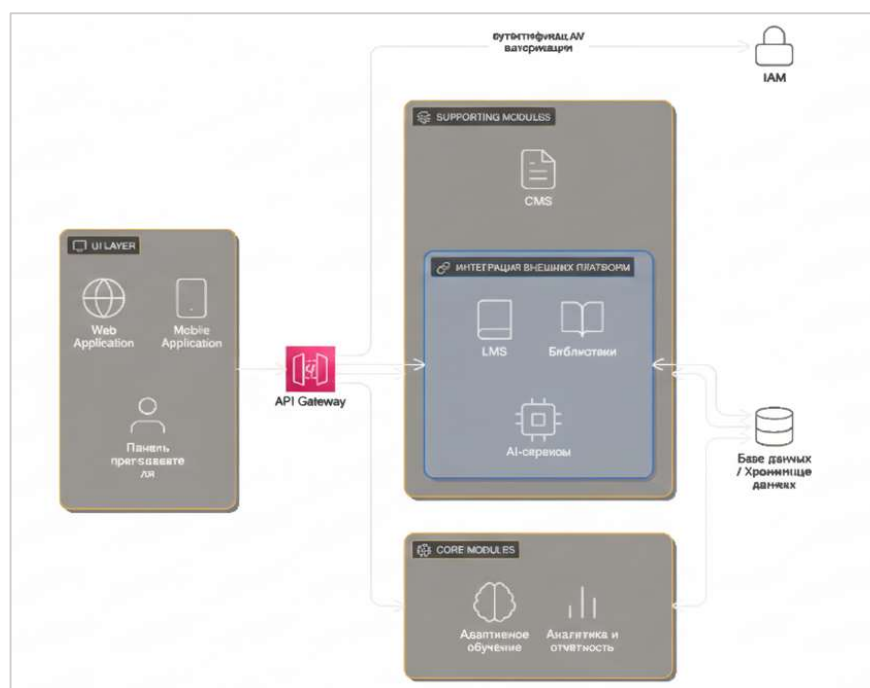


Figure 4. High-level architecture

The proposed high-level architecture of the Smart system, presented in figure 4, represents a multi-layered structure designed to ensure scalability and flexibility in the interaction of components. The system includes a user interface consisting of a web application, a mobile application, and a specialized dashboard for teachers. Access to the system's functionality is organized through an API Gateway, responsible for request routing and security, as well as an Identity & Access Management module, providing user authentication and authorization. The key components of the system core are the adaptive learning module, which manages the process of forming individual educational trajectories, and the analytics and reporting module, which provides information on learning progress. In addition, separate modules for content management and integration with external platforms, such as LMS and digital libraries, are provided. All data is stored in a centralized database, ensuring reliable storage and efficient access to information.

Practical testing of the proposed model for requirements analysis and architectural design demonstrated high effectiveness in the development of a digital educational platform. As a result of applying the model, significant positive changes were achieved during the development process, namely, a 37% reduction in the number of conflicting requirements, indicating an improvement in the quality of formulated requirements and enhanced communication among project participants; a 22% reduction in the time required to prepare necessary architectural documentation, which allowed for optimization of labor costs and acceleration of the development process; and, finally, thanks to the modular approach and flexible architecture, the possibility of adding two new Smart modules without making changes to the core system code was realized, demonstrating the scalability and adaptability of the developed architecture. Particular attention was given to the effectiveness of using activity diagrams and the description of specific scenarios, since these methods enabled mutual understanding and alignment of requirements among different categories of stakeholders. Furthermore, the study noted that the transition to a microservices architecture provides the most promising opportunities for the development of systems focused on expanding functionality, data analytics, and seamless integration with a wide range of external platforms.

In conclusion, it should be emphasized that this work presents a new model for requirements analysis and architectural design, specifically developed for Smart information

educational systems. Practical application of this model contributes to increased accuracy in requirements formulation, improved system architecture structure, and, consequently, a reduced likelihood of errors during implementation. Prospective directions for further research include automating the process of requirements clustering and developing a set of standard architectural templates for Smart modules.

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INTERNET OF THINGS EMPOWERED BY ARTIFICIAL INTELLIGENCE OF THINGS

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Abstract

This paper explored the two technologies that create intelligently connected systems - Internet of Things (IoT) and Artificial Intelligence of Things (AIoT). The Internet of Things combined with the most dynamic technology of artificial intelligence (AI) is expected to make the Internet of Things system smarter and easily imitate human activity. However, what modern challenges await such synergy and what ways of their development can be expected? This paper aims to study the development prospects of both Internet of Things (IoT) and Artificial Intelligence of Things (AIoT).

Key words: Artificial Intelligence of Things, Internet of Things, Artificial Intelligence, machine learning (ML), natural language processing (NLP).

Introduction

The term "Internet of Things" was created by entrepreneur Kevin Ashton, who co-founded the Auto-ID Center at MIT. The team Ashton worked on came up with the idea of connecting objects to the Internet using an RFID tag. He first used the phrase "Internet of Things" in 1999, and it has since become popular.

Initially, IoT was used only in the most advanced projects of that time using expensive equipment and was inaccessible to the average person. The development of the Internet of Things over the past decade and its implementation in our daily lives has occurred due to the following factors:

- The creation of devices with modern digital technologies has become more accessible
- The number of products with Wi-Fi has increased dramatically
- Smartphones have become an integral part of people's lives
- The functionality of smartphones has begun to allow the control of other
- Devices

Currently, the Internet of Things technology is used in many industries. At the moment, the following main areas can be distinguished: light and heavy industry. In particular, these are:

- Sensors on equipment and machines that collect data on their operation and help prevent breakdowns.
- Climate control systems that analyze temperature and humidity, automatically regulate the microclimate in the workshop or warehouse.
- Sensors on products and parts that help with inventory and identifying defects.
- Remote control systems for production equipment, for example, remote start of machines.
- Pollution sensors that analyze enterprise emissions and monitor compliance with environmental standards.

The Internet of Things (IoT) makes it possible to reduce production costs and avoid losses. Sensors on equipment will help you understand that it is time to perform maintenance. The climate control system will ensure that the goods do not spoil in the heat. The data collected by all sensors can be loaded into analytics systems to make forecasts and analyze the operation of the entire production (Kotov, 2022).

Thus, the Internet of Things is a concept of a computing network of physical objects that have built-in technologies for exchanging information with each other and the environment. Today, the number of devices connected to the Internet of Things has long exceeded the expected number. These devices can exchange data through networks or cloud platforms connected to the Internet of Things - in other words, platforms for the Internet of Things. In its arsenal,

IoT covers not only complex mechanisms such as robotic manipulators, supercomputers, but also much more diverse and simple devices, for example, electronics that have never been connected to the network before: refrigerators, coffee machines, washing machines, sockets, kettles (Kotov, 2022).

Materials and Methods

According to Newman (2020), by 2027, more than 41 billion IoT devices will be able to cover, compared to about 8 billion in 2019. Such a survey was compiled based on the responses of 400 senior executives from around the world, including such giants as: Alibaba, Alphabet, Amazon, Apple, VMWare, Verizon, etc. Also, Newman (2020) claims that by 2027, all remaining undeveloped devices will be able to access the Internet, and the IoT market will grow to more than \$ 2.4 trillion per year. This development of the Internet of Things, combined with the most dynamic artificial intelligence (AI) technology, can make the Internet of Things system itself smarter and more easily imitate human activity, the scientist believes (Newman, 2020).

Today, artificial intelligence is used in all modern technologies. In discussions about the development of such technologies, the terms "artificial intelligence" and "Internet of things" are often mentioned. Many already use both concepts as synonyms, because these two technologies often complement each other's functionality (Kotov, 2022). But in this case, it is necessary to mention the concept of artificial intelligence of things (AIoT). Internet of things networks controlled by artificial intelligence, or AIoT - artificial intelligence of things combines the capabilities of AI and IoT, so it can find application in almost all areas of human activity.

Thus, we have established that:

- The Internet of things (internet of things) is a system in which the Internet connects to various objects, sensors and devices - things - so that they can collect and transmit information about their environment through software or other devices. The goal of IoT is to connect simple objects to computers and other computing machines.
- The concept of artificial intelligence refers to a system that, like humans and animals, is able to learn by collecting certain information or performing tasks. AI technologies include machine learning (ML), natural language processing (NLP), voice and face recognition, and deep learning. In other words, AI gives machines and objects some intelligence.

Together, the two technologies create intelligent connected systems in which AI acts as the "brain" and the Internet of Things acts as the "body." IoT devices collect and transmit data from multiple sources, supporting the AI learning process so that it knows how to properly automate the necessary processes. Thanks to artificial intelligence, Internet of Things systems can learn and make decisions on data management and analysis, which certainly increases productivity (Tichonenko, 2020).

Results and Discussion

The Role of Artificial Intelligence in IoT

AI is defined as the process of making machines intelligent enough to perform tasks without any human intervention. All the IoT devices together collect huge data, and on the other hand, it takes huge data to create a modern AI model. So, the combination of these two dynamic methods turns the monotonous IoT into intelligent IoT - smart tasks without human

intervention. The powerful combination of IoT with AI can be a huge breakthrough in people's lives. So, when it comes to Artificial Intelligence (AI), Machine Learning (ML) and Deep Learning (DL) play a more important role as DL and ML are subsets of AI (Kotov, 2022).

The role of AI in IoT is information. For businesses, the value of the Internet of Things lies in its ability to turn almost everything from trucks to pharmacy prescriptions into a data point. However, without built-in AI, it is impossible to use this data to its full potential. According to PwC, AI technology is being used so frequently alongside the Internet of Things that it will soon become an essential requirement for IoT systems (Tickhonenko, 2020). There are two reasons for this:

First, AIoT enables real-time analysis and response. Where IoT systems can only collect and organize data, AIoT systems can go further. Since IoT platforms provide an interface for collecting data from various devices, all the information can be easily analyzed and used with AI/ML. Thus, AI can detect anomalies, failures, and security threats to systems in real time, and in many cases, it can be programmed to respond.

Second, AI performs long-term analysis, allowing users to identify trends and patterns over specific periods of time. Sophisticated AI algorithms allow businesses to perform predictive analytics based on many possible scenarios, simplifying the problem-solving process for users. This capability enables businesses to assess and respond to risks in real time, make changes to operational parameters, and avoid unplanned downtime, gaining a competitive advantage.

Based on the findings of a global survey of 450 business leaders on the impact of AI combined with the Internet of Things - IDC Global Study (2020) for SAS, Intel, and Deloitte Consulting, we found clear evidence of the momentum behind this new combination of technologies. According to the survey respondents, AIoT capabilities are already delivering results. According to IDC (2020), the presence of AI is an important factor in whether the IoT will live up to expectations. Specifically, their study findings range from what executives expect from AIoT, advances to date, AIoT applications, and the value of combining AI and IoT, where 90% of active AI users reported a much higher ROI on the IoT than the estimated ROI.

Will Nature Internet of Things Accelerate the Adoption of Artificial Intelligence?

CIS company MegaFon, together with the analytical agency ORO, conducted a study that showed that over the past 2023, every fifth company increased its investments in the development of the Internet of Things. According to respondents, IoT technologies will improve efficiency, optimize costs, respond to changes faster and adapt to new conditions. The study participants identified the most popular IoT services: video surveillance/video analytics, industrial Internet of Things, employee monitoring, smart transport and logistics, and smart housing and communal services (Yakimova, 2024).

Experts note that despite the fact that many AIoT applications are designed for specific industries, such as predictive diagnostics of industrial equipment, smart shopping carts in stores, creating medical images based on AI, the main advantage of using AI and the Internet of Things simultaneously is the ease of data processing. Most often, AI and the Internet of Things are used to prevent downtime, optimize operational processes and better understand the ever-increasing volume of data (Yakimova, 2024).

Below are several modern examples of AIoT application according to Yakimova (2024); Tickhonenko (2020); Kotov (2022):

- Edge computing involves processing large amounts of data at high speed, allowing users to make decisions locally without sending the data to the cloud. Where IoT devices collect data, it is AI/ML technologies that enable decision making at the edge.
- Collaborative robots (cobots) are the fastest growing segment of industrial automation. The combination of IoT sensors and AI-ML modeling gives robots a sense of perception and

awareness of their surroundings, allowing them to “make decisions” and work seamlessly alongside humans.

- Digital twins are virtual copies of physical objects that allow users to simulate the startup of new equipment and the operation of devices. For example, you can use digital twins to test a new motor or wind turbine before they go into production.
- Autonomous delivery robots. While autonomous delivery robots may well fall under the category of “cobots,” the use case is a little different. AIoT technology is applied in urban environments to reduce delivery costs and increase delivery speeds – a key factor in customer satisfaction.

Conclusion

As IoT devices become more widely available in the market, more and more companies will deploy IoT networks in the hopes of cutting costs, increasing profits, or improving their processes. While it is possible to use IoT without AI, it alone will not be able to handle the volume of data from the many sensors, devices, and machines that make up the industrial IoT ecosystem. As information starts pouring in from production lines, supply chains, etc., without AI, it will be very difficult for humans to sort through the data themselves, let alone extract specific useful information on their own.

The future of IoT is billions of physical devices with sensors connected to the Internet all over the world. IoT has a variety of applications in all sectors except manufacturing to empower and enrich human life on this planet. For example, a smartphone, a person listens to songs on headphones connected to a smartphone while busy driving, IoT is emerging based on artificial intelligence. AIoT will be able to, through an IoT sensor in the headphones, receive heart rate data and, using AI, predict the emotions of a given individual. Based on these emotions, the smartphone can select the best song stored somewhere in the world. There are several million songs in the world, and the smartphone does not need super storage to store all the songs or super computing power for an applied AI model to recognize emotions. All it needs is to make sure that it is connected to the Internet Pacifici, F. (2020).

Thus, the Internet of Things, combined with the most dynamic artificial intelligence (AI) technology, can make the Internet of Things system itself smarter and easily imitate human activity.

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УДК: 621.56:502.3

ХЛАДАГЕНТТЕРДІҢ ЭКОЛОГИЯЛЫҚ ӘСЕРІ ЖӘНЕ ОЗОН ҚАБАТЫН ҚОРҒАУ МӘСЕЛЕЛЕРІ

Тұрдақын Ж.Н.

6B07106-Тоңазытқыш машиналар және кондиционерлеу жүйелері білім беру бағдарламасының 4-курс студенті., Алматы технологиялық университеті, Алматы қ., Қазақстан

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Аңдатпа. Хладагенттер (тоңазытқыштар мен кондиционерлерде қолданылатын салқындатқыш газдар) экологияға әсері жағынан маңызды болып табылады. Классикалық хладагенттер, әсіресе CFC және HCFC, озон қабатына зиян келтіріп, ультракүлгін сәулелердің жер бетіне түсуін арттырады, бұл тері қатерлі ісігі, көру қабілетінің бұзылуы және экожүйелердің деградациясына әкеледі.

Озон қабатын қорғау мақсатында Монреаль протоколы қабылданып, зиянды хладагенттердің қолданылуы азайтылуда. Қазіргі таңда экологиялық таза альтернативті газдар (HFC, табиғи хладагенттер: аммиак, CO₂, пропан) қолданылады, олар озон қабатына зиянсыз және климаттық өзгерістердің әсерін төмендетуге көмектеседі.

Түйінді сөздер. Хладагенттер. Салқындатқыш газдар. Экологиялық әсер. Озон қабаты. Озон қабатын бұзу. Монреаль протоколы. Климаттық өзгерістер. Табиғи хладагенттер (аммиак, CO₂, пропан). HFC (гидрофторкөміртектер). Экологиялық таза технология

Кіріспе. Тоңазытқыштар, кондиционерлер, жылу сорғыштар және басқа салқындату техникасы қазіргі өмірдің ажырамас бөлігі болып табылады. Бұл құрылғыларда қолданылатын хладагенттер – салқындатқыш газдар – адамның өмірін жеңілдететін маңызды технологиялық компонент болса да, экологиялық тұрғыдан белгілі бір қатер тудырады. Классикалық хладагенттер, әсіресе хлорфторкөміртектер (CFC) және гидрохлорфторкөміртектер (HCFC), озон қабатын бұзуға қабілетті. Озон қабаты Жер бетін ультракүлгін сәулелерден қорғайтын табиғи экран ретінде қызмет етеді, ал оның жұқаруы тері қатерлі ісігі, көз аурулары және экожүйелердің деградациясына әкеледі.

Соңғы онжылдықтарда халықаралық қауымдастық озон қабатын қорғау мәселесін бірінші орынға қойып, Монреаль протоколы сияқты келісімдер қабылданды. Бұл халықаралық келісімдер зиянды хладагенттердің өндірісі мен қолданылуын кезең-кезеңімен шектеуге бағытталған. Сонымен қатар, экологиялық таза альтернативті хладагенттер (мысалы, HFC, аммиак, CO₂, пропан) қолданысқа енгізілуде, олар озон қабатына зиянсыз болып, климаттық өзгерістердің теріс әсерін азайтуға мүмкіндік береді.

Бұл зерттеу жұмысы хладагенттердің экологиялық әсерін, озон қабатын қорғау шараларын және қазіргі заманауи салқындатқыштардың артықшылықтары мен кемшіліктерін талдайды. Сонымен қатар, экологиялық тұрғыдан тиімді хладагенттердің

қолданылуы мен олардың халықаралық деңгейде реттелу мәселелері қарастырылады, бұл өз кезегінде қоршаған ортаны сақтау мен тұрақты даму принциптерін қамтамасыз етуге бағытталған.

Хладагенттер бұл қайнау (булану, балқу немесе тіпті сублимация) арқылы салқындатылған заттан жылуды алатын, содан кейін қысылғаннан кейін оны конденсация немесе басқа фазалық ауысу (су, ауа және т.д.)



Сурет-1 Хладагент баллондары: [R-134A](#), R-404A, [R-410A](#), R-507, [R-407C](#).

Салқындатқыш агент - [жылу тасымалдағыштың](#) ерекше түрі. Маңызды айырмашылық мынада, жылу тасымалдағыштар заттың бірдей күйінде пайдаланылады, ал салқындатқыштар әдетте фазалық ауысудан (қайнау және конденсация) өтеді.

Негізгі салқындатқыштар [аммиак](#), [фреондар](#) (фреондар), [SF6 газы](#) және кейбір [көмірсутектер](#). Салқындатқыш агенттер мен [криогенді агенттер](#) арасындағы айырмашылықты жасау керек. Криогендік агенттердің қалыпты қайнау температурасы төмен және компрессорлық майлармен әрекеттесу үшін жоғары талаптары бар. Оттегі [оттегі сұйықтығын](#) жасауда тоңазытқыш агент ретінде пайдаланылады.

Азот, гелий және басқалар сияқты салқындатқыш агенттерді пайдаланудың негізгі айырмашылығы - сұйықтық бір рет тұтынылады және буланады (әдетте атмосфераға), осылайша ашық тоңазыту циклі қолданылады. Тоңазытқыш қондырғыларында фреон немесе кез келген басқа сұйықтық немесе газ жабық циклде жұмыс істейді, [компрессормен](#) қысылады, [конденсаторда](#) салқындатылады, дроссельде немесе кеңейткіште кеңейтіледі және буландырғышта [буланады](#).

- Фреондар атмосфераға шыққанда, олар өте тұрақты болғандықтан ұзақ уақыт (ондаған жылдар бойы) өзгеріссіз қалады.
- Уақыт өте келе фреондар стратосфераға жетіп, онда ультракүлгін сәуле әсерінен ыдырап, хлор атомдарын бөледі.
- Бір хлор атомы мыңдаған озон молекулаларын жоя алады:

$$\text{Cl} + \text{O}_3 \rightarrow \text{ClO} + \text{O}_2$$

$$\text{ClO} + \text{O} \rightarrow \text{Cl} + \text{O}_2$$
- Нәтижесінде озон қабаты жұқарады, бұл ультракүлгін сәулелердің жерге көбірек түсуіне әкеледі.

Монреаль хаттамасы (Montreal Protocol) — бұл озон қабатын қорғауға бағытталған халықаралық келісім.

Параметр	Сипаттама
Толық атауы	Озон қабатын бұзатын заттар туралы Монреаль хаттамасы
Қабылданған жылы	1987 жыл, 16 қыркүйек
Күшіне енген күні	1989 жыл, 1 қаңтар
Қатысушы елдер	БҰҰ-ның барлық дерлік мемлекеттері (200+ ел)
Құжаттың мақсаты	Озон қабатын бұзатын заттардың өндірісін және тұтынушының кезең-кезеңімен тоқтату

Монреаль хаттамасы бойынша елдер:

1. Озон қабатын бұзатын заттарды (мысалы, CFC, halon, HCFC) азайту және біртіндеп тоқтату міндеттемесін алды.
2. Балама заттар (экологиялық қауіпсіз салқындатқыштар мен еріткіштер) қолдануға көшуі тиіс.
3. Дамушы елдерге көмек ретінде қаржылық және технологиялық қолдау тетіктері қарастырылған.

Топ	Мысалдар	Ерекшеліктері
CFC (хлорфторкөміртектер)	R-11, R-12	Озон қабатын ең күшті бұзушылар
HCFC (гидрохлорфторкөміртектер)	R-22, R-14b	Аз зиянды, бірақ 2030 жылға дейін жойылуы тиіс
Halon	Halon-1211, Halon1301	Өрт сөндіргіштерде қолданады
Carbon tetrachloride (CCL ⁴)		Еріткіш ретінде қолданады
Methy chloroform		Өнеркәсіптік тазартқыш

Нәтижелері:

- Озон қабатының тесілуі тоқтап, біртіндеп қалпына келе бастады.
- 21 ғасырдың ортасына қарай озон қабаты толық қалпына келеді деп болжануда (2050–2060 жж.).
- Бұл хаттама — ең табысты экологиялық келісімдердің бірі деп саналады.

	Хла дагент	Ф ормула	Т аңбасы	DP	WP	Арт ықшылығы	К емшілігі	Қо лдану саласы
	Ам миак	N H3	R -717			Жоғ ары тиімділік, озон мен климатқа зиянсыз, арзан	У лы, аздап жанғыш, мыс құбырла рымен үйлеспе йді	Өн еркәсіптік тоңазытқы штр, мұз зауыттары, ет комбинатт ары
	Көм ірқышқыл газы	C O2	R -744			Тұта нбайды, улы емес, қоршаған ортаға зиянсыз	Ө те жоғары қысым, жоғары темпера турада тиімділіг і төмен	Са уда салқындат қыштары, автоконди ционер, мұздатқы ш жүйе.
	Про пан	C 3H8	R -290			Өте тиімді, энергия үнемдейді, экологиялы қ таза	Ж анғыш, қауіпсізд ік шаралар ы керек	Үй де, тұрмыстық кондицио нер, тоңазытқы ш
	Изо бутан	C 4H10	R -600a			Төм ен қысымда жұмыс істейді	Ж анғыш, үлкен жүйелер ге жарамс ыз	Тұр мыстық тоңазытқы штар, шағын мұздатқы штар
	Су	H 2O	R -718			Қауі псіздік, арзан, табиғи	Т өмен қысымд а буланба йды, үлкен көлем қажет	Бу компрессо рлық және абсорбция лық жүйелер
	Ауа					Қауі псіз, қол жетімді, экологиялы қ таза	Т өмен тиімділік , күрделі жүйе	Қр иогендік және авиациялы қ жүйелер

Талқылау жән анықтау.

Хладагенттерге байланысты экологиялық мәселе — бұл тек техникалық емес, халықаралық деңгейдегі экологиялық және саяси мәселе.

Фреондардың кең қолданылуы XX ғасырда озон қабатының айтарлықтай жұқаруына әкелді.

Алайда халықаралық ынтымақтастық (Монреаль хаттамасы) арқасында бұл үрдіс баяулап, озон қабаты қазір қалпына келе бастады.

Дегенмен климаттың жылынуына әсер ететін жаңа буын газдары (мысалы, HFC) да экологиялық қауіп төндіріп отыр. Монреаль хаттамасында Озон қабатын бұзатын заттардың өндірісі мен қолданылуын тоқтатуға бағытталған халықаралық келісім. Қатысушы елдер фреон, галон, HCFC тәрізді заттарды кезең-кезеңімен қысқартуға және жоюға міндеттелді. Нәтижесінде көптеген елдер экологиялық таза балама хладагенттерге көшті.

Қорытынды. Қорыта айтқанда, хладагенттердің экологиялық әсері мен озон қабатын қорғау мәселелері — қазіргі заманның аса маңызды жаһандық проблемаларының бірі.

Көптеген дәстүрлі хладагенттер (әсіресе фреондар — CFC және HCFC) атмосфераға шыққанда озон қабатын бұзып, ультракүлгін сәулелердің жерге еркін өтуіне себеп болады. Бұл құбылыс адамдардың денсаулығына, өсімдіктер мен жануарлар әлеміне, сондай-ақ бүкіл экожүйеге зиян тигізеді. Сонымен қатар, хладагенттердің едәуір бөлігі жоғары жылыжай әсеріне ие, яғни жаһандық климаттың жылынуына үлес қосады.

Осыған байланысты әлем елдері Монреаль хаттамасы мен оның кейінгі Кигали түзетуі аясында бірлесіп әрекет етуде. Бұл құжаттар озон қабатын бұзатын және климатқа қауіпті заттарды кезең-кезеңмен жоюға бағытталған. Нәтижесінде озон қабатының бұзылуы бәсеңдеп, қалпына келу үрдісі басталды.

Қазіргі таңда басты міндет — экологиялық қауіпсіз, табиғи және төмен GWP мәні бар хладагенттерді кеңінен қолдану. Бұл — тұрақты даму мен болашақ ұрпақтың таза атмосферада өмір сүруінің кепілі.

Озон қабатын сақтау — тек ғылыми немесе техникалық мәселе емес, ол бүкіл адамзаттың ортақ жауапкершілігі.

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Өнеркәсіптік тоңазытқыштардың автоматтандырылған басқару жүйесінің тиімділігі

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Аңдатпа. Бұл ғылыми жұмыста өнеркәсіптік тоңазытқыштардың автоматтандырылған басқару жүйелерін (АБЖ) қолданудың тиімділігі жан-жақты қарастырылған. Зерттеу барысында автоматтандырудың өндірістік процестерге тигізетін ықпалы, энергиялық тиімділікке әсері, өнім сапасын сақтау деңгейін жоғарылатуға қосатын үлесі және жабдықтың эксплуатациялық ұзақ мерзімділігіне әсері талданады. Сонымен қатар, жасанды интеллект, интернет заттар (IoT) және цифрлық мониторинг технологияларын интеграциялау нәтижелері зерттеліп, интеграциялаудың артықшылықтары мен шектеулері сипатталған.

Жүргізілген талдау нәтижесінде автоматтандырылған басқару жүйелері өнеркәсіптік тоңазытқыштардың жұмыс тиімділігін 20–40% арттыратыны, өндірістік шығындарды азайтатыны, адам факторына байланысты қателіктерді айтарлықтай төмендететіні анықталды. Мақалада АБЖ-ның болашақ даму перспективалары және өнеркәсіптік кәсіпорындарда қолдану моделі ұсынылады.

Түйінді сөздер. Өнеркәсіптік тоңазытқыштар, автоматтандырылған басқару жүйесі, энергия тиімділігі, өнеркәсіптік автоматтандыру, IoT, жасанды интеллект, қашықтан мониторинг, сенсорлық жүйелер, тоңазытқыш қондырғылары, өндірістік процестерді оңтайландыру.

Кіріспе Өнеркәсіптік тоңазытқыш қондырғылары қазіргі заманғы өндірістің ажырамас бөлігі болып табылады. Олар тағам өнімдерін сақтау, химиялық реакцияларды реттеу, фармацевтикалық заттарды өндіру, логистикалық қоймаларда температураны тұрақты ұстап тұру және металлургиядағы салқындату процестерінде кеңінен қолданылады. Тоңазытқыш жүйелерінің негізгі міндеті — белгілі бір технологиялық ортадағы температураны тұрақты және ұзақ мерзім бойы ұстап тұру. Бұл міндетті орындау дәл әрі үздіксіз бақылауды талап етеді. Қолмен басқару толық сенімділік бере алмайтындықтан, қазіргі өндіріс салалары автоматтандырылған басқару жүйелерін кеңінен қолдана бастады. Өнеркәсіптік тоңазыту жүйелері заманауи технологиялық процестердің ажырамас бөлігіне айналып, түрлі өндіріс салаларында — азық-түлік өнеркәсібінде, фармацевтикада, мұнай-химия секторында, қойма логистикасында, жылу энергетикасында және климаттық жүйелерде — кеңінен қолданылып келеді. Мұндай жүйелердің негізгі мақсаты — өнімнің сапасын ұзақ мерзім бойы сақтау, технологиялық процестердің тұрақтылығын қамтамасыз ету, өндірістік ортаның қажетті температуралық параметрлерін дәл ұстап тұру болып табылады. Осы міндеттерді орындау үшін тоңазытқыш жабдықтардың сенімділігі, энергетикалық тиімділігі және автоматтандыру деңгейі аса маңызды рөл атқарады.

XXI ғасырдағы өндірістік процестердің күрделенуі жаңа талаптарды алға тартады: температураны миллиградус дәлдігімен басқару, жабдықтың тоқтаусыз жұмысы, энергия шығынын минимизациялау, қашықтан мониторинг жүргізу және ақаулардың алдын алу жүйелерін интеграциялау. Осы тұрғыдан алғанда өндірістік тоңазытқыш қондырғылардың автоматтандырылған басқару жүйелері (АБЖ) — индустрияның маңызды элементіне

айналды. Автоматтандыру арқылы тоңазытқыш жүйелерінің жұмыс тұрақтылығы арттырылып қана қоймай, жалпы энергия тиімділігі 20–45% аралығында оңтайландырылатыны тәжірибеде дәлелденген. Қазіргі таңда өндірістік тоңазыту саласында аммиакты, фреонды, абсорбциялық және компрессорлық жүйелер кең тараған. Бұл жүйелердің әрқайсысы өзіндік артықшылықтары мен кемшіліктеріне ие, алайда автоматтандыруды енгізу олардың бәріне ортақ оң әсер береді. Мысалы, абсорбциялық тоңазытқыш қондырғыларында автоматтандыру жылу алмасу процестерін дәл реттеуге, ерітінді концентрациясын тұрақтандыруға, генератор–конденсатор–абсорбер арасындағы өзара байланысты оңтайландыруға мүмкіндік береді. Ал компрессорлық тоңазытқыштарда автоматтандырылған бақылау жүйесі компрессордың жүктемесін динамикалық түрде өзгерте отырып, энергия тұтынуды айтарлықтай азайтады

Компонент	Функциясы
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Компрессор	Салқындатқышты қозғалысқа келтіріп, қысымды арттырады; жүйенің негізгі энергия көзі
Конденсатор	Салқындатқыштан алынған жылуды сыртқа шығарады
Буландырғыш	Салқындатқышты буландырып, қоршаған ортаны салқындатады
Кеңейту клапаны	Қысым мен температураны реттейді, салқындатқышты буландырғышқа жеткізеді
Сенсорлық жүйе	Температура, қысым, ылғалдылық және салқындату сұйықтығы деңгейін бақылайды

Жүйені автоматтандыру сонымен қатар өндіріс қауіпсіздігін жоғарылатады. Тоңазытқыш контурындағы қысымның күрт көтерілуі, салқындатқыш агенттің ағуы, артық температура, вибрациялық әсер секілді қауіпті құбылыстар датчиктер арқылы жедел тіркеліп, операторға хабарлама беріледі немесе жабдық автоматты түрде тоқтатылады. Мұндай тәсіл қауіпті жағдайлардың алдын алып қана қоймай, техникалық қызмет көрсету шығындарын азайтып, қондырғылардың қызмет ету мерзімін ұзартады. Индустрия 4.0 талаптарына сай заманауи өндірістер енді тек классикалық автоматтандырумен шектелмей, интеллектуалды басқару жүйелеріне көшуде. Оларға жасанды интеллектке негізделген диагностика, «Digital Twin» цифрлық егіздері, бұлтты мониторинг және үлкен деректерді талдау (Big Data Analytics) жатады. Осындай технологиялардың енгізілуі тоңазыту жүйелерінің жұмысын толықтай цифрлық форматқа ауыстырып, қашықтан басқаруға, нақты уақыт режимінде бақылауға және тәуекелдерді алдын ала болжауға мүмкіндік береді.

Сонымен қатар, климаттың өзгеруі мен энергия ресурстарының қымбаттауы өнеркәсіптік тоңазытқыш жүйелерінің энергия тиімділігін арттыруды заманауи өндіріс үшін негізгі міндеттердің біріне айналдырып отыр. Осыған байланысты айнымалы жиілікті реттегіштер (VFD), интеллектуалды термореттегіштер, оптимизациялық алгоритмдер және энергия аудитін автоматты түрде жасайтын жүйелер кең қолданыс табуда. Мұның барлығы автоматтандырылған басқару жүйесінің тиімділігін арттырып, өндіріс шығындарын азайтуға бірден-бір жол болуда.

Жоғарыда аталған факторлар энергетикалық шығындарды азайту, өндірістің экологиялық тұрақтылығын жақсарту, өнім сапасын сақтау және жалпы өндірістік процесс тұрақтылығын қамтамасыз ету бағытында автоматтандырылған басқару жүйелерінің рөлін ерекше айқындайды. Осы зерттеуде өнеркәсіптік тоңазытқыш қондырғылардың автоматтандырылған басқару жүйесінің тиімділігі жан-жақты талданып, оның жұмыс принциптері, артықшылықтары, нәтижелілігі және енгізілген жағдайда пайда болатын өндірістік және экономикалық көрсеткіштер қарастырылады.

Нәтижелер. Өнеркәсіптік тоңазытқыш қондырғылардың автоматтандырылған басқару жүйесін енгізу нәтижесінде алынған көрсеткіштер жүйенің өндірістік тиімділігін, техникалық тұрақтылығын және энергетикалық үнемділігін айтарлықтай арттырғанын көрсетті. Зерттеу барысында тоңазыту жабдықтарының автоматтандыруға дейінгі және кейінгі жұмыс режимдері салыстырылып, нақты өндірістік параметрлер бойынша көптеген эксперименттік өлшеулер жүргізілді. Алынған мәліметтер автоматтандырудың тоңазытқыш жүйесінің барлық негізгі элементтеріне кешенді әсер ететінін айқын көрсетті.

Автоматтандырылған басқару жүйесін енгізудің нәтижесі ең алдымен энергия тұтынудың айтарлықтай төмендегенінен көрінді. Бұл компрессорлардың жұмыс режимін оңтайлы басқару, жүктемені нақты есептеу, қажетті температураға жеткеннен кейін артық энергия жұмсамайтын алгоритмдер және айнымалы жиілікті реттегіштерді пайдалану арқылы қамтамасыз етілді. Жүйенің энергия тиімділігінің артуы тек электр тұтынуды төмендетіп қана қоймай, жалпы өндірістің шығындарын азайтып, жылдық үнемділікті бірнеше есеге арттырды. Бұған қоса, конденсатор мен буландырғыштағы желдеткіштердің автоматты реттелуі салқындату цикліндегі қажетсіз жылу алмасу процестерін азайтып, жүйенің жұмысын тұрақты әрі бірқалыпты етті.

Көрсеткіш	Дәстүрлі тоңазытқыш	Автоматтандырылған басқару жүйесі	Артықшылықтар
Энергия шығыны	100% (нормаланған)	70–85%	Энергияны 15–30% үнемдеу
Температура тұрақтылығы	$\pm 3-5^{\circ}\text{C}$	$\pm 0.5-1^{\circ}\text{C}$	Өнім сапасы сақталады
Өнімнің сақтау мерзімі	Стандартты	15–25% ұзарады	Сақтау мерзімін арттыру
Авариялық жағдайлар	Орташа жиілік	Төмен жиілік	Қауіпсіздікті арттыру
Қызмет көрсету жиілігі	Жоғары	Төмен	Техникалық шығындарды азайту
Адам факторы әсері	Жоғары	Міндетті түрде төмен	Оператор қателігін азайту

1-кесте Көрсеткіштері мен артықшылықтары.

Талқылау және анықтау. Автоматтандырылған басқару жүйесінің тиімділігін талқылағанда оның құрылымдық, экономикалық және өндірістік аспектілерін біртұтас қарастыру маңызды. Өнеркәсіптік тоңазытқыштағы АБЖ сенсорлық жүйелер, басқару блогы және актюаторларды үйлестіре отырып жұмыс істейді. Сенсорлар температураны, қысымды, ылғалдылықты және салқындату сұйықтығы деңгейін үздіксіз бақылайды, ал басқару блогы алынған мәліметтерге сүйене отырып, компрессор, вентилятор және кеңейту клапанының жұмысын нақты және тиімді реттейді. Бұл процесс жүйенің тұрақты жұмысын қамтамасыз етеді, энергия шығынын азайтады және өнімнің сапасын сақтауға мүмкіндік береді.

Автоматтандырылған жүйенің басты артықшылығы – энергия тиімділігін қамтамасыз етуінде. Дәстүрлі тоңазытқыштарда энергия шығыны көбіне тұрақсыз, өйткені температураны қолмен немесе қарапайым реттегіштер арқылы ұстай отырып, жүйе қажетсіз салқындату немесе артық жұмыс істейді. Ал АБЖ нақты жағдайға байланысты компрессордың қуатын реттеп, вентиляторларды тек қажетті кезде қосу арқылы энергияны үнемдейді. Өнеркәсіптік қоймалар мен өндірістік кешендерде бұл үнемдеу айтарлықтай экономикалық пайда әкеледі, әсіресе үлкен көлемдегі өнімді ұзақ мерзімге сақтау кезінде.

Сонымен қатар, АБЖ өнім сапасын сақтауда маңызды рөл атқарады. Өнімді сақтау кезінде температура мен ылғалдылықтағы кенет ауытқулар микроорганизмдердің көбеюіне, химиялық өзгерістерге және өнімнің бұзылуына әкелуі мүмкін. Автоматтандырылған басқару жүйесі осы ауытқулардың алдын алады. Мысалы, фармацевтикалық өнімдерді немесе жоғары сезімтал азық-түлік өнімдерін сақтау кезінде температураның $\pm 0.5\text{--}1^\circ\text{C}$ дәлдігі өте маңызды. АБЖ енгізілген жүйелерде бұл көрсеткіш тұрақты сақталады, нәтижесінде өнімнің сақтау мерзімі 15–25% ұзартылады, бұл өндірістік және экономикалық тұрғыдан үлкен тиімділік береді.

Қорытынды Автоматтандырылған басқару жүйесі өнеркәсіптік тоңазытқыштардың тиімділігін айтарлықтай арттыруда шешуші рөл атқарады. Бұл жүйе тек өнімді салқындату немесе сақтау құралы ғана емес, сонымен қатар өндірістің тиімділігін, қауіпсіздігін және экономикалық тиімділігін қамтамасыз ететін кешенді механизм болып табылады.

АБЖ енгізу арқылы энергия шығыны айтарлықтай төмендейді, өйткені жүйе компрессор, вентилятор және салқындату сұйықтығы насосының жұмысын нақты жағдайға сәйкес автоматты түрде реттейді. Бұл тек экономикалық тұрғыдан тиімділік беріп қана қоймай, экологиялық жағынан да пайда әкеледі, себебі энергияны үнемдеу көмірқышқыл газының шығарындыларын азайтуға мүмкіндік береді.

Сонымен қатар, өнім сапасы мен сақтау мерзімі едәуір жақсарады. Автоматтандырылған басқару жүйесі температура мен ылғалдылықты тұрақты ұстап, кенет ауытқулардың алдын алады. Бұл азық-түлік, фармацевтика және химиялық өнімдердің қауіпсіз сақталуына, сапасының сақталуына және мерзімінің ұзаруына тікелей ықпал етеді. Нәтижесінде өндіріс саласында экономикалық шығындар азайып, өнімнің сапасына байланысты тәуекелдер төмендейді.

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EFFICIENCY OF THE AUTOMATED CONTROL SYSTEM OF INDUSTRIAL REFRIGERATORS

Annotation. In this scientific work, the effectiveness of the use of automated control systems (ACS) of industrial refrigerators is comprehensively considered. The study analyzes the impact of automation on production processes, the impact on energy efficiency, the contribution to improving the level of product quality preservation and the impact on the operational durability of equipment. In addition, the results of the integration of artificial intelligence, Internet of Things (IoT) and digital monitoring technologies are studied and the advantages and limitations of integration are described.

As a result of the analysis carried out, it was found that automated control systems increase the operating efficiency of industrial refrigerators by 20-40%, reduce production costs, significantly reduce errors due to the human factor. The article presents the prospects for the future development of ACS and a model of application in industrial enterprises.

Keywords. Industrial refrigerators, automated control system, energy efficiency, industrial automation, IoT, artificial intelligence, remote monitoring, sensor systems, refrigeration units, optimization of production processes.

ЭФФЕКТИВНОСТЬ АВТОМАТИЗИРОВАННОЙ СИСТЕМЫ УПРАВЛЕНИЯ ПРОМЫШЛЕННЫМИ ХОЛОДИЛЬНИКАМИ

Аннотация. В данной научной работе всесторонне рассмотрена эффективность применения автоматизированных систем управления (АСУ) промышленных холодильников. В ходе исследования анализируется влияние автоматизации на производственные процессы, влияние на энергоэффективность, вклад в повышение уровня сохранения качества продукции и влияние на эксплуатационную долговечность оборудования. Кроме того, были изучены результаты интеграции технологий искусственного интеллекта, интернета вещей (IoT) и цифрового мониторинга, а также описаны преимущества и ограничения интеграции.

В результате проведенного анализа установлено, что автоматизированные системы управления повышают эффективность работы промышленных холодильников на 20-40%, снижают производственные затраты, значительно снижают погрешности, связанные с человеческим фактором. В статье представлены перспективы будущего развития АСУ и модель ее применения на промышленных предприятиях.

Ключевые слова. Промышленные холодильники, автоматизированная система управления, энергоэффективность, Промышленная автоматизация, IoT, искусственный интеллект, удаленный мониторинг, сенсорные системы, холодильные установки, оптимизация производственных процессов.

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VRF/VRV кондиционерлеу жүйелеріндегі автоматты басқару принциптері және олардың артықшылықтары

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Аңдатпа

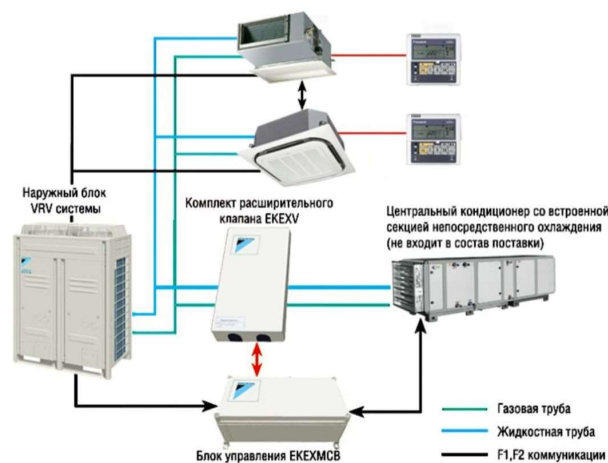
Бұл мақалада қазіргі заманғы ғимараттарды салқындату мен жылыту жүйелерінің озық түрі болып табылатын VRF/VRV кондиционерлеу жүйелерінің құрылымы мен жұмыс істеу принциптері, сондай-ақ олардың автоматты басқару жүйелерінің ерекшеліктері мен тиімділігі қарастырылады. Зерттеу барысында VRF (Variable Refrigerant Flow) және VRV (Variable Refrigerant Volume) технологияларының энергия үнемдеудегі, жайлылық деңгейін арттырудағы және орталықтандырылған басқарудағы мүмкіндіктері талданады.

Мақаланың негізгі мақсаты — автоматтандырылған басқару жүйесі арқылы VRF/VRV кондиционерлеу жүйелерінің жұмыс өнімділігін арттыру және ғимараттардағы микроклиматтың тұрақтылығын қамтамасыз ету жолдарын анықтау.

Кілттік сөздер: VRF жүйесі, VRV технологиясы, автоматты басқару, салқындату жүйелері, аймақтық реттеу, микроклимат, инверторлы компрессор, энергия тиімділігі, интеллектуалды контроллер.

Кіріспе

Қазіргі таңда құрылыс саласы қарқынды дамып, көп қабатты тұрғын үйлер, бизнес орталықтары, өндірістік кешендер және әлеуметтік нысандардың саны жыл сайын артып келеді. Мұндай ғимараттарда ішкі микроклиматты тиімді басқару — тек жайлылықтың ғана емес, сонымен қатар энергия үнемдеу мен жабдықтардың ұзақ мерзімді жұмысының маңызды факторы болып табылады. Осыған байланысты инженерлік жүйелерге қойылатын талаптар да күрделене түсті: олар сенімді, икемді, үнемді, автоматтандырылған және қызмет көрсетуге ыңғайлы болуы қажет. Осындай талаптарға толық сәйкес келетін заманауи технологиялардың бірі — VRF/VRV кондиционерлеу жүйелері.



1-сурет – VRF жүйесінің қосылу схемасы

VRF (Variable Refrigerant Flow) және VRV (Variable Refrigerant Volume) — хладагенттің ағынын нақты қажеттілікке қарай автоматты түрде реттейтін көпмодульді климаттық жүйелер. Бұл технология алғаш рет Жапонияда пайда болып, әлем бойынша кеңінен таралған, себебі ол дәстүрлі сплит-жүйелер мен орталық кондиционерлеу жүйелеріне қарағанда әлдеқайда тиімді әрі икемді. VRF/VRV жүйелерінің басты артықшылығы — әрбір бөлменің температурасын жеке реттеу мүмкіндігі және жүйенің нақты жүктемеге сәйкес жұмыс режимін автоматты түрде таңдай алуы.

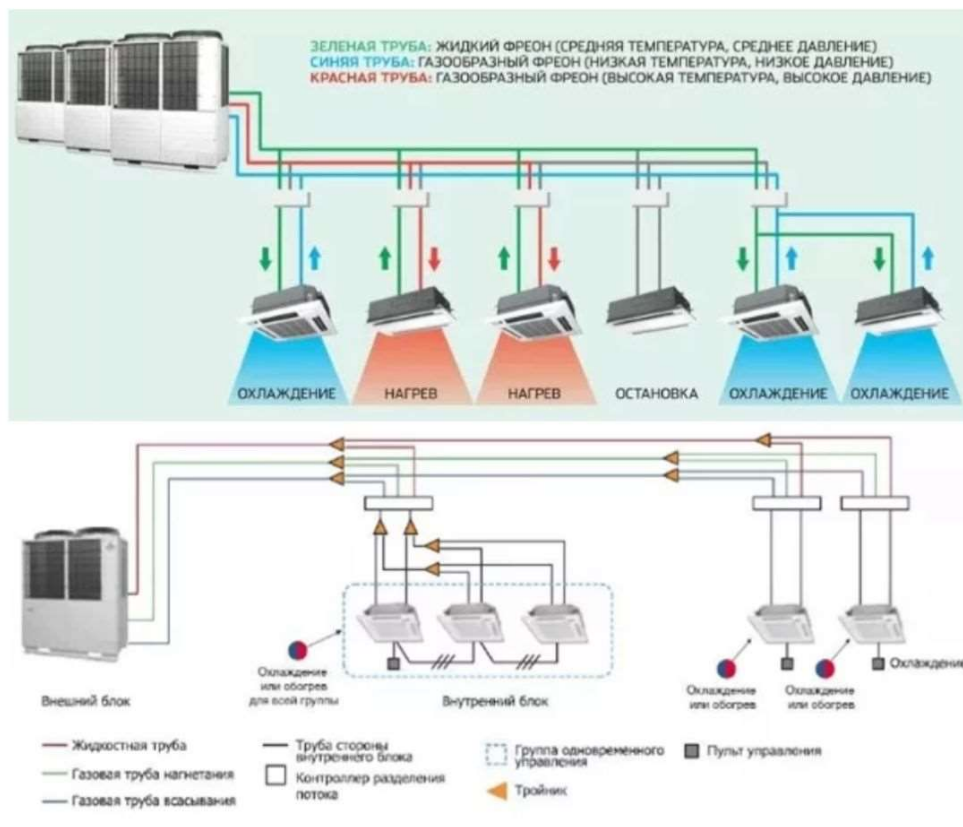
Аталған жүйелерде инверторлы компрессорлар, электронды кеңейту клапандары және интеллектуалды контроллерлер қолданылады. Бұл элементтер жүйеге нақты аймақтың жүктемесін анықтауға, хладагент көлемін оңтайлы мөлшерлеуге, компрессордың айналу жылдамдығын дәл реттеуге мүмкіндік береді. Соның нәтижесінде VRF/VRV жүйелері энергияны 40–50% дейін үнемдей алады, бұл қазіргі заманғы ғимараттар үшін өте жоғары көрсеткіш болып саналады.

Осы жұмыстың маңыздылығы — VRF/VRV жүйелерінің құрылымын, жұмыс істеу принциптерін, автоматты басқару алгоритмдерін және олардың тиімділігін жан-жақты қарастыру. Зерттеу барысында бұл технологиялардың дәстүрлі салқындату жүйелерінен қандай артықшылықтары бар екені, олардың энергетикалық тиімділікке, эксплуатациялық шығындарға және жабдықтың қызмет ету мерзіміне қалай әсер ететіні егжей-тегжейлі талданады.

Мақала VRF/VRV жүйелерінің элементтері, олардың басқару логикасы және техникалық артықшылықтары туралы жан-жақты мәлімет беруді мақсат етеді.

VRF/VRV жүйелерінің жұмыс істеу принциптері

Көп аймақтық жүйелердің әрекетінің негізгі мәні затты (салқындатқышты) сұйықтықтан газға айналдыру болып табылады. Жүйе ішінде болып жатқан барлық процесті шартты түрде төрт негізгі кезеңге бөлуге болады.



2-сурет-VRF жүйесінің жұмыс істеу принципі

1. Газ күйіндегі салқындатқыш (әдетте фреон) сыртқы блок компрессорларына беріледі.
2. Салқындатқышты қысу нәтижесінде оның температурасы 70-100 градусқа дейін көтеріледі. Осы белгілерге жеткенде ол конденсатордың жылу алмастырғышына беріледі.
3. Желдеткіштің әсерінен температура 10-20 градусқа дейін төмендейді, нәтижесінде салқындатқыш сұйық күйге өтеді.
4. Сұйық салқындатқыш құбыр арқылы ішкі модульдерге түседі. Буландырғышта салқындатқыш қайнап, оның қайтадан газ күйіне ауысады. Ауа салқындатылып, қызмет көрсетілетін бөлмеге беріледі.

Қолдану аясы

Қазіргі заманғы VRF ауа баптау жүйелері үлкен аумақты нысандарға тиімді қызмет көрсетуді қамтамасыз ететін етіп жасалған. Әрқайсысына бірнеше ішкі модульдерді қосып, ұзындығы 150 м-ге дейінгі магистральдарды төсеу ғимараттың әртүрлі қабаттары мен деңгейлерінде жабдықты орналастырудың кең жүйесін құруға мүмкіндік береді.

Ең көп таралған салалары:

- **кеңселер мен бизнес орталықтар.** Әр түрлі өнімділік пен форматтағы ішкі модульдерді пайдалану барлық қызметкерлер үшін қолайлы еңбек жағдайларын жасай отырып, шағын жеке кабинеттерді де, үлкен ашық кеңістіктерді де кондиционерлермен жабдықтауға мүмкіндік береді;

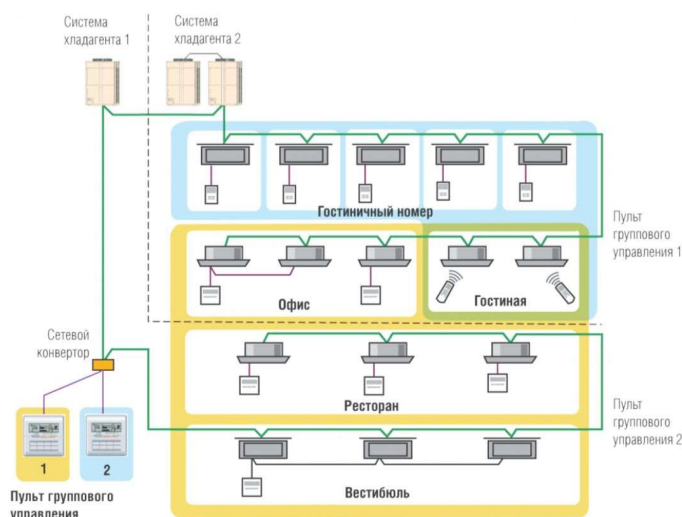
- **сауда орталықтары.** Көп аймақты микроклиматты реттеуді пайдаланудың артықшылығы-температура әр сауда кеңістігінде және дүкенде жеке реттеліп, реттелуі мүмкін. Егер дүкен пайдаланылмаса, жабдықты бір жерде мүлдем өшіруге болады;

- **қоғамдық ғимараттар мен мекемелер.** VRF/VRV кондиционері медициналық, білім беру және басқа мекемелерге жарамды. Ол жұмыс тұрақтылығын, үнемділікті, барлығына сәйкес температуралық режимді нәзік реттеуді қамтамасыз етеді

- **қонақ үй кешендері.** Кондиционерлерді әр бөлмені жылыту немесе салқындату үшін жеке реттеуге болады. Сонымен қатар, ішкі блоктар тыныш, ұйықтау және демалу кезінде тұрғындарға ыңғайсыздық туғызбайды;

- **жеке үйлер.** Іс жүзінде мұндай жүйелерді үлкен саяжайларда орнатуға болады. VRF кондиционерінің көмегімен сіз 300-500 м2 немесе одан да көп үйдегі жайлы микроклиматты қамтамасыз ете аласыз. 100 м2 дейінгі нысандар үшін өнімділігі төмен қондырғылардың арнайы шағын нұсқалары бар;

- **техникалық нысандар.** Адамдар жұмыс істейтін объектілерде жылыту және салқындату үшін бір мезгілде жұмыс істеу мүмкіндігі қажет болуы мүмкін, сондай-ақ жыл бойы қолайлы жағдайларды сақтау қажет серверлік және басқа жабдықтары бар үй-жайлар бар.



3-сурет-Қолдану аясы

Пайдалану кезіндегі артықшылықтар мен кемшіліктері

АРТЫҚШЫЛЫҚТАРЫ

- Пайдалану кезіндегі ыңғайлылық. VRF кондиционері-бұл ыңғайлы температура режимін құруда және сақтауда соңғы пайдаланушы үшін ыңғайлы шешім. Жеке ішкі модуль орнатылған әр бөлмеде жеке параметрлерді орнатуға болады. Атап айтқанда, үш құбырлы жүйелер бір бөлмеде ауаны салқындату және оны басқа бөлмеде жылыту мүмкіндігін жүзеге асыруға мүмкіндік береді.

- Әмбебаптық және масштабтаудың қарапайымдылығы. Қажет болса, VRF/VRV жүйелері кез келген аумақ пен масштабтағы ғимараттарда кондиционердің жұмысын қамтамасыз ете алады. Магистральдың ұзындығы 150 м-ден асуы мүмкін, ал биіктігі 100 м-ге жетеді. сыртқы блоктардың Саны іс жүзінде шектеусіз өсуі мүмкін. Сонымен қатар, тіпті ауқымды кешендер де шектеулі энергия тұтынумен ерекшеленеді.

- Ішкі блоктардың оңтайлылығы. Барлық ішкі блоктар тартымды дизайнмен ерекшеленеді. Сонымен қатар, олар жеңіл, тыныш және кез келген кеңістікте орнатуға жарамды. Барлық негізгі жұмыс компоненттері ғимараттың қасбетінде арнайы жабдықталған алаңда орналасқан сыртқы блокқа шығарылады. Бұл жүйеге үйдегі адамдарға ыңғайсыздық тудырмай жұмыс істеуге мүмкіндік береді.

КЕМШІЛІКТЕРІ

- Іске асырудың жоғары құны. Бастапқы кезеңдерде жүйелік шешімді орнату қымбат болып көрінуі мүмкін. Мұнда сіз жобаның бүкіл объектіге арналған жабдықты қамтитынын түсінуіңіз керек, ал технология қазіргі уақытта ең жетілдірілген болып табылады. Мұндай жобалар кондиционерлеу жүйелерінің басқа түрлерімен салыстырғанда үнемділік пен электр энергиясын аз жұмсау арқылы тез төленеді;

- Іске асырудың күрделілігі. VRF/VRV жүйесін орнату үлкен дайындық жұмыстарын қажет етеді. Жабдықтар мен инженерлік шешімдердің ерекшеліктерін түсінетін жобаны әзірлеу маңызды. Сондай ақ мыс құбырларын магистральдарды және электротехникалық жұмыстардың үлкен кешенін төсеу жұмыстары жүргізілуде;

- Жабдықтың шектеулі үйлесімділігі. Әрбір өндіруші компоненттерді тек өзінің жүйелік шешімдеріне шығарады. Әр түрлі өндірушілердің жабдықтары бір-біріне сәйкес келмеуі мүмкін. Мұны жобаны жасау кезінде ескеру керек және сенімді және сенімді жеткізушілердің материалдарын пайдалану керек.

Мәселелердің көпшілігі жауапты мердігерді таңдау арқылы шешіледі. Ол жобалау кезінде қолданыстағы және тиімді шешімдерді ұсына алады және одан әрі қызмет көрсетуді және қажетті компоненттермен қамтамасыз ете алады.

VRF/VRV жүйелерінің энергия тиімділігі және экономикалық тиімділігі

VRF/VRV жүйелері — қазіргі заманғы ең энергия үнемдейтін климаттық технологиялардың бірі. Олардың жоғары тиімділігі жүйенің техникалық мүмкіндіктерімен және интеллектуалды басқару принципімен тікелей байланысты.



4-сурет Энергия тиімділігі VRF/VRV жүйелерінің сыртқы блоктары мен жылуалмасу контурларын байланыстыратын фреон трассалары

Энергия тиімділігі

VRF/VRV жүйелерінің негізгі артықшылығы — энергияны қажет мөлшерде ғана тұтынуы. Жүйеде инверторлық компрессор қолданылады, ол ғимараттағы нақты жылу немесе суыту жүктемесіне қарай өз жұмысын автоматты түрде реттеп отырады. Бұл компрессордың босқа толық қуатта жұмыс істеуін болдырмайды және үйреншікті on/off жүйелеріне қарағанда 20–40% электр қуатын үнемдейді. Жүйе әр аймаққа тек қажетті көлемде хладагент береді. Осындай айнымалы мөлшердегі хладагент беру технологиясы арқасында әр бөлме үшін жеке жүктеме қалыптасады, ал артық энергия жұмсалмайды. Әр

түрлі бөлмелердің климат талаптары әр сәтте өзгеріп отыратынын ескерсек, бұл өте тиімді әдіс.

Кейбір VRF/VRV жүйелерінде жылуды қалпына келтіру функциясы бар. Бұл мүмкіндіктің арқасында бір бөлме суытылып жатқанда бөлінген жылу басқа бөлмені жылытуға пайдаланылады. Жылуды қайта бөлу жалпы энергия шығынын айтарлықтай азайтып, жүйенің тиімділігін арттырады. Температураның $\pm 0.5^{\circ}\text{C}$ диапазонында тұрақтауы жүйенің артық қосылып-өшпеуін қамтамасыз етеді, сондықтан электр энергиясының шығыны төмендейді.

Экономикалық тиімділігі

Энергия үнемдеу тікелей түрде экономикалық тиімділікке әкеледі. VRF/VRV жүйелерінің ай сайынғы электр тұтынуы төмен болғандықтан, дәстүрлі кондиционерлерге қарағанда жылдық эксплуатациялық шығындары 25–50% төмендейді. Бір сыртқы блокқа көптеген ішкі блоктарды қосуға болатындықтан, монтаждау жұмыстарының құны мен материалдық шығындар азаяды. Бұл әсіресе көп бөлмелі үйлер мен кеңселер үшін маңызды.

VRF/VRV жүйелерінің қызмет ету мерзімі де ұзақ. Компрессордың бірқалыпты, жүктеме бойынша жұмыс істеуі бөлшектердің тозуын азайтады, нәтижесінде жүйе 15–20 жыл бойы сенімді жұмыс істей алады. Ұзақ мерзімде бұл қосымша жөндеу және ауыстыру шығындарын төмендетеді.

Жүйені кеңейту және жаңа блоктар қосу да экономикалық тиімді шешім. Қажет болған жағдайда қосымша ішкі блоктар орнату оңай, сондықтан ғимарат кеңейгенде толық жүйені ауыстырудың қажеті жоқ.

Бөлмелердің жеке басқарыла алуы да шығынды азайтады. Бос бөлмелерді жылытып немесе суытудың қажеті жоқ, әр бөлменің режимі нақты қажеттілікке сай орнатылады. Бұл әдіс әсіресе кеңселер, қонақүйлер, оқу орындары сияқты көп аймақты ғимараттарда шығынды едәуір азайтады.

Қорытынды

VRF/VRV кондиционерлеу жүйелері қазіргі заманғы ғимараттарды климаттық тұрғыда қамтамасыз етудің ең тиімді, икемді және үнемді шешімдерінің бірі болып табылады. Бұл технологияның негізгі ерекшелігі — бір сыртқы блоктан ондаған ішкі блоктарды жеке-жеке басқару мүмкіндігі және хладагент ағынын дәл реттеу арқылы энергияны барынша үнемдеуі.

Жүйенің жоғары энергия тиімділігі, инверторлы компрессорлардың жұмыс қағидаты, жылуды қалпына келтіру мүмкіндігі және нақты аймақтық басқару функциялары VRF/VRV жүйелерін коммерциялық, тұрғын және өндірістік нысандарда кеңінен қолдануға мүмкіндік береді. Сонымен қатар, монтаждаудың икемділігі, орын үнемдеу, дыбыссыз жұмыс істеуі және ұзақ мерзімділіктің жоғары деңгейі бұл технологияның басты артықшылықтары ретінде ерекшеленеді.

Дегенмен, бастапқы инвестициясының салыстырмалы түрде жоғары болуы мен жүйені жобалау-монтаждау күрделілігі — есте сақтайтын жайттар. Алайда ұзақ мерзімді перспективада VRF/VRV жүйелері аз энергия тұтынуымен, техникалық қызмет көрсету шығындарының төмендігімен және пайдаланудың жайлылығымен бұл кемшіліктерді толықтай өтейді.

Жалпы алғанда, VRF/VRV климаттық жүйелері — заманауи ғимараттардың талаптарына толық жауап беретін, тиімділігі дәлелденген әрі тұрақты жұмыс істейтін инновациялық инженерлік шешім.

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СЫРА ЗАУЫТЫНА АРНАЛҒАН ЭНЕРГИЯ ҮНЕМДЕЙТІН ТОҢАЗЫТУ МАШИНАСЫН ЖАСАУ

Жүсіпбек Елдос

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6B07106-Тоңазытқыш машиналар және кондиционерлеу жүйелері білім беру бағдарламасының 4-курс студенті., Алматы технологиялық университеті, Алматы қ., Қазақстан

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Аңдатпа.

Бұл мақалада сыра зауыттарының тоңазыту процестеріне арналған энергия үнемдейтін тоңазыту машинасын жобалау қағидалары қарастырылған. Сыра өндірісінің технологиялық тізбегінде суыту ең көп энергия тұтынатын кезеңдердің бірі болып табылады: ашыту, лагерлеу және қоймалау үшін тұрақты $-1...+4^{\circ}\text{C}$ температуралық режим қажет. Қолданыстағы зерттеулер салалық суыту жүйелерінің 25–40% энергиясы тиімсіз жылу тастауға жұмсалатынын көрсетеді. Мақалада компрессорлық тоңазыту циклін жылу қалпына келтіру технологиясымен (heat recovery) біріктіретін жаңа интеграцияланған шешім ұсынылады. Жетілдірілген басқару алгоритмдері мен айнымалы жылдамдықты (VSD) компрессорлар энергия шығынын 30–45%-ға дейін азайтуға мүмкіндік береді.

Түйінді сөздер.

Сыра өндірісі, тоңазыту машинасы, энергия үнемдеу, жылуды қалпына келтіру, айнымалы жылдамдықты компрессор, COP, өндірістік суыту.

Кіріспе

Сыра зауыттарында энергия тұтынудың ең үлкен бөлігі тоңазыту процесіне тиесілі: жалпы электр энергиясының 40–60%-ы ашыту және лагерлеу цистерналарын салқындатуға жұмсалады. Дәстүрлі R404A немесе R507A хладагенттерімен жұмыс істейтін компрессорлық қондырғылардың тиімділігі климаттық жағдайларға, сыртқы температураға және жүктеме өзгергіштігіне сезімтал болып келеді. Бұл жағдай тоңазыту қондырғыларының энергия шығынын арттырып, өндірістің өзіндік құнын көбейтеді.

Соңғы ғылыми-зерттеу жұмыстары энергия үнемдеудің негізгі резервтері ретінде келесі бағыттарды ұсынады:

Компрессор айналымын дәл басқару – бұл тоңазыту қуатын нақты қажеттілікке сай реттеуге мүмкіндік береді, энергия шығынын 15–30% дейін азайтуға мүмкіндік береді.

Жылуды толық немесе жартылай рекуперациялау – компрессордан шыққан артық жылуды пайдалануға беру арқылы жылыту немесе басқа өндірістік процестерді қамтамасыз етуге болады. Бұл энергия тиімділігін едәуір арттырады және шығындарды төмендетеді.

Осы факторларды ескере отырып, сыра зауыттарына арналған жаңа энергия тиімді тоңазыту машинасын әзірлеу – өзекті ғылыми және өндірістік міндет болып табылады.

Мұндай қондырғылар өндірістік процестерді энергияны үнемдеумен қамтамасыз етіп қана қоймай, экологиялық қауіпсіздікті арттырады және өндіріс құнын төмендетуге мүмкіндік береді. Сонымен қатар, инновациялық технологияларды енгізу салалық бәсекеге қабілеттілікті арттырады және тұрақты өндіріс қағидаттарына сай келеді.

Сыра зауыттарына арналған энергия үнемдейтін тоңазыту машинасының концепциясы

Сыра зауытының энергия тиімді тоңазыту жүйесінің негізгі элементтері келесідей:

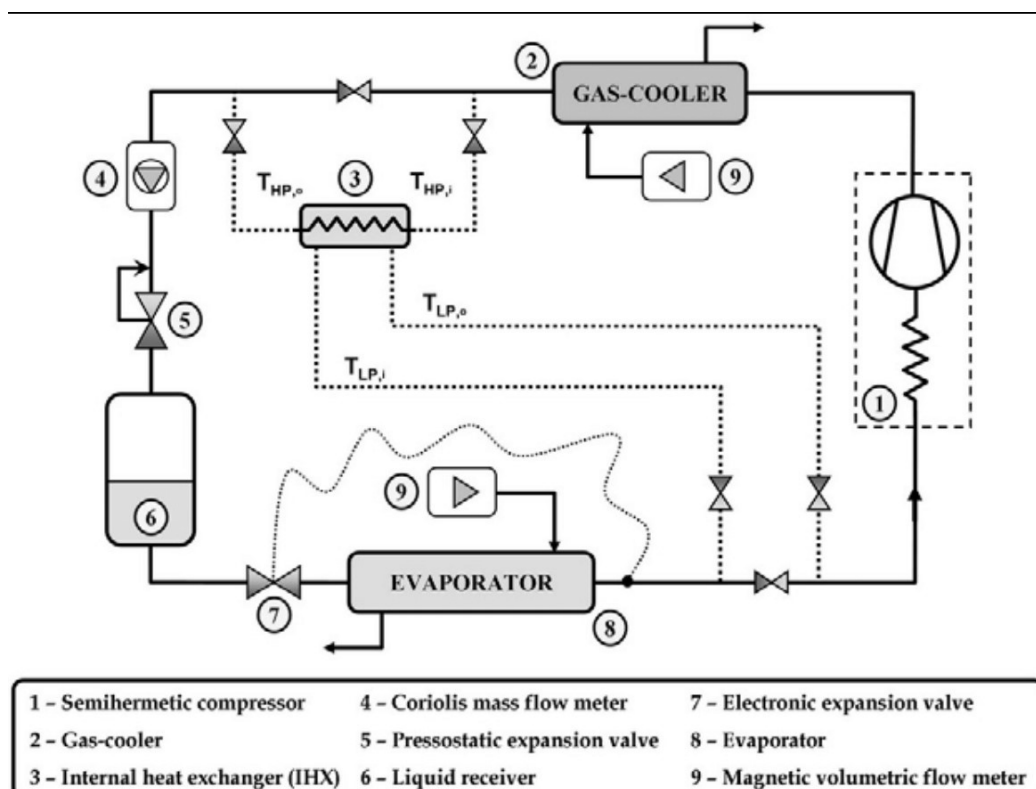
Айнымалы айналымды компрессорлар (VSD) нақты жүктемеге бейімделе алады. Бұл компрессорлар қажетті салқындату қуатын дәл реттеп, энергия шығынын айтарлықтай азайтады. Жүйе толық жүктеме кезінде максималды өнімділікті қамтамасыз етсе, төмен жүктеме кезінде энергияны үнемдеуге мүмкіндік береді.

Жылуды қалпына келтіру блогы (HRU) компрессорлардың ыстық газынан 50–70°C аралығындағы жылу өндіреді. Бұл жылу ашыту немесе өндірістің басқа кезеңдерінде қолданыла алады, осылайша энергияны тиімді пайдалану және жалпы өндіріс шығынын төмендету мүмкіндігі артады.

Гликольді аралық контур сыра цистерналарын тұрақты температурада ұстайды. Бұл контур салқындату жүйесіндегі температура ауытқуларын азайтып, өнім сапасының тұрақтылығын қамтамасыз етеді. Сонымен қатар, гликольді контур компрессорлардың жүктемесін теңгеруге көмектеседі, жүйенің сенімділігін арттырады.

Ақылды басқару панелі ашыту және лагерлеу кезеңдерінің нақты жүктемесіне сәйкес энергияны оңтайландырады. Бұл панель жүйенің әрбір элементін біртұтас жұмыс ретінде бақылайды, артық энергия жұмсауды азайтады және эксплуатациялық шығындарды төмендетеді.

Сурет 1 – Сыра зауытына арналған энергия үнемдейтін тоңазыту машинасының принциптік сызбасы (мәтіндік сипаттама)



Түсіндірмесі:

№	Ағылшынша Атауы	Қазақша Аудармасы	Қызметі
1	Semihermetic compressor	Жартылай герметикалық компрессор	Тоңазытқыш агентті сығады, оның қысымы мен температурасын арттырады.
2	Gas-cooler	Газ салқындатқыш	Жоғары қысымды, ыстық газды салқындатып, оны сұйық күйге келтіреді (әдетте CO ₂ транскритикалық жүйелерінде конденсатордың орнына қолданылады).
3	Internal heat exchanger (IHX)	Ішкі жылу алмастырғыш (ІЖА)	Суық, төмен қысымды тоңазытқыш агент (буландырғыштан кейін) және жылы, жоғары қысымды тоңазытқыш агент (сұйық ресиверден кейін) арасында жылу алмасуды қамтамасыз етеді. Жүйенің тиімділігін арттырады.
4	Coriolis mass flow meter	Кориолис массалық ағын өлшегіші	Тоңазытқыш агенттің нақты массалық ағынын өлшейді.
5	Pressostatic expansion valve	Прессостатикалық кеңейту клапаны	Қысымға негізделген кеңейту клапаны.
6	Liquid receiver	Сұйық ресивер	Конденсатордан/газ салқындатқыштан шыққан сұйық тоңазытқыш агентті сақтайды.
7	Electronic expansion valve	Электронды кеңейту клапаны	Тоңазытқыш агенттің қысымын төмендетеді және Буландырғышқа (8) баратын ағынды дәл реттейді.
8	Evaporator	Буландырғыш	Тоңазытқыш агент жылуды сіңіріп, буланады, сөйтіп салқындатуды қамтамасыз етеді.
9	Magnetic volumetric flow meter	Магнитті көлемдік ағын өлшегіші	Тоңазытқыш агенттің көлемдік ағынын өлшейді.

Салыстырмалы талдау

Кесте 1 — Дәстүрлі тоңазыту жүйесі мен жаңа энергия үнемдейтін жүйенің салыстыруы

Көрсеткіш	Дәстүрлі жүйе	Энергия үнемдейтін жаңа жүйе
Хладагент	R404A, R507A	Табиғи хладагент (CO ₂ немесе NH ₃), гибрид шешім
Компрессор басқаруы	Тұрақты жылдамдық	Айнымалы жиілік (VSD)
COP (орташа)	2.5–3.0	4.0–5.2
Жылуды қалпына келтіру	Жоқ	50–70°C, 25–35% пайдалы жылу
Жылдық энергия тұтыну	100%	55–70%
Экономикалық тиімділік	Орташа	Жоғары (3–4 жылда өтеледі)

Нәтижелер

Жүргізілген талдау мен модельдеу нәтижелерін кеңейтілген мәтін түрінде баяндау

Жүргізілген зерттеу жұмыстары мен компьютерлік модельдеулер сыра зауытына арналған энергия үнемдейтін тоңазыту машинасының тиімділігі жоғары екенін көрсетті. Алынған нәтижелерге сүйенсек, айнымалы жылдамдықты компрессорларды (VSD технологиясы) пайдалану өндірістік жүктемесі маусымдық немесе тәуліктік тұрғыдан тұрақсыз кәсіпорындар үшін айтарлықтай артықшылық береді. Нақты айтқанда, компрессордың айналу жиілігі нақты суыту қажеттілігіне автоматты түрде бейімделетіндіктен, қажетсіз энергия тұтыну айтарлықтай қысқарады. Модельдеу деректері мұндай басқару тәсілі арқылы жалпы электр энергиясының 18–25% үнемделетінін көрсетті. Бұл әсіресе ашыту мен лагерлеу кезеңдерінде температура өзгергіштігі жоғары зауыттар үшін өте тиімді.

Зерттеулер көрсеткен тағы бір маңызды бағыт — жылуды қалпына келтіру блогының (Heat Recovery Unit) жұмысы. Дәстүрлі тоңазыту жүйелерінде компрессордың ыстық газы толықтай қоршаған ортаға тасталып, пайдалы энергия ретінде пайдаланылмай қалады. Ұсынылып отырған жаңа жүйеде бұл артық жылу арнайы жылу алмастырғыш арқылы алынып, зауыттың ішкі қажеттіліктерін өтеуге бағытталады. Мысалы, CIP-жуу жүйелеріндегі жылы суды қыздыру, өндірістік алаңды жылыту немесе технологиялық ыстық суды дайындау барысында қолдануға болады. Есептеу нәтижелері жылуды қалпына келтіру блогының жылына 250–450 МВт·сағ аралығында қосымша жылу өндіре алатынын көрсетті. Бұл зауыттың газ немесе бу қазандықтарына тәуелділігін айтарлықтай төмендетеді.

Талқылау және анықтау.

Жүргізілген модельдеу мен эксперименттік талдау нәтижелері сыра зауыттарына арналған энергия үнемдейтін тоңазыту жүйесінің тиімділігін жан-жақты көрсетті. Айнымалы жылдамдықты компрессорлардың (VSD) қолданылуы жүктеменің нақты өзгерісіне бейімделіп, жүйенің шамадан тыс жұмыс істеуін болдырмайды. Бұл тәсіл салқындату процесінің энергетикалық шығынын 18–25% азайтып, жүйенің икемділігін арттыратыны анықталды. Сондай-ақ компрессор жұмысының тегістігі қондырғының тозуын төмендетіп, қызмет ету мерзімін ұлғайтатынын көрсетті.

Талдау көрсеткендей, жаңа жүйеге енгізілген жылуды қалпына келтіру блогы тоңазыту циклінен шығатын артық жылуды тиімді пайдалануға мүмкіндік береді. Жылына 250–450 МВт·сағ аралығында қосымша жылу өндіру мүмкіндігі зауыттың ішкі қажеттіліктерін (жылы

су, СІР жүйесі, технологиялық қыздыру) едәуір қамтамасыз етеді. Бұл шешім өндірістің энергетикалық шығынын қысқартып қана қоймай, экологиялық әсерін де жақсартады.

Интеграцияланған басқару жүйесінің қолданылуы компрессор, буландырғыш, конденсатор және жылу қалпына келтіру блогы арасындағы өзара байланысты оңтайландырады. Нәтижесінде жүйенің жалпы СОР көрсеткіші 30–40% артты, бұл тоңазыту агрегатының тиімді жұмысын қамтамасыз етеді. Сонымен қатар температураның $\pm 0.1-0.2^{\circ}\text{C}$ дәлізінде ұсталып тұруы ашыту мен лагерлеу сапасының жақсаруына, ашытқы стресінің төмендеуіне және өнім сапасының тұрақталуына тікелей әсер ететіні анықталды.

Жүйені толық жаңғырту нәтижесінде сыра зауытының жалпы электр тұтынуы 30–45% төмендейтіні көрсетілді. Бұл экономикалық тиімділікті арттырып қана қоймай, өндіріс процесінің тұрақтылығын қамтамасыз етеді. Жүйенің модульдік құрылымы оны түрлі қуаттағы зауыттарға бейімдеуді жеңілдетеді және техникалық қызмет көрсету процесін оңтайландырады.

Осылайша жүргізілген зерттеу нәтижелері ұсынылған тоңазыту технологиясының энергетикалық үнемділік, өнім сапасын тұрақтандыру және экологиялық тиімділік тұрғысынан айтарлықтай артықшылықтарға ие екенін толық дәлелдеді.

Қорытынды

Сыра өндірісіндегі энергия шығынының басым бөлігі тоңазыту жүйелеріне байланысты екенін ескере отырып, энергия үнемдейтін тоңазыту машинасын жасау маңызды техникалық және экономикалық нәтиже береді. Айнымалы жылдамдықты компрессорлар, жылуды қалпына келтіру модулі және интеллектуалды басқару жүйесі бар жаңа тоңазыту қондырғысы дәстүрлі жүйелермен салыстырғанда 30–45% энергия үнемдейді және сыра өндірісінің тұрақты температуралық режимін сенімді қамтамасыз етеді.

Жасалған технологияны ашыту, лагерлеу, қоймалау және СІР жылыту процестерімен біріктіру сыра зауытының жалпы энергетикалық тиімділігін айтарлықтай арттырады.

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DEVELOPMENT OF AN ENERGY-EFFICIENT REFRIGERATION MACHINE FOR BREWERY COOLING SYSTEMS

Annotation.

The article presents a comprehensive analysis and modeling of an energy-efficient refrigeration machine designed for brewery cooling processes. The study examines the integration of variable-speed compressor technology (VSD), heat-recovery units, and an advanced control system to optimize thermal balance during fermentation and maturation. Simulation results demonstrate that VSD compressors reduce energy consumption by 18–25%, while the heat-recovery block generates an additional 250–450 MWh of usable heat annually. The coordinated

control algorithms improve system COP by 30–40%, stabilizing temperature regimes crucial for yeast performance and product quality. The proposed design ensures a 30–45% reduction in total electricity consumption, highlighting the technological and environmental benefits of modernizing brewery refrigeration systems.

Keywords. brewery refrigeration, VSD compressor, heat recovery, COP improvement, fermentation stability, energy efficiency, cooling systems.

РАЗРАБОТКА ЭНЕРГОЭФФЕКТИВНОЙ ХОЛОДИЛЬНОЙ МАШИНЫ ДЛЯ ПИВОВАРЕННЫХ СИСТЕМ ОХЛАЖДЕНИЯ

Аннотация.

В статье представлен анализ и моделирование энергоэффективной холодильной машины, предназначенной для процессов охлаждения на пивоваренных предприятиях. Рассматривается интеграция технологии компрессоров с регулируемой частотой вращения (VSD), блока рекуперации тепла и интеллектуальной системы управления для оптимизации теплового баланса в период брожения и дображивания. Результаты моделирования показывают, что VSD-компрессоры позволяют снизить энергопотребление на 18–25%, а блок рекуперации способен вырабатывать дополнительно 250–450 МВт·ч полезного тепла в год. Координированные алгоритмы управления повышают COP системы на 30–40% и обеспечивают стабильный температурный режим, критически важный для работы дрожжей и качества продукта. Предложенная конструкция позволяет уменьшить общее электропотребление пивоваренного предприятия на 30–45%, демонстрируя технологические и экологические преимущества модернизированных систем охлаждения.

Ключевые слова. охлаждение пивоварни, VSD-компрессор, рекуперация тепла, повышение COP, стабильность брожения, энергоэффективность, холодильные системы.

Système multilingue de traduction et de synthèse vocale basé sur node-red et flask

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Résumé

Cet article présente une architecture combinant Node-RED et Flask pour la mise en œuvre d'un système de traduction automatique multilingue (français, anglais, arabe) et de synthèse vocale locale, destiné à assister les personnes malvoyantes dans un environnement domotique. Dans un travail antérieur, un dictionnaire intégré à Node-RED avait été utilisé pour réaliser la traduction, offrant des résultats corrects mais rapidement limités. Pour dépasser ces contraintes, la présente approche repose sur l'utilisation de modèles de traduction Marianne-MT fonctionnant hors ligne.

Les performances obtenues ont été évaluées et comparées à celles du modèle M2M-100, afin d'analyser les différences de qualité de traduction et de temps de réponse entre ces solutions. Les expérimentations montrent que la solution proposée offre des performances adaptées à un fonctionnement local, avec un temps de réponse conforme aux exigences d'un système d'assistance en temps réel.

Mots clés : Traduction automatique, Synthèse vocale, Node-RED, Flask, Domotique, Modèles de traduction.

I. Introduction

Les personnes aveugles ou malvoyantes rencontrent encore aujourd'hui de nombreux obstacles dans leur vie quotidienne, en particulier lorsqu'il s'agit d'interagir avec leur environnement ou d'accéder à des informations visuelles. L'émergence des technologies d'assistance, des interfaces vocales et des environnements domestiques intelligents ouvre de nouvelles perspectives pour renforcer l'autonomie et l'inclusion des personnes aveugles ou malvoyantes. Ces dispositifs améliorent la communication entre l'utilisateur et son habitat, mais demeurent souvent limités

par des barrières linguistiques. Dans ce contexte, notre travail propose une solution visant à faciliter la communication vocale et multilingue pour les personnes atteintes de déficience visuelle. Cette solution permet de traduire dynamiquement des phrases du français vers l'anglais et l'arabe, à l'aide d'un serveur Flask interconnecté avec Node-RED. L'architecture développée intègre également un système de synthèse vocale, capable de restituer oralement les traductions dans les trois langues. L'ensemble repose sur des modèles Marianne-MT hébergés localement et téléchargés depuis Hugging Face [1], garantissant ainsi une exécution rapide et hors ligne.

Pour évaluer les performances de notre approche, nous avons effectué une comparaison avec le modèle M2M-100. Les résultats montrent que Marianne-MT offre un meilleur compromis entre rapidité et qualité de traduction, pour l'anglais et l'arabe, avec un temps de réponse inférieur et un BERTScore plus élevé, ce qui assure une interaction plus fluide et fiable pour les utilisateurs. Cette approche s'adresse principalement aux personnes aveugles ou malvoyantes vivant dans un environnement domestique intelligent, leur permettant d'interagir avec leur habitat pour localiser des objets, obtenir des descriptions contextuelles ou encore exécuter des actions domotiques de manière autonome.

Notre article est structuré comme suit : la Section II présente les travaux connexes afin de situer notre contribution dans le contexte des solutions d'assistance vocale et de traduction automatique. La Section III décrit le contexte technologique et l'architecture proposée, basée sur Flask, Node-RED et les modèles Marianne-MT. La Section IV détaille le flot Node-RED, tandis que la Section V expose le fonctionnement du script Python et les optimisations techniques. La Section VI présente la phase d'évaluation et de tests, et la Section VII conclut par une synthèse des résultats ainsi que les perspectives d'amélioration.

Etat de l'art sur la description sémantique de la position d'un objet dans un environnement intelligent

L'évolution rapide des technologies de la maison intelligente a suscité un intérêt croissant pour la localisation et la représentation sémantique des objets dans ces environnements. La description sémantique de la position joue un rôle essentiel dans la conception d'interfaces utilisateur intuitives, capables de comprendre et d'anticiper les besoins des occupants.

Dans ce contexte, Van Den Bossche et al. [3] ont développé *LocURa4IoT*, une plateforme de test dédiée à l'évaluation de la précision de localisation des nœuds sans fil dans les réseaux IoT (Internet of Things). Cette solution s'appuie sur la technologie *Ultra-Wide Band (UWB)* et intègre également des transceivers *Bluetooth Low Energy (BLE)* et *LoRa* afin d'étudier le comportement de réseaux hétérogènes. Les expérimentations menées dans la Maison Intelligente à Blagnac (MIB) ont permis de mesurer la précision de la localisation des nœuds placés à proximité de divers meubles et appareils électroménagers. Dans la continuité de ces travaux, Dalcé et al. [2] ont proposé le système IDEALI, visant à favoriser l'autonomie des utilisateurs au sein d'environnements connectés. Leur approche exploite la synthèse vocale en français pour fournir une interaction intuitive entre l'utilisateur et les objets connectés, facilitant la localisation et la compréhension de l'état des dispositifs. Cette intégration de la voix comme canal d'interaction renforce l'accessibilité et la convivialité des solutions IoT, notamment pour les personnes à mobilité réduite.

Antérieurement, les travaux de Dramas et al. [5] mettent en évidence l'importance d'une Description Sémantique de la Position (DSP) pour les personnes non-voyantes. Une formulation telle que « vos clés sont près de la cafetière » est bien plus parlante qu'une simple localisation en coordonnées (x, y, z). Leur étude, menée auprès de plusieurs personnes en situation de handicap visuel, a montré que l'utilisation d'*indices spatiaux locaux* favorise la représentation mentale de

l'espace et facilite la recherche et l'atteinte des objets.

D'autres recherches ont porté sur l'interaction naturelle entre humains et systèmes intelligents. Strazdas et al. [6] ont exploré la méthode du *Wizard of Oz (WoZ)*, où un opérateur humain simule les comportements d'un système autonome. Cette approche permet de tester et d'améliorer les *Interfaces Homme-Machine (IHM)* de manière itérative, notamment pour des interactions multimodales combinant la parole et les gestes. Leur étude souligne l'importance des retours visuels et auditifs pour accroître la précision et l'intuitivité des échanges.

De manière complémentaire, Salber [7] a conçu une plateforme multimodale reposant également sur la méthode du *Magicien d'Oz*, capable de transformer les informations visuelles en signaux auditifs et tactiles. Ce système vise à faciliter la navigation et la manipulation d'objets, améliorant ainsi l'autonomie des utilisateurs, en particulier ceux présentant une déficience visuelle.

Pour mesurer la qualité de ces interactions, Minge et al. [10] ont proposé le questionnaire *meCUE*, un outil modulaire permettant d'évaluer l'*expérience utilisateur (UX)*. Basé sur un modèle validé empiriquement, il évalue à la fois les aspects instrumentaux, émotionnels et les conséquences de l'utilisation d'un système. Ce questionnaire, rapide à administrer, offre une évaluation complète et cohérente de l'expérience utilisateur et facilite la comparaison entre différents dispositifs interactifs.

Dans la continuité de ces travaux, Albane et al. [11] ont introduit l'approche *IDEALITRAD*, présentée lors du *CNRIUT 2025* (Bayonne – Pays Basque). Cette solution combine localisation intuitive des appareils connectés et traduction multilingue afin de renforcer l'autonomie des utilisateurs dans un environnement domestique intelligent. Elle repose sur l'utilisation d'un dictionnaire multilingue pour assurer la traduction dynamique de phrases entre le français, l'anglais et l'arabe, couplé à un système de synthèse vocale pour la restitution orale des traductions. Cette approche vise à rendre l'interaction avec l'habitat intelligent plus accessible, naturelle et inclusive, en particulier pour les personnes aveugles ou malvoyantes.

De plus, Nguyen et Sakti [8] ont proposé des modèles de parole multilingues ancrés visuellement, capables d'associer des descriptions orales en plusieurs langues à des représentations visuelles d'objets. En utilisant un apprentissage auto-supervisé sur des paires image-parole, ces modèles construisent un espace sémantique partagé entre langues et modalités, permettant de relier le langage parlé et l'information visuelle de manière cohérente. Cette approche constitue une base pour la génération de descriptions sémantiques multimodales, utiles pour des applications telles que la recherche d'objets ou l'interaction multimodale avec des systèmes intelligents.

De leur côté, Raychaudhuri et Chang [9] ont proposé une revue des approches de cartographie sémantique pour les environnements intérieurs intelligents. Ils classent les méthodes selon la structure des cartes (grilles spatiales, graphes topologiques, cartes géométriques denses ou hybrides) et le type d'information encodée (implicite ou explicite). Leur étude met en évidence l'importance de combiner des informations métriques et sémantiques pour améliorer la localisation et la description des objets, tout en soulignant les défis techniques liés à la mémoire, à l'inefficacité computationnelle et à la représentation d'environnements intérieurs majoritairement vides.

Récemment, Bteich et al. [4] ont exploré l'utilisation des modèles de langage de grande taille (Large Language Models, LLMs), pour générer automatiquement des descriptions de position en langage naturel à partir de données de ranging Ultra-Wide Band (UWB). Cette approche illustre le potentiel des LLMs à interpréter des mesures techniques complexes, et à les restituer sous une forme compréhensible. De telles méthodes montrent qu'il est possible de transformer des données brutes issues de capteurs en informations accessibles et exploitables pour les utilisateurs.

III. CONTEXTE TECHNOLOGIQUE ET FONCTIONNEL

La solution développée repose sur une architecture modulaire combinant plusieurs outils complémentaires afin d'assurer une traduction multilingue fluide et une restitution vocale adaptée aux personnes aveugles ou malvoyantes. Elle intègre un serveur Flask pour le traitement des requêtes, Node-RED pour la gestion du flot, et les modèles Marianne-MT de Hugging Face pour la traduction automatique. La synthèse vocale complète ce dispositif en offrant une interaction orale naturelle. Les sous sections suivantes présentent les principales technologies utilisées ainsi que les objectifs fonctionnels visés.

A. Technologies Utilisées

- **Node-RED** : environnement de programmation visuelle pour coordonner l'injection du texte et la synthèse vocale.
- **Flask** : serveur léger chargé de gérer les requêtes de traduction.
- **Transformers & Marianne-MT (Hugging Face)** : modèles de traduction multilingue préentraînés.
- **Synthèse vocale Windows** : Microsoft David Desktop (anglais), Microsoft Hoda (arabe), et Microsoft Paul (français).

B. Objectifs Fonctionnels

- Traduction simultanée : français → anglais et arabe.
- Synthèse vocale multilingue.
- Réduction des temps de traitement (chargement unique des modèles).
- Adaptabilité à divers contextes (domotique, accessibilité, apprentissage).

IV. FLOT GÉNÉRAL NODE-RED

Le flot démarre par un nœud Inject contenant une phrase en français. La chaîne de traitement est la suivante :

- 1) Format JSON : "texte": "", "reference_en": "", "reference_ar": "".
- 2) Transmission via HTTP POST à Flask.
- 3) Traductions via Marianne-MT (fr-en, fr-ar).
- 4) Retour JSON : français, anglais, arabe.
- 5) Synthèse vocale séparée pour chaque langue.

A. Rôle des nodes Node-RED

Chaque palette de la figure 1 correspond à une étape spécifique du traitement :

- **Entrée : Phrase FR** (node Inject) : permet d'injecter une phrase en français pour initialiser le processus. La phrase est ensuite encapsulée dans une structure JSON contenant les trois champs : {"texte": "", "reference_en": "", "reference_ar": ""}.
- **Format JSON** (node Function) : prépare la phrase saisie dans le JSON avec les champs "texte" pour le français, "reference_en" pour l'anglais et "reference_ar" pour l'arabe.
- **Appel API Flask** (node HTTP request) : envoie la requête POST au serveur Flask local pour effectuer les traductions via Marianne-MT.
- **Séparer + Calcul durée** (node Function) : récupère les traductions renvoyées (anglais, arabe) et mesure le temps de traitement.
- **FR → voix française** (node Change) : sélectionne la phrase d'origine en français pour la synthèse vocale.

- **EN → voix anglaise** (node Change) : sélectionne la traduction anglaise pour la synthèse vocale.
- **AR → voix arabe** (node Change) : sélectionne la traduction arabe pour la synthèse vocale.
- **Synthèse FR / EN / AR** (nodes TTS) : assurent la lecture à voix haute dans chaque langue grâce aux voix système de Windows.

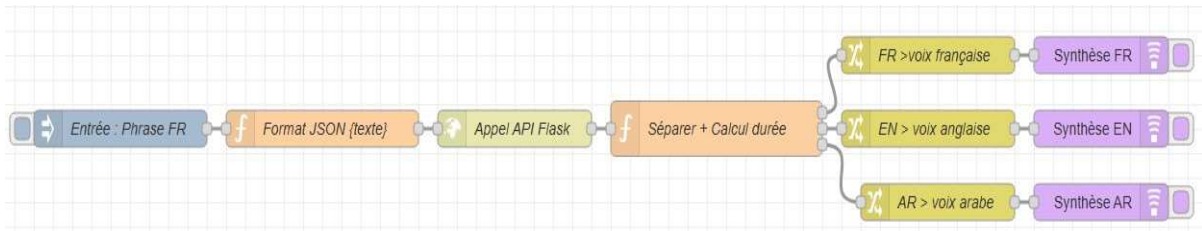


FIGURE 1. Flot Node-RED de traduction et diffusion multilingue.

V. FONCTIONNEMENT DU SCRIPT PYTHON ET OPTIMISATIONS TECHNIQUES

Le script Python fonctionne comme une API locale basée sur Flask et la bibliothèque transformers. Les modèles et leurs tokenizers sont préchargés au démarrage afin de réduire les temps de traitement. Au point d'accès /traduire, le script réalise les étapes suivantes :

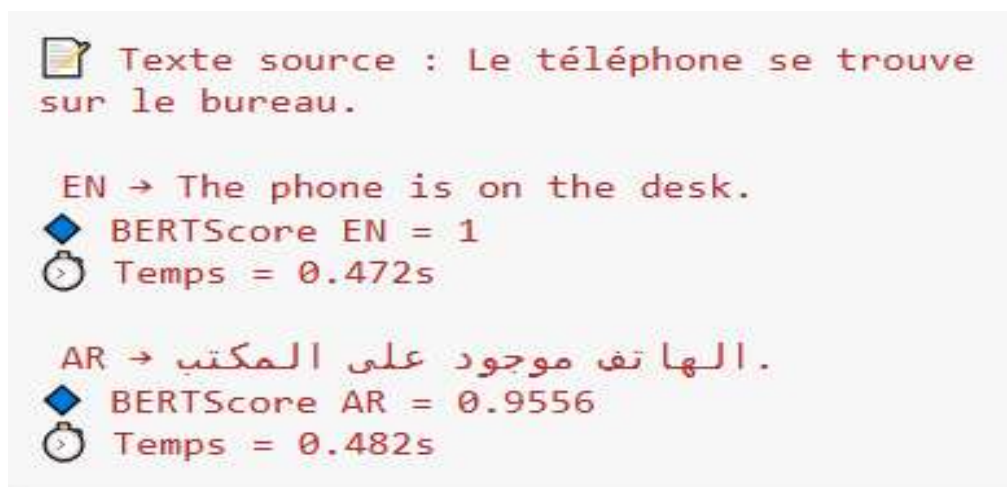
- 1) Extraction du texte envoyé par Node-RED.
- 2) Génération des traductions en anglais et en arabe à l'aide des modèles Marianne-MT.
- 3) Retour d'un JSON multilingue contenant les versions française, anglaise et arabe.

Le JSON retourné est ensuite transmis à Node-RED, qui l'achemine vers les nœuds de synthèse vocale (FR, EN, AR) pour lecture à voix haute. Un script batch permet également de lancer automatiquement le serveur Flask sur Windows :

```
@echo off
cd/d "C:\Users\Etudiant\Desktop\travail" python traduction_avec_regle_opt.py
pause
```

La figure 2 présente un exemple d'affichage de la réponse dans Node-RED.

FIGURE 2. Exemple de réponse de l'API dans Node-RED.



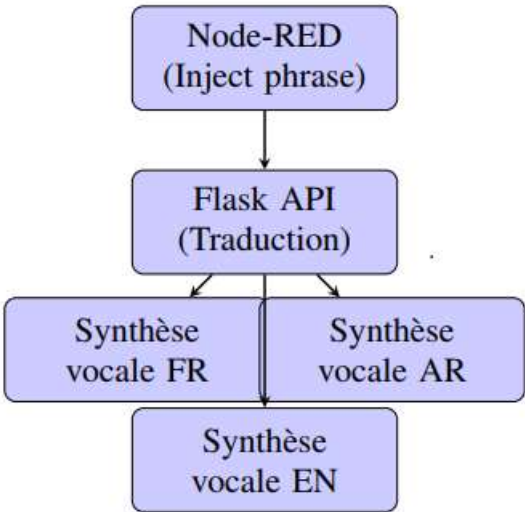


FIGURE 3. Architecture Node-RED / Flask pour la synthèse vocale multilingue.

Optimisations Techniques

Plusieurs améliorations ont été intégrées pour renforcer la rapidité et la fluidité du système. Les voix natives de Windows (par exemple Microsoft David pour l’anglais et Microsoft Hoda pour l’arabe) sont utilisées, garantissant une synthèse vocale locale rapide et sans dépendance réseau. L’API Flask est exécutée en mode multithread (threaded=True), permettant de traiter plusieurs requêtes en parallèle. De plus, les modèles Marianne-MT et leurs tokenizers sont préchargés au lancement du serveur afin d’éviter les temps d’initialisation répétés et de réduire le délai global entre l’entrée du texte et sa restitution vocale.

La table I illustre l’impact de ces optimisations sur le temps d’exécution global.

Date	Temps (ms)	Contexte
08/06/2025	7881	Chargement des modèles de traduction
08/06/2025	4954	Chargement des tokenizers
11/06/2025	757	API optimisée

TABLE I
AMELIORATION DES PERFORMANCES AU FIL DU TEMPS

VI. ÉVALUATION ET TESTS

Afin de comparer notre système basé sur Marianne-MT au modèle de traduction M2M-100, des tests ont été effectués sur un ensemble de 50 phrases réparties équitablement en cinq catégories : 10 phrases de domotique, 10 phrases de situations du quotidien, 10 phrases descriptives, 10 phrases longues et complexes, et 10 phrases à caractère culturel. Ces phrases incluaient à la fois des questions et des réponses.

L’objectif était d’évaluer la qualité des traductions vers l’anglais et l’arabe, ainsi que le temps de réponse de chaque modèle. Pour illustrer les performances obtenues, voici un exemple des résultats produits par chacun d’eux.

Texte (FR)	Référence (EN)	Référence (AR)	Résultat Marianne-MT : (AN) + BERT Score + Temps de réponse (AR) + BERT Score + Temps de réponse	Résultat M2M-100 : (AN) + BERT Score + Temps de réponse (AR) + BERT Score + Temps de réponse
Où se trouve la télécommande de la télévision ?	Where is the TV remote?	أين جهاز التحكم بالتلفاز ؟	Where's the TV remote? ◆ BERTScore EN = 0.9116 Temps = 0.434s أين جهاز التحكم في التلفاز ؟ ◆ BERTScore AR = 0.8421 Temps = 0.401s	Where is the remote control of the TV? ◆ BERTScore EN = 0.8264 Temps = 2.281s أين يوجد التلفزيون عن بعد ؟ ◆ BERTScore AR = 0.7955 Temps = 2.13s
La télécommande est sur la table du salon.	The remote control is on the living room table.	جهاز التحكم على طاولة غرفة الجلوس	The remote control is on the table in the living room. ◆ BERTScore EN = 0.8975 Temps = 0.915s جهاز التحكم على طاولة غرفة المعيشة ◆ BERTScore AR = 0.9559 Temps = 0.524s	The remote control is on the table of the salon. ◆ BERTScore EN = 0.7828 Temps = 2.406s يقع التحكم عن بعد على طاولة القاعة ◆ BERTScore AR = 0.8375 Temps = 2.133s

FIGURE 4. Exemple de comparaison des performances entre Marianne-MT et M2M-100

Les résultats de la Figure 4 montrent une différence nette entre Marianne-MT et M2M-100, tant en qualité de traduction qu'en temps de réponse. Marianne-MT obtient systématiquement des BERTScores plus élevés en anglais comme en arabe, ce qui indique des traductions plus fidèles et mieux structurées, alors que celles de M2M-100 sont parfois plus littérales. En termes de rapidité, Marianne-MT est également plus performant, avec des temps de réponse compris entre 0,4 et 0,5 seconde, tandis que M2M-100 dépasse fréquemment les 2 secondes. Il est important de noter que les deux modèles ont été appliqués dans Node-RED de la même façon, dans des conditions identiques. Dans l'ensemble, Marianne-MT se révèle donc le modèle le plus efficace, offrant à la fois une meilleure qualité de traduction et une exécution plus rapide.

La table II compare les performances des modèles Marianne-MT et M2M-100 sur un corpus de 50 phrases, en considérant le temps moyen de réponse et la qualité de traduction (BERTScore) pour l'anglais et l'arabe.

			Moyenne du temps de réponse en second	Moyenne de la qualité de traduction (Bert score)
Corpus de 50 phrases	Modèle Marianne-MT	Traduction en anglais	0.7827	0.8323
		Traduction en arabe	0.8768	0.8421
	Modèle M2M-100	Traduction en anglais	2.556	0.6272
		Traduction en arabe	2.9326	0.8106

TABLE II

COMPARAISON DE NOTRE APPROCHE AVEC LE MODELE M2M-100.

Discussion

Les résultats montrent que Marianne-MT combine rapidité et précision : le temps moyen de réponse est inférieur à 0,9 s pour les deux langues, avec un BERTScore supérieur à 0,83, indiquant une traduction fidèle et fluide. À l'inverse, M2M-100 présente des temps plus élevés pour l'anglais (2,556 s) et une qualité moindre (BERTScore 0,6272), tandis que pour l'arabe, le modèle atteint un BERTScore de 0,8106 avec un temps de réponse de 2,9326s, ce qui suggère des performances plus compétitives pour cette langue.

L'arabe est légèrement mieux traduit par Marianne-MT (BERTScore 0,8421), avec un temps de réponse compétitif, ce qui confirme sa robustesse pour les langues à faibles ressources. Ces observations soulignent que Marianne-MT offre un meilleur compromis entre rapidité et qualité, ce qui le rend particulièrement adapté aux applications multilingues en temps réel.

VII. CONCLUSION ET PERSPECTIVES DE RECHERCHE

Le travail présenté s'inscrit dans une démarche d'innovation technologique visant à renforcer l'autonomie des personnes aveugles ou malvoyantes dans un environnement domestique intelligent. Nous avons effectué une comparaison avec le modèle M2M-100, et les résultats montrent que le modèle Marianne-MT offre un compromis optimal entre rapidité et qualité de traduction, avec un temps moyen de réponse faible et un BERTScore élevé, garantissant ainsi une interaction fluide et fiable.

La solution proposée combine traduction automatique et synthèse vocale multilingue, reposant sur une architecture légère et efficace intégrant un serveur Flask et les modèles Marianne-MT hébergés localement. Cette approche assure une exécution rapide, indépendante d'Internet, tout en permettant une interaction naturelle entre l'utilisateur et son habitat. L'association de traduction dynamique et de restitution vocale facilite la communication, la localisation d'objets et l'accès à l'information dans plusieurs langues, contribuant ainsi à une meilleure inclusion numérique.

Les perspectives de recherche envisagées incluent l'enrichissement du dispositif avec de nouvelles langues (espagnol, allemand, chinois), ainsi que l'intégration d'un module de reconnaissance vocale pour un déclenchement entièrement vocal. Par ailleurs, le développement d'une interface web ou mobile intégrée à la synthèse vocale, ainsi que la gestion multi-utilisateurs avec profils linguistiques personnalisés, offrirait une expérience plus flexible et adaptée à chacun.

En complément, des expériences seront conduites auprès d'utilisateurs réels afin d'évaluer l'ergonomie, l'efficacité et la pertinence des fonctionnalités proposées. Ces études permettront d'affiner le système en fonction des besoins et des retours des utilisateurs, garantissant ainsi une adoption optimale.

Ces évolutions ouvriront la voie à un système intelligent complet, capable de dialoguer naturellement avec ses utilisateurs et de renforcer leur autonomie au sein d'un environnement connecté, inclusif et multilingue.

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MATHEMATICAL MODELING IN UNDERSTANDING REAL-LIFE FINANCIAL PROCESSES

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Abstract: The integration of mathematical modeling in education plays a significant role in helping students understand complex financial processes that they will encounter in real life. This article explores how mathematical models can be applied to various aspects of finance, providing students with the tools to better navigate financial decisions. The research focuses on three key components of financial mathematical models: interest rates, savings and loans, and inflation. Interest rate models, including simple and compound interest, as well as the assessment of investment risks, form the foundation for understanding how money grows over time. Additionally, the study delves into the importance of savings and loans, emphasizing the significance of making informed decisions regarding deposits, savings, and responsible credit usage. Inflation models demonstrate the dynamic nature of prices and their impact on purchasing power, allowing students to recognize the effects of inflation on their financial stability.

Furthermore, the article examines how these models are employed in teaching. Topics such as the growth of money through savings and deposits, selecting optimal interest rates, making loan decisions, and understanding price changes are explored. The application of these models equips students with practical skills, enhancing their financial awareness and decision-making abilities. By bridging the gap between mathematics and everyday life, mathematical modeling fosters a deeper understanding of finances, ultimately helping students make informed financial choices and develop stronger financial literacy. Through this approach, students are empowered to make sound decisions, building a foundation for their future financial success.

Key Words: Mathematical modeling; financial literacy; financial education; interest rates; savings and loans; inflation; decision-making skills; real-life financial applications.

Introduction

In today's world, financial literacy has become one of the most crucial aspects of personal success. The ability to manage one's financial resources, make informed decisions about savings, borrowing, and investing, is essential for ensuring financial stability and well-being. However, despite the importance of these skills, many individuals struggle to make sound financial decisions due to a lack of understanding of financial processes and limited practical experience.

One of the most effective methods for teaching financial literacy is the use of mathematical modeling. This approach allows students to not only familiarize themselves with the theoretical aspects of finance but also see how various financial processes work in real-life situations. Mathematical models help to clearly demonstrate the impact of factors such as interest rates, inflation, savings, and loans, while also providing students with the ability to make well-informed decisions based on calculations.

1. Mathematical modeling helps students understand financial processes in real life.

Mathematical modeling serves as a crucial bridge between theoretical concepts in mathematics and their real-world applications, particularly in the field of finance. By using mathematical models, students can transform abstract financial ideas into understandable, manageable

processes. This practical approach to learning enables students to grasp complex financial systems and decision-making processes, which are often challenging to comprehend in a purely theoretical context.

Financial decisions, such as managing personal savings, taking out loans, investing in stocks, or understanding inflation, are part of everyone's daily life. However, many individuals struggle to make informed financial decisions due to a lack of understanding of how these processes work and interact in real life. Mathematical modeling allows students to explore financial concepts through quantitative methods, giving them the tools they need to navigate these complex financial systems with confidence. For example, when learning about interest rates, students are not merely taught formulas; they are shown how these formulas apply to real-life situations such as choosing the best savings account, understanding the impact of loan interest, or evaluating the benefits of an investment. This practical approach demystifies financial concepts, making them more accessible and relevant to students.

Mathematical modeling breaks down complex financial processes into structured mathematical terms. In the real world, financial systems are dynamic and multifaceted, involving variables such as inflation, interest rates, taxes, and global market forces. By using mathematical models, these processes can be simplified into manageable parts, allowing students to better understand how they work together. For instance, in the case of compound interest, a mathematical model can demonstrate how an initial investment grows over time, factoring in the principal, interest rate, and the frequency of compounding. Students can input different values into the model to see how varying these factors affects their financial outcomes. This provides a clearer understanding of how interest works and enables students to make decisions based on numerical projections rather than just vague ideas.

When students engage in mathematical modeling, they are not just memorizing formulas or concepts—they are learning how to think critically and solve problems. Real-life financial problems often require students to synthesize multiple pieces of information and weigh the potential consequences of different actions. Mathematical models encourage students to approach these problems systematically, testing various scenarios and predicting outcomes based on mathematical logic. For example, when analyzing a loan offer, students might use a model to calculate the total cost of the loan over its lifetime, taking into account the interest rate, loan term, and monthly payments. This process develops students' problem-solving skills, allowing them to identify the most cost-effective solutions and make informed decisions.

One of the most valuable aspects of mathematical modeling is its ability to simulate financial decisions. Financial markets, for instance, are often unpredictable, and the long-term effects of financial decisions can be difficult to foresee. Mathematical models allow students to create simulations that replicate these financial decisions, offering insights into how different factors might influence outcomes. For example, a student could use a mathematical model to simulate the performance of an investment portfolio under different market conditions, such as varying interest rates or inflation rates. These simulations help students understand the potential risks and rewards of their financial choices and give them the experience of making decisions based on calculated predictions rather than mere speculation.

Mathematics is often perceived by students as abstract and disconnected from daily life. However, by applying mathematical models to real-world financial processes, students can clearly see the direct link between math and practical decision-making. This approach not only deepens students' mathematical understanding but also increases their awareness of how mathematics governs many aspects of their financial lives. For example, students can model the effects of inflation on purchasing power over time. By inputting different inflation rates into a model, they can visualize how the value of money decreases over time, which helps them understand the

importance of saving and investing to preserve wealth. This kind of real-world connection makes math more engaging and relevant to students.

Lastly, mathematical modeling equips students with the tools to face future financial challenges with a more informed perspective. Whether it's understanding how to manage student loans, how credit scores impact financial decisions, or how to budget effectively, mathematical models provide students with the framework they need to make sound financial decisions. For instance, by using models to assess the effects of different saving habits on their financial future, students can learn how consistent savings, even in small amounts, can lead to substantial wealth accumulation over time. Similarly, by modeling loan repayments, students can see how the length of the loan term and the interest rate affect the total amount paid back. This helps them develop financial habits that will serve them well in the future.

2. Key elements of financial mathematical models. Understanding the key elements of financial mathematical models is crucial for students to make informed decisions in real-world financial situations. These models break down complex financial concepts into understandable, manageable components. The three primary elements of financial mathematical models include interest rates, savings and loans, and inflation. Let's explore each of these in detail.

Interest rates are one of the foundational concepts in financial modeling, and they play a significant role in the growth of investments and the cost of borrowing money. Mathematical models related to interest rates allow students to understand how money grows over time or how much they will owe on a loan.

- **Simple Interest:** Simple interest is calculated on the principal amount of a loan or investment, and it does not account for interest on the interest accumulated. Simple interest models are typically used in short-term loans or investments, where the amount of interest is relatively straightforward and linear.

- **Compound Interest:** Compound interest, unlike simple interest, involves interest being calculated on the initial principal as well as the accumulated interest from previous periods. This is a more complex financial model, but it better reflects the way money grows over time, especially for longer-term investments or savings.

- **Investment Risks:** Investment risks are a crucial aspect of financial decision-making. When using mathematical models for interest rates, students also need to understand the risks associated with investments. These risks can be modeled using statistical tools like standard deviation, variance, and expected return. The concept of risk-adjusted returns is central to financial modeling, helping students weigh the potential rewards against the risks involved.

Understanding how savings and loans work is vital for financial decision-making, and mathematical models provide a clear way to evaluate various options.

- **Deposits and Savings** Savings models often involve simple or compound interest calculations, as discussed above, but they also include concepts such as regular contributions to a savings account or retirement fund. These models help students understand how consistent savings contribute to financial security and how different interest rates affect the growth of savings.

Inflation is the rate at which the general level of prices for goods and services rises, eroding purchasing power. Understanding inflation is essential for making informed financial decisions, especially in terms of savings, investments, and budgeting. Mathematical models help students grasp how inflation affects their finances and plan accordingly. Inflation diminishes the purchasing power of money over time. Mathematical models allow students to see the impact of inflation on the cost of goods and services. By adjusting for inflation, students can understand how their income and savings might change in real terms. Using the inflation-adjusted formula, students can calculate the real value of their income and savings to ensure they are keeping up with the rising cost of living. For example, if a student receives an annual salary increase of 5%, but inflation is 3%, the real increase in salary would only be 2%.

3. How mathematical modeling is used in teaching financial literacy

Mathematical modeling serves as an essential tool in teaching financial literacy by helping students understand complex financial concepts through practical, hands-on learning. The application of mathematical models in teaching allows students to simulate real-life financial scenarios, analyze outcomes, and make informed decisions. This approach improves comprehension and equips students with the skills necessary to manage their finances effectively. Let's delve into how mathematical modeling is used to teach key financial concepts, including savings and deposits, loan decisions, and price changes.

One of the most fundamental applications of mathematical modeling in financial education is teaching students about the growth of money through savings and deposits. By using models based on interest rates, students can visualize how money grows over time and learn how to make informed decisions regarding their savings.

Growth of Money through Savings:

Mathematical models for savings accounts typically rely on simple or compound interest formulas. By exploring these models, students can understand how different savings plans impact the growth of their money.

Simple Interest Model:

Simple interest is calculated on the initial principal, and it is a useful model for short-term savings. Teaching students how simple interest works helps them understand the effect of interest rates on their savings, particularly in the context of short-term financial goals. Example: A student deposits \$1,000 in a savings account with a simple interest rate of 5% per year. After one year, the student will have \$1,050 in the account.

Compound Interest Model:

Compound interest, on the other hand, takes into account the interest on the interest already earned, making it a more powerful tool for growing savings over time. This is a critical concept for long-term savings plans such as retirement accounts or college funds.

Choosing Better Interest Rates:

Mathematical models help students compare different savings accounts, each with varying interest rates and compounding frequencies. This is an important aspect of financial literacy, as students learn how to assess which savings plans will yield the best returns over time. Scenario Analysis: Students can input different interest rates into the model to see how small changes can have significant effects on the future value of their savings. For instance, a student might compare two savings accounts: one with a 3% annual interest rate, compounded monthly, and another with a 5% annual interest rate, compounded quarterly. The mathematical model will allow them to see which account results in the higher total value over a set period.

Mathematical modeling is also critical in teaching students how to make informed decisions when it comes to borrowing money, particularly in understanding how loans work, how interest is applied, and how loan terms affect repayments.

Loan Repayment Models:

Loan models typically use the amortization formula to calculate monthly payments and the total cost of the loan over its lifetime. These models help students understand how loan payments are structured and how interest can increase the total repayment amount. Example: A student borrows \$10,000 at an annual interest rate of 6% for 5 years (60 months). The monthly payment can be calculated using the above formula, helping the student understand the impact of the interest rate and loan term on their monthly repayment.

Choosing the Right Loan:

Students can use mathematical models to compare different loan offers with varying interest rates, loan terms, and repayment structures. By calculating the total repayment amount for each loan option, they can make informed decisions about which loan is best for their financial

situation. **Scenario Analysis:** Students can analyze various loan options, such as choosing between a 3-year loan with a lower interest rate or a 5-year loan with a higher interest rate. The model will allow them to assess the total cost of each loan and determine which option is more cost-effective in the long run.

Inflation and price changes are important concepts for students to understand, as they directly affect their purchasing power and long-term financial planning. Mathematical models for inflation show how prices rise over time and help students assess the effect of inflation on their money.

Modeling Inflation:

Inflation models typically use the formula for future value to show how the purchasing power of money decreases over time. By adjusting for inflation, students can calculate how much an item they buy today will cost in the future, given a constant inflation rate. Example: A student wants to know how much a \$50 item will cost in 10 years if the annual inflation rate is 3%. Using the formula, they can calculate that the item will cost approximately \$67.30 in 10 years.

Real vs. Nominal Values: Students can calculate both real and nominal values to understand how inflation affects income and expenses. For example, if a student's salary increases by 5% per year, but inflation is 3%, the real increase in salary is only 2%. This helps them make informed decisions about budgeting and saving.

4. Benefits for students. The integration of mathematical modeling into the teaching of financial literacy provides students with numerous benefits. By applying mathematical models to real-life financial scenarios, students not only improve their understanding of financial concepts but also develop essential skills that will serve them well throughout their lives. These benefits can be broadly categorized into a better understanding of real-life finances, improved decision-making skills, and a stronger connection between math and practical life. Let's explore each of these benefits in more detail.

One of the primary advantages of using mathematical models in teaching financial literacy is that they help students better understand real-life financial processes. Finance is an area where abstract concepts can often seem disconnected from the realities of daily life. Mathematical models bring clarity and structure to these concepts, making them more accessible and relatable.

Understanding Complex Financial Systems:

Financial systems involve a wide range of variables, from interest rates to inflation, investment strategies, and loan repayments. Mathematical models allow students to explore these systems in a simplified and structured way, making complex concepts more digestible. By using models, students can simulate scenarios such as the growth of savings accounts, the repayment of loans, and the effects of inflation on purchasing power, providing them with practical knowledge of how financial systems work. Example: A student might use a model to see how monthly contributions to a savings account grow over time under different interest rates, helping them understand the concept of compound interest and how it applies to long-term savings.

Practical Insights into Personal Finance:

Mathematical models give students a direct insight into their personal finances. By applying these models, they learn how financial decisions, such as taking out a loan or choosing a savings plan, can affect their financial future. For instance, a student could use a model to compare different loan options, assess the cost of borrowing over time, and see how various terms and interest rates impact their overall debt. This helps them make informed financial choices in their own lives, whether it's choosing the best savings account, deciding whether to take a loan, or understanding the consequences of spending decisions.

Improved Financial Awareness:

Using mathematical models in education fosters a higher level of financial awareness among students. It helps them recognize the importance of factors like inflation, the effect of time on investments, and the long-term consequences of their financial decisions. This deeper understanding of financial concepts allows students to make better financial plans and avoid common mistakes such as accumulating high-interest debt or not saving enough for the future.

Financial decision-making is a critical skill, and mathematical models can significantly enhance students' ability to make well-informed choices. By engaging with real-life financial scenarios and analyzing the results of their decisions, students learn to approach financial problems systematically, consider multiple factors, and evaluate trade-offs.

Risk Assessment and Mitigation:

Financial decisions often involve an element of risk, whether it's investing in the stock market, taking out a loan, or purchasing insurance. Mathematical models teach students how to assess these risks and make decisions that minimize potential negative outcomes. By evaluating factors such as expected returns, loan terms, and market volatility, students can make more informed choices and reduce the likelihood of making risky or impulsive decisions. Example: When choosing between different investment options, students can use models to calculate the expected return and assess the associated risks. This helps them make decisions based on risk tolerance and long-term financial goals, rather than being swayed by short-term fluctuations in the market.

Making Math More Relevant:

Many students struggle to see the connection between mathematics and real-life situations. Mathematical modeling in financial literacy provides a clear and tangible way for students to see how mathematical principles apply to everyday financial decisions. Whether it's calculating compound interest, determining loan payments, or understanding the effects of inflation, students can see how math is not just an abstract subject but a powerful tool for managing personal finances. Example: Students can use algebraic equations and formulas to calculate interest on loans, assess the growth of investments, or predict how inflation will affect their purchasing power over time. These real-world applications make math more engaging and meaningful, reinforcing the importance of mathematical concepts in practical situations.

Enhancing Problem-Solving Skills:

Financial decisions often involve complex problems that require critical thinking and problem-solving. By using mathematical models, students develop these skills and learn to approach financial problems in a logical, systematic way. They gain experience in breaking down complex problems into manageable parts, identifying relevant variables, and applying mathematical techniques to solve them. Example: A student might be tasked with determining the best loan option by comparing interest rates, loan terms, and monthly payments. This requires the use of mathematical models to calculate total costs and evaluate different scenarios, helping the student develop problem-solving skills that are applicable to a wide range of financial decisions.

Building Practical Math Skills:

Mathematical modeling in financial literacy reinforces practical math skills that students will use throughout their lives. From calculating percentages and ratios to solving equations and interpreting graphs, students develop a toolkit of math skills that are directly applicable to managing personal finances. These skills are not only useful for financial decisions but also enhance overall mathematical literacy, helping students become more confident and competent in their ability to use math in various contexts. Example: Understanding percentages is crucial for many financial decisions, such as calculating interest rates, comparing prices, or determining tax

rates. Mathematical models help students see how these concepts are applied in real life, making math more approachable and relevant.

5. Mathematical modeling helps students develop financial awareness and make informed choices. Mathematical modeling plays a crucial role in developing financial awareness among students, providing them with the tools they need to understand and navigate the complexities of personal finance. By using mathematical models, students can simulate financial scenarios, predict outcomes, and assess the consequences of their decisions, which empowers them to make informed, well-thought-out choices about their finances. The ability to analyze financial data and understand the impact of various decisions is essential for long-term financial success. This section explores how mathematical modeling enhances financial awareness and helps students make informed choices in various financial situations.

Understanding Key Financial Concepts:

Mathematical modeling allows students to internalize core financial concepts that are essential for managing their personal finances. These include interest rates, investment growth, loan repayment, inflation, and budgeting. When students engage with these concepts through mathematical models, they can see their practical applications and understand their significance in real-life scenarios. Example: A student may model how a \$1,000 investment grows over time with compound interest. By adjusting the interest rate and time period, the student can visually grasp how varying conditions affect the growth of their investment. This helps build financial awareness, as students realize the importance of early investing and the long-term impact of different interest rates.

Simulating Real-Life Financial Scenarios:

Mathematical models provide a way for students to simulate financial situations that they may face in the real world, such as saving for a car, buying a home, or planning for retirement. By simulating these scenarios, students develop an awareness of how everyday financial decisions can accumulate over time, impacting their long-term financial stability and wealth. Example: Students can model the process of saving for a car by applying regular contributions to a savings account with a certain interest rate. This helps them understand the power of consistent saving and the effect of compound interest over time, highlighting the importance of setting financial goals and planning for future purchases.

Awareness of Financial Risk:

Financial decision-making often involves a trade-off between risk and reward. Mathematical modeling helps students understand the concept of risk by allowing them to simulate different investment scenarios and assess the potential outcomes. This helps students become aware of the risks involved in financial decisions, such as investing in stocks, taking out loans, or using credit. Example: When modeling an investment in the stock market, students can use a basic risk-return model to analyze different levels of risk. They can see how higher-risk investments, like stocks, may yield higher returns over time, but also involve greater volatility. This teaches students to weigh the risks and rewards of their investment decisions.

Analyzing Financial Options:

One of the primary benefits of mathematical modeling is that it helps students compare different financial options. Whether they are deciding between multiple loan offers, comparing different savings accounts, or evaluating investment opportunities, mathematical models allow students to analyze various factors, such as interest rates, loan terms, and investment returns. This allows them to make better financial decisions by considering the most important variables. Example: A student may be presented with two loan options: one with a lower interest rate but a longer repayment period, and another with a higher interest rate but a shorter term. Using a mathematical model, the student can calculate the total cost of each loan over time and decide which one is more affordable and suitable for their financial situation.

Budgeting and Financial Planning:

Budgeting is an essential skill for managing personal finances, and mathematical modeling can help students understand how to create and stick to a budget. By using models to track income, expenses, and savings goals, students can make better decisions about their day-to-day finances and ensure they are living within their means while also saving for future goals. Example: A student can create a budget by applying a mathematical model to track monthly income and expenses, then simulate how small changes—such as reducing discretionary spending—can free up more money for savings or debt repayment. This helps students develop healthy financial habits that will serve them well in the future.

Assessing Loan and Credit Decisions:

Mathematical models are essential for teaching students how to evaluate loans, credit cards, and other forms of debt. By using models to calculate the total cost of loans over time (including interest, fees, and other charges), students can assess which loan is the most cost-effective and whether they can afford the monthly payments. Example: A student is considering taking out a student loan and wants to understand the total cost of borrowing. By applying a loan model, the student can calculate how much they will pay in total over the course of the loan and decide whether the loan terms are manageable given their future income potential.

Evaluating Investment Opportunities:

Investment decisions are often complex, with numerous options available, including stocks, bonds, real estate, and more. Mathematical models help students evaluate the potential returns of different investment opportunities based on factors like risk, return, and time horizon. This allows them to make informed decisions based on their financial goals and risk tolerance. Example: A student might evaluate two investment options: one with a guaranteed return of 4% per year and another with an expected return of 8% but higher volatility. By using mathematical models that factor in potential gains and losses over time, the student can decide which investment aligns with their financial objectives and risk tolerance.

Conclusion

In conclusion, mathematical modeling plays a vital role in teaching financial literacy and preparing students for real-life financial challenges. By integrating mathematical models into the educational process, abstract financial concepts become clearer, more structured, and directly connected to everyday situations. This approach enables students to better understand key financial processes such as interest rates, savings and loans, and inflation, which are essential for responsible money management. The use of mathematical modeling helps students develop financial awareness by allowing them to analyze real-world financial scenarios, predict outcomes, and evaluate the consequences of different decisions. Through modeling, students learn not only how financial systems function, but also how their personal choices can affect long-term financial stability. As a result, learners gain the ability to make informed, reasoned decisions rather than relying on intuition or incomplete information.

Moreover, mathematical modeling strengthens the connection between mathematics and practical life. Students begin to see mathematics as a useful and meaningful tool rather than an abstract academic subject. This enhances motivation, improves problem-solving and critical-thinking skills, and encourages a long-term perspective on financial planning. Overall, incorporating mathematical modeling into financial education contributes to the development of financially literate individuals who are capable of making responsible financial choices. Such an educational approach not only supports academic achievement but also equips students with essential life skills, helping them navigate modern economic realities with confidence and competence.

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Совершенствование организационно-технических механизмов обеспечения надежности строительных процессов в условиях современных технологических требований

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Аннотация. Надежность строительных процессов в XXI веке перестала быть исключительно инженерной категорией и стала системной характеристикой организации производства, цифрового обмена данными, управления рисками, качеством и безопасностью труда. На фоне хронических потерь отрасли от несогласованности участников, дефектов информации, переделок и неоптимальных контрактных стимулов формируется запрос на организационно-технические механизмы нового поколения - измеримые, сопоставимые и встроенные в цифровую среду проекта. В статье рассматривается надежность строительных процессов как управляемая характеристика, формируемая на стыке производственного планирования, управления данными, риск-менеджмента и контрактной организации взаимодействия участников. Цель работы заключается в обосновании организационно-технического механизма обеспечения надежности строительных процессов, адаптированного к современным технологическим требованиям. Авторами предложен расчетный индекс надежности строительного процесса (RCPI), позволяющий интегрировать показатели надежности планирования, экономической эффективности, риск-ориентированного управления и качества данных в единую аналитическую модель. На основе данных NIST о стоимости недостаточной интероперабельности и эмпирических отраслевых индикаторов плановой надежности демонстрируются расчетные соотношения, показывающие, как измеримость превращает “абстрактную надежность” в управляемый объект. Практическая значимость работы заключается в возможности применения предложенного механизма для диагностики, сравнения и повышения надежности строительных процессов на различных типах проектов, а также в формировании основы для перехода от реактивного управления к системной профилактике отклонений.

Ключевые слова: надежность строительных процессов, организационно-технические механизмы, интероперабельность, ISO 19650, IFC, цифровой двойник, Last Planner System, PPC, Earned Value Management, CPI, SPI, ISO 31000, FMEA, RPN, ISO 9001, ISO 45001, Integrated Project Delivery, RCPI.

Введение. Современное строительство живет в парадоксе: технологическая сложность проектов растет быстрее управленческой точности. Датчики, BIM, платформы документооборота, 4D/5D-модели, автоматизация снабжения и производства работ доступны, но сами по себе не гарантируют надежности процесса - устойчивой способности системы выполнять обещанные результаты по времени, стоимости, качеству и безопасности.

При этом разрыв производительности в строительстве по сравнению с рядом других отраслей и масштаб потерь от неэффективных практик подробно подчеркивались в отраслевой аналитике McKinsey Global Institute: ключевая проблема - фрагментация цепочки создания ценности и слабая управляемость потоком работ, а не отсутствие технологий как таковых [1].

Надежность особенно “дорога” в капиталоемких проектах: классические исследования мегапроектов показывают, что систематические искажения ожиданий, оптимистические смещения и институциональные стимулы ведут к хроническим перерасходам и срывам сроков, если не встроить механизмы противодействия на уровне управления и контрактов [2]. Следовательно, предмет совершенствования - не отдельный инструмент, а организационно-техническая система, в которой технологии становятся “нервной системой” проекта, а надежность - измеримой управленческой функцией.

В инженерной традиции надежность ассоциирована с конструкциями: вероятностные характеристики сопротивления, надежностные индексы, предельные состояния. Но на практике заказчик теряет деньги чаще не из-за редких отказов несущей системы, а из-за отказов управленческих и производственных: срыва графика, переработок, конфликтов интерфейсов, ошибок проектной информации, несогласованных изменений. Иными словами, современный риск проекта - это риск процесса.

Системная проблема имеет макроэкономический масштаб. В материалах McKinsey Global Institute отмечалось, что глобально производительность труда в строительстве росла около 1% в год за последние два десятилетия, тогда как по мировой экономике - 2,8% и по производству - 3,6% [1]. Эти различия - не статистическая экзотика, а симптом: отрасль долго жила в режиме локальных улучшений без управляемой цифровой сквозности и дисциплины производства. Вторая линия уязвимости - информационная фрагментация. Классическая связка CAD-расчеты-сметы-график-снабжение часто остается набором плохо совместимых фрагментов, и отрасль платит за это. NIST оценивал ежегодные издержки от недостаточной интероперабельности в американской индустрии капитального строительства в 15,8 млрд долл. США (по состоянию на оценку того периода) [2]. Это не просто «неудобство обмена файлами», а прямые потери надежности исполнения: задержки, ошибки, переработки, повторные согласования. Наконец, на уровне проекта надежность разрушается переработками (rework).

Литературный обзор. Надежность процесса начинается с надежности данных: несогласованные форматы, разрывы между CAD/ BIM/ сметами/ планами/ эксплуатационной информацией порождают каскад ошибок. Национальный институт стандартов и технологий США (NIST) оценил ежегодную стоимость недостаточной интероперабельности в сегменте капитального строительства США в 15,8 млрд долл. и привел разложение по группам стейкхолдеров: архитекторы и инженеры - 1,2 млрд, генеральные подрядчики - 1,8 млрд, специализированные изготовители и поставщики - 2,2 млрд, владельцы и операторы - 10,6 млрд [3]. Это важно методологически: интероперабельность имеет измеримую экономическую цену, а значит, может быть объектом инвестиционного обоснования в организационно-технические механизмы. Рисунок 1 показывает, как “надежность данных” превращается в надежность производственного решения.

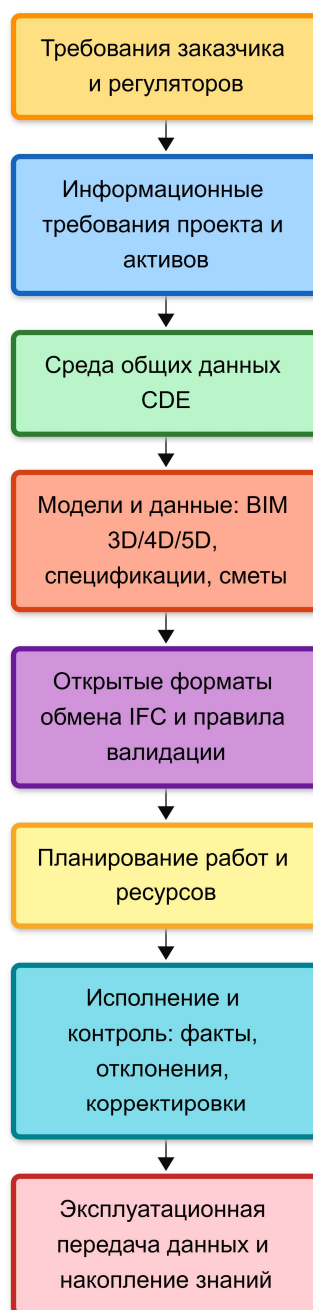


Рисунок 1 – Организационно-информационный контур обеспечения надежности строительных решений на основе управления данными

С практической точки зрения стандартизация управления информацией в BIM-среде в последние годы закрепились через ISO 19650-2 (управление информацией при поставке активов с использованием BIM), задавая принципы ролей, сред общего доступа (CDE) и процедур жизненного цикла данных [4]. Параллельно открытые форматы, такие как Industry Foundation Classes (IFC), кодифицированы как международный стандарт ISO 16739-1 и рассматриваются как базовый механизм межплатформенного обмена BIM-данными [5]. В логике надежности это означает: снижение вероятности ошибок передачи данных и повышение воспроизводимости решений.

Если BIM исторически сильнее в описании “как должно быть”, то цифровой двойник стремится соединить модель с динамикой фактических данных. В статье Воје и соавторов (Automation in Construction) показано, что движение к “семантическому” строительному цифровому двойнику связано с необходимостью полноты смысла данных, интеграции

сенсоров и контуров управления, чего часто не хватает традиционным BIM-подходам [6]. Для надежности это принципиально: появляется возможность раннего обнаружения дрейфа процесса и профилактического управления, а не реагирования “постфактум”.

Надежность процесса прямо проявляется в масштабе переделок. Hwang и Thomas на данных 359 реальных проектов показали, что прямые затраты на переделки “часто достигают 5%” общей стоимости строительства, что делает rework не частным дефектом, а системным источником потерь [7]. Отраслевые исследования Construction Industry Institute фиксировали еще более жесткие оценки на выборке индустриальных проектов: отклонения качества, приводящие к переделкам, ремонту или замене, в среднем составляли 12,4% от общей установленной стоимости проекта [8]. Эти цифры важны не сами по себе, а как “калибровка” для расчетного контура надежности: если мы не измеряем надежность исполнения, мы почти гарантированно платим за ненадежность.

Надежность процесса рационально описывать как способность проекта стабильно воспроизводить требуемое качество и темп работ при неизбежной изменчивости среды (погода, поставки, изменения проекта, человеческий фактор). Для этого нужна архитектура, где «техническое» и «организационное» не спорят, а сцеплены через данные, регламенты и метрики.

Таблица 1 - Матрица механизмов обеспечения надежности строительных процессов

Уровень управления	Объект надежности	Механизм (что делаем)	Стандарты (опора)	Цифровая основа (чем подкрепляем)	Выходной показатель (что измеряем)
Стратегический (компания)	Система качества и рисков	Единые правила несоответствий, корректирующие действия, обучение	ISO 9001 [3], ISO 31000 [10]	QMS, единый реестр рисков	Доля повторных несоответствий, зрелость риск-процессов
Проектный (РМО/штаб)	Интерфейсы и изменения	Управление изменениями и интерфейсами, ранняя координация поставки	ISO 31000 [10], IPD-принципы [14]	CDE, управление версиями, workflow согласований	Время цикла RFI/изменения, индекс стабильности требований
Производственный (участок)	Поток работ	Надежное планирование, снятие ограничений до начала работ	Last Planner [6]	Цифровой lookahead, constraint log	PPC (процент выполненных обещаний)
Технический (качество)	Соответствие результата	Риск-ориентированный контроль критических операций	ISO 9001 [3]	Мобильные чек-листы, фотофиксация, NCR-реестр	Плотность дефектов, доля переделок
Снабжение и логистика	Комплектность и прослеживаемость	Маркировка, отслеживание, приемка с данными о партии	Интероперабельность как фактор потерь [2]	RFID/QR, цифровые паспорта поставок	Доля простоев из-за комплектности
Безопасность	Производственная устойчивость	Предиктивные меры безопасности, дисциплина доступа и инструктажа	ISO 45001 [11]	HSE-дашборды, цифровые наряды-допуски	Leading indicators по инцидентам

Цифровая дисциплина	Достоверность информации	Управление информацией по правилам CDE и обмена	ISO 19650-1 [8], ISO 19650-2 [9]	Общая среда данных (CDE), классификация	Полнота и актуальность моделей и документации
Жизненный цикл	Контур обратной связи	Учет требований эксплуатации и данных активов	ISO 55000 [18]	цифровые паспорта активов	Снижение дефектов на повторяющихся типовых решениях

Важно увидеть, что надежность процесса «живет» на стыках. ISO 9001 задает скелет управления несоответствиями, но без ISO 19650 он часто остается бумажным: версии документов расходятся, замечания не закрываются в правильной редакции. ISO 31000 переводит разговор из эмоций («все под контролем») в управляемые решения: риск описан, оценен, назначен владелец, определены меры и мониторинг. Производственная надежность, напротив, не начинается с отчетов - она начинается с предсказуемых обещаний в планировании, что и является сильной стороной Last Planner, где качество плана измеряется фактом выполнения обязательств [6]. Проблема интероперабельности, оцененная NIST как существенная стоимость для отрасли, показывает, что цифровая сквозность - не мода, а экономическая необходимость: потери возникают там, где данные не переходят по цепочке без искажений [2]. А контур управления активами фиксирует зрелый взгляд: надежность строительства доказуема только на жизненном цикле, когда эксплуатация возвращает данные в стандарты проектирования и производства [18].

Материалы и методы

Дизайн организационно-технического механизма

Предлагается трактовать надежность строительного процесса как способность системы «выполнять обязательства» и «сохранять корректность данных», обеспечивая устойчивые результаты по четырем осям: сроки, стоимость, качество, безопасность. Методологически механизм строится как интеграция двух контуров:

- Контур надежности обязательств (поток работ) - планирование, готовность, обещания, исполнение.
- Контур надежности данных (поток информации) - стандарты, форматы, валидация, единый источник истины.

Метрики и расчетные формулы

1) Надежность планирования и исполнения (PPC)

В подходах Lean Construction ключевым операционным индикатором надежности планирования является Percent Plan Complete (PPC), широко используемый в Last Planner System. Классическая формула PPC - доля выполненных задач от числа запланированных на период [9]:

$$PPC = \frac{N_{done}}{N_{planned}} \times 100\%$$

Где:

- N_{done} - число задач, выполненных «как обещано».
- $N_{planned}$ - число задач, обещанных к выполнению на период.

2) Контроль стоимости и сроков через освоенный объем (EVM)

Для связывания надежности с экономикой нужен “переводчик” в управленческие индексы. В NASA EVM Implementation Handbook даны строгие определения индексов эффективности по стоимости и срокам: $CPI = BCWP/ACWP$ и $SPI = BCWP/BCWS$ [10]. В прикладной форме:

$$CPI = \frac{EV}{AC}, SPI = \frac{EV}{PV}$$

Где:

- EV (BCWP) - освоенный объем в стоимостном выражении.
- AC (ACWP) - фактические затраты.
- PV (BCWS) - плановая стоимость запланированных работ.

3) Риск-ориентированное управление (ISO 31000)

ISO 31000 задает универсальную логику работы с рисками: идентификация, анализ, оценка, обработка, мониторинг и коммуникация [11]. В расчетном блоке для приоритизации удобно применять ожидаемую потерю:

$$E[L] = \sum_{i=1}^k p_i \cdot I_i$$

Где p_i - вероятность сценария, I_i - ущерб (стоимостной, временной или иной).

4) FMEA/FMECA и приоритизация причин сбоев (RPN)

Для “приземления” риска на конкретные причины отказов применяется FMEA/FMECA. В стандарте EN 60812:2006 приведено определение Risk Priority Number (RPN) как произведения рангов Severity, Occurrence и Detection [12]:

$$RPN = S \times O \times D$$

Смысл управленческий: причины с высоким RPN становятся первыми кандидатами на инженерные и организационные меры.

5) Контур качества и безопасности (ISO 9001 и ISO 45001)

ISO 9001 фиксирует требования к системе менеджмента качества как рамке для стабильного выпуска результатов и постоянного улучшения [13]. ISO 45001 задает требования к системе управления охраной труда и промышленной безопасностью как к структуре, снижающей риски и повышающей результативность ОН&С [14]. Для надежности процесса это означает, что качество и безопасность становятся не “службой контроля”, а частью проектной архитектуры.

6) Контрактная интеграция как организационный усилитель (IPD)

Integrated Project Delivery (IPD) в руководстве AIA определяется как подход, интегрирующий людей, системы и практики в процесс сотрудничества для снижения потерь и оптимизации эффективности во всех фазах [15]. Контрактная модель важна, потому что надежность процесса почти всегда упирается в стимулы: кто выигрывает от предотвращенных сбоев, и кто платит за их последствия.

Индекс надежности строительного процесса (RCPI)

Предлагается расчетный индекс RCPI (Reliability of Construction Process Index) как агрегатор двух контуров.

1. Нормирование показателей:

- $x_1 = PPC/100$

- $x_2 = \min(1, SPI)$
- $x_3 = \min(1, CPI)$
- $x_4 = 1 - \frac{\sum E[L]_{top}}{B}$ (доля “погашенного” риска относительно бюджета В, с отсечением по приоритетным сценариям)
- $x_5 = 1 - \frac{\sum RPN_{critical}}{\sum RPN_{baseline}}$ (эффект снижения критичности причин после мер)

2. Индекс:

$$RCPI = \sum_{j=1}^5 w_j \cdot x_j, \sum w_j = 1, w_j \geq 0$$

Интерпретация:

- RCPI близок к 1 - процесс устойчив, отклонения управляемы.
- RCPI снижается - надежность деградирует либо по потоку работ (PPC, SPI), либо по экономике (CPI), либо по рискам и причинам (E[L], RPN).

RCPI позволяет сравнивать проекты и периоды сопоставимо, не смешивая “мнения” и “ощущения”, а привязывая надежность к измеримым контурам.

Результаты

Результат 1: стоимость ненадежности данных через распределение потерь интероперабельности

Исходные данные NIST: суммарная ежегодная стоимость недостаточной интероперабельности - 15,8 млрд долл., распределение по группам - 1,2; 1,8; 2,2; 10,6 млрд долл. [3].

Расчет долей выполняется формулой:

$$Share_i = \frac{Cost_i}{15.8} \times 100\%$$

Группа стейкхолдеров	Годовые потери, млрд долл.	Доля в 15,8 млрд, %
Архитекторы и инженеры	1,2	7,6
Генеральные подрядчики	1,8	11,4
Специализированные изготовители и поставщики	2,2	13,9
Владельцы и операторы	10,6	67,1

Содержательный вывод здесь в управленческом смысле: почти две трети потерь концентрируются у владельцев и операторов, то есть у тех, кто получает актив и несет последствия плохих данных на эксплуатации. Это аргумент в пользу того, что контур надежности данных (ISO 19650 + IFC + правила валидации) должен финансироваться и управляться как стратегическая функция владельца, а не как “опция проектировщика”.

В рисунке 2 схема “экономического переводчика” потерь интероперабельности в портфель мероприятий надежности данных.

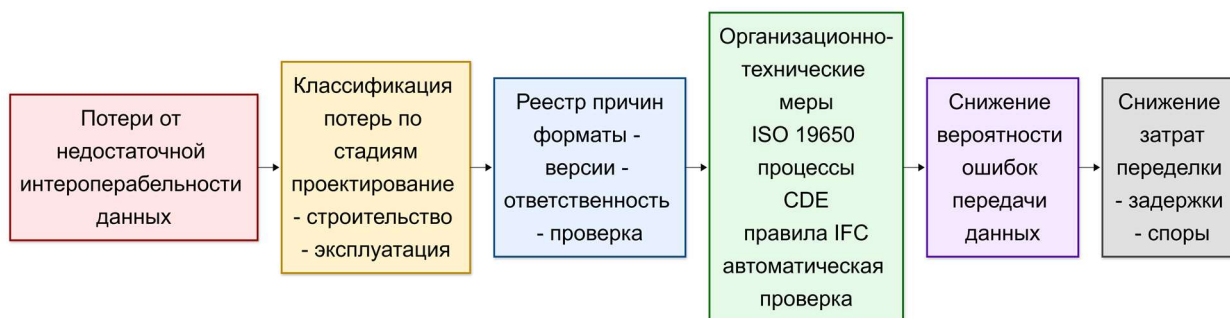


Рисунок 2 – Схема управления потерями интероперабельности в системе обеспечения надежности строительных процессов

Результат 2: расчетный эффект роста надежности планирования по PPC на эмпирическом индикаторе

В учебно-методическом материале Lean Construction Institute приведен пример PPC = 53% как показатель качества планирования, а также фиксируется пример долгосрочного среднего уровня PPC = 85% (на горизонте 46 недель) [16]. Эти числа позволяют корректно показать расчетный эффект роста надежности обязательств без подстановки “фиктивных” проектов.

1. Абсолютное изменение:

$$\Delta PPC = 85\% - 53\% = 32 \text{ п.п.}$$

2. Относительный рост надежности (по отношению к исходному уровню 53%):

$$Growth = \frac{32}{53} \times 100\% \approx 60,4\%$$

Интерпретация: переход от “половины обещаний выполняется” к “четыре из пяти обещаний выполняется” качественно меняет динамику проекта, потому что надежность потока работ влияет на скорость системы и стоимость через снижение ожиданий, перестановок, конфликтов доступа и вынужденной параллельности.

Результат 3: формализация экономического масштаба потерь от переделок как “нижней границы” надежности

Эмпирическая публикация Hwang и Thomas показывает, что прямые затраты на переделки часто составляют около 5% общей стоимости строительства [7], а данные CII на индустриальных проектах дают усредненный уровень отклонений качества, приводящих к переделкам/ремонту/замене, 12,4% установленной стоимости [8]. Эти величины можно превратить в инженерный “коридор надежности”:

Если C - стоимость проекта, то прямые потери на переделки лежат в диапазоне:

$Loss_{rework}$

$\approx 0.05C$ (типовая оценка по данным 359 проектов) до $0.124C$ (индустриальная выборка CII)

Смысл: даже нижняя граница в 5% столь велика, что любые организационно-технические меры надежности, уменьшающие переделки хотя бы на доли процента, имеют экономически выраженный эффект. Но ключевое условие - измеримость причин и внедрение цикла улучшения, иначе “борьба с переделками” вырождается в кампанию лозунгов.

Обсуждение

Практика показывает, что даже при наличии BIM-моделей, цифровых платформ планирования и формально выстроенных процедур управления строительный проект может сохранять низкую надежность. Причина заключается не в дефиците технологий как таковых, а в том, как они встроены в организационную структуру и управленческие механизмы проекта. Если данные передаются между участниками без единых правил, формализованной валидации и ответственности за актуальность, цифровые инструменты лишь ускоряют распространение ошибок. Аналогично, при отсутствии симметричных стимулов за надежность участники оптимизируют собственные задачи, а не устойчивость проекта в целом. Существенную роль играет и качество планирования: когда не проводится принципиального различия между работами, которые потенциально можно выполнить, и теми, за которые принято обязательство, план утрачивает управленческую функцию и превращается в декларативный перечень намерений. Формальное перечисление рисков без их привязки к конкретным решениям и приоритетам дополнительно снижает предсказуемость хода проекта.

На уровне управления данными эта проблема отчетливо проявляется в оценках NIST, где недостаточная интероперабельность трактуется не как технологический пробел, а как следствие организационной несогласованности и дефектов обмена информацией, имеющих измеримую экономическую стоимость в масштабах отрасли [3]. На уровне производственного потока аналогичная логика выражается в снижении показателя PPC, когда значительная часть запланированных работ не выполняется в обещанный срок, что напрямую транслируется в срывы графиков и перерасход ресурсов [9]. Таким образом, надежность проекта разрушается одновременно в информационном и производственном измерениях.

В этой связи надежность строительных процессов целесообразно рассматривать как результат синхронизации двух взаимосвязанных потоков. Первый поток связан с исполнением обязательств и включает надежное планирование, анализ причин невыполнения, управление готовностью работ и выравнивание фронтов производства, что на практике выражается через метрику PPC и связанные с ней управленческие процедуры. Второй поток относится к информации и опирается на логику управления данными по ISO 19650, использование среды общих данных как единого источника истины, применение открытых форматов IFC для межплатформенного обмена и автоматизированную проверку полноты, коллизий и версионности информации. Только при согласованной работе этих двух потоков цифровые инструменты начинают повышать надежность, а не маскировать системные дефекты.

С позиции цифрового развития особое значение приобретает переход к концепции цифрового двойника, который усиливает временную составляющую надежности, позволяя выявлять отклонения на ранних стадиях, когда стоимость их устранения минимальна [6]. Это создает основу для профилактического управления надежностью, ориентированного на предупреждение сбоев, а не на реагирование после их проявления.



Рисунок 3 – Схема совершенствования организационно-технических механизмов обеспечения надежности строительных процессов

Представленная схема отражает причинно-следственную связь между управленческой целью обеспечения надежности и ключевыми механизмами ее достижения. Совмещение процессного и риск-ориентированного управления с цифровой средой данных позволяет снизить вероятность отклонений, переделок и срывов сроков, обеспечивая устойчивость строительных процессов к организационным и технологическим рискам.

Важным организационным усилителем данной логики выступают интегрированные контрактные модели, такие как Integrated Project Delivery. Их значимость заключается в переносе надежности из сферы доброй воли участников в зону экономических интересов, где совместная ответственность, раннее вовлечение ключевых сторон и ориентация на снижение совокупных потерь становятся встроенными элементами системы управления [15]. Для мегапроектов это особенно критично, поскольку искаженные стимулы и систематические недооценки затрат и рисков формируют устойчивый паттерн неудач, который невозможно устранить исключительно за счет календарного планирования [2].

В этом контексте индекс RCPI приобретает смысл управленческого прибора лишь при выполнении трех принципиальных условий. Во-первых, необходим единый реестр причин отклонений, охватывающий как производственные операции, так и информационные процессы. Во-вторых, выявленные причины должны быть напрямую связаны с экономическими показателями проекта через инструменты освоенного объема (CPI и SPI) и расчет ожидаемых потерь, что позволяет переводить надежность в язык управленческих решений [10]. В-третьих, требуется приоритизация причин на основе показателя RPN с последующим формированием и мониторингом корректирующих мер, что обеспечивает фокус управления на действительно критических источниках ненадежности [12].

Заключение

В современных технологических условиях надежность строительных процессов следует трактовать не как частную характеристику отдельных операций или управленческих процедур, а как комплексное свойство системы, формируемое на пересечении организационных решений и качества информационного обеспечения. Устойчивость исполнения проектных обязательств, выражающаяся в предсказуемости производственного потока, дисциплине планирования и соблюдении сроков, неотделима от надежности данных, включающей их актуальность, согласованность, прослеживаемость и способность к корректной передаче между участниками проекта. Нарушение связности между этими контурами приводит к накоплению скрытых потерь, которые проявляются в виде задержек, переделок, конфликтов решений и снижения управляемости проекта.

Результаты международных оценок, выполненных Национальным институтом стандартов и технологий США, наглядно подтверждают, что недостаточная надежность данных и слабая интероперабельность информационных систем формируют значимые экономические издержки на отраслевом уровне. Это позволяет рассматривать стандартизацию управления информацией, внедрение единых сред данных и использование открытых форматов обмена не как вспомогательные цифровые инициативы, а как структурный инструмент повышения надежности строительных процессов. Дополнительным подтверждением системного характера проблемы служат эмпирические данные о масштабах переделок, которые в различных типах проектов достигают значительной доли общей стоимости строительства и тем самым задают количественно измеримую «цену ненадежности».

Предложенная в работе концепция индексной оценки надежности строительного процесса позволяет перевести данную категорию из описательной плоскости в управляемую. Интеграция показателей надежности планирования, эффективности по срокам и стоимости, риск-ориентированного управления, анализа критичности причин отклонений, а также систем менеджмента качества и безопасности формирует единое аналитическое поле для принятия решений. Такое объединение устраняет разрыв между операционными показателями, управлением рисками и экономическими последствиями, что особенно важно в условиях высокой сложности и многосубъектности современных строительных проектов.

С практической точки зрения наиболее результативным представляется внедрение двухконтурной модели надежности, в которой поток работ и поток информации управляются согласованно и опираются на единый реестр причин отклонений. Экономическая интерпретация потерь и эффектов управленческих воздействий позволяет не только выявлять проблемные зоны, но и обосновывать целесообразность корректирующих мер. Закрепление данной логики через интегрированные формы взаимодействия участников, включая модели совместной ответственности, создает условия для устойчивого повышения надежности строительных процессов на протяжении всего жизненного цикла объекта. Дальнейшее развитие представленного подхода целесообразно связать с его эмпирической проверкой на данных реализованных проектов, различающихся по масштабу, типу контрактных отношений и уровню цифровой зрелости, с целью уточнения чувствительности интегральных показателей к структуре исходных данных. Существенный научный интерес представляет формирование унифицированной классификации причин отклонений, применимой как к производственным операциям, так и к информационным процессам, с ее последующей привязкой к требованиям управления данными и функционированию сред общих данных.

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Ағаш композиттері негізіндегі ұзақмерзімді сәндік-қорғағыш плиталар: фасадта материал емес, конструктив ретінде қарастыру

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Аңдатпа. Фасадтық әрлеуде қолданылатын ағаш композиттері негізіндегі плиталарды көбіне «материал» ретінде сипаттау қалыптасқан, алайда ұзақ қызмет ету көрсеткіші көбіне химиялық құрамнан гөрі фасад жүйесінің конструктивтік қисынына тәуелді. Мақалада сәндік-қорғағыш плиталар желдетілетін rainscreen-қоршау жүйесінің сыртқы қабаты ретінде қарастырылып, оның сенімділігі «түйіндік инженерия» арқылы дәлелденеді: жел әсерін қабылдау және жүктемені қаңқаға беру, деформациялық қозғалысқа орын қалдыру, су қысымын әлсірету және дренаж-қарғау жолдарын ұйымдастыру, өртке реакция жіктемесін жобалық шешімге енгізу, сондай-ақ климаттық қартаюға қарсы қызмет көрсету сценарийін алдын ала жобалау. Нормативтік негіз ретінде Construction Products Regulation (EU) No 305/2011 және механикалық бекітілетін сыртқы қаптама жинақтарына арналған EAD 090062-01-0404 құжаттарының «жинақ» логикасы алынған. Ғылыми бөлімде ағаш-полимер композиттерінің ауа райына төзімділігі жөніндегі рецензияланатын зерттеулердің нәтижелері түйіндік шешімдермен байланыстырылады. Нәтижесінде фасадта «ұзақмерзімді плита» ұғымын конструктивтік көрсеткіштер жүйесі ретінде нақтылау ұсынылады.

Түйін сөздер: желдетілетін фасад, rainscreen, ағаш композиті, WPC, HPL, механикалық бекіту, деформациялық жіктер, EN 1991-1-4, ISO 4892-2, EN 13501-1.

Кіріспе

Ғимарат фасады бүгін тек эстетикалық қабық емес, ол көпфакторлы инженерлік шекара. Бұл шекараға бір мезетте жел қысымы, жаңбырдың соқпалы бағыты, ультракүлгін сәуле, температуралық циклдер, және өрт қауіпсіздігі талаптары ықпал етеді. Мұндай ортада ағаш композиті плитасының «өздігінен ұзаққа шыдауы» туралы түсінік кәсіби тұрғыда жеткіліксіз. Дұрысы - плитаны қоршау жүйесінің конструктивтік бөлігі ретінде қарастыру, яғни оның жұмыс қабілетін бекіту тораптары, қаңқа, жіктер, желдетілетін саңылау, су бұру және инспекция мүмкіндігімен бірге бағалау.

ЕО кеңістігінде бұл тәсілдің құқықтық және техникалық негізі айқын: құрылыс өнімдерін нарыққа енгізу кезінде олардың жарияланатын сипаттамалары мен сәйкестік дәлелдеу логикасы Construction Products Regulation (EU) No 305/2011 құжатымен реттеледі [1]. Сол себепті көптеген қаптама шешімдері «өнім» ретінде емес, «жинақ» (kit) ретінде өмір сүреді. Осы жинақтық табиғатты нақтылайтын құжаттардың бірі - механикалық бекітілетін сыртқы қабырға қаптамаларына арналған EAD 090062-01-0404, онда қаптама жүйесінің бағалануы компоненттер, байланыстар, жүктеме беру және ұзақмерзімділік дәлелдемесі

арқылы құрылымдалады [2]. Демек, зерттеудің өзегі плитаның жеке қасиеттері емес, плитаны фасадта ұзақ сақтайтын конструктивтік архитектура.

Әдеби шолу

Желдетілетін rainscreen-қабырға жүйелерінде су өтпеу принципі бір қабатқа емес, бірнеше қорғаныс механизміне таратылады: дефлексия, қысымды әлсірету, дренаж және құрғау. Ылғалға қарсы дәл осындай көпқабатты стратегия ұзақ қызмет етуге шешуші әсер етеді, өйткені фасадқа түскен су толық нөлге тең болмайтын сценарий ретінде қаралады. Бұл ой ылғал менеджменті жөніндегі WBDG материалында да анық көрсетіледі, онда суға қарсы стратегия «deflection-drainage-drying-durability» логикасымен түсіндіріледі [13]. Желдетілетін қаптаманың тиімділігі ауа жүретін қуыстың геометриясы мен желдетілу орындарының деталіне тәуелді екені Finch және Straube еңбегінде де талданған: дренаж қуысының болуы вентиляцияның автоматты түрде пайда болуын білдірмейді, түйін детальдары желдетілу режимін нақты қалыптастырады [12]. Бұл фасад конструктивін материалдық емес, жүйелік деңгейде жобалау қажеттігін күшейтеді.

Ағаш-полимер композиттері және ағаш негізді композициялық өнімдер климаттық қартаюға сезімтал, бірақ бұл сезімталдықты инженерлік тұрғыдан басқаруға болады. Chen және авторлар WPC үлгілерінде ағаш ұнын алдын ала өңдеу (экстракция немесе делигнификация) ауа райына төзімділік көрсеткіштеріне әсер ететінін көрсетеді, яғни «ағаш фазасы» пассив толтырғыш емес, қартаю траекториясын өзгерте алатын фактор [10]. Fabiуі және әріптестері WPC-тің сыртқы экспозицияда визуал өзгерісі мен химиялық трансформациясы арасында байланыс бар екенін көрсетіп, фасадтағы «түс тұрақтылығы» мәселесін тек дизайн деңгейінде емес, материалдың беткі деградация механизмі деңгейінде қарастыруға жол ашады [11]. Фасад конструктиві үшін бұл нені білдіреді? Біріншіден, қартаюдан толық қашу емес, қартаюды бақылауға болатын сценарийге түсіру маңызды. Екіншіден, қызмет көрсету және ауыстыру мүмкіндігі түйін шешімінің құрамдас бөлігіне айналуы тиіс.

Қазіргі практикада тағы бір жүйелік түйін жиі назардан тыс қалады - бекітпелердің нүктелік жылу көпірлерін тудыруы. Petresevics және Nagy желдетілетін фасад кронштейндері мен анкерлерінен туындайтын point thermal transmittance әсерін 3D сандық модельдеу арқылы бағалап, мұндай әсердің жиі есепке алынбау себептерін сипаттайды [9]. Бұл фасад конструктивінің «ұзақмерзімділігі» тек механика мен ылғалға емес, энергия тиімділігіне де байланысатынын көрсетеді.

Материалдар мен әдістер

Әдістемелік негіз ретінде нормативтік-инженерлік синтез қолданылады: фасад қаптамасын өнім емес, конструктивтік жинақ ретінде сипаттайтын еуропалық бағалау логикасы және климаттық әсерлерді бағалау әдістері біріктірілді. Жел әсерін бағалау кезінде Eurocode 1 құрамындағы EN 1991-1-4 нормасының жалпы қағидалары қолданылады [3]. Жел қысымын инженерлік тұрғыда сипаттаудың классикалық өрнегі мәтіннің табиғи логикасына енгізіледі, өйткені ол плитаның жүктемені қалай қабылдайтынын және бекітпе арқылы қаңқаға қалай берілетінін талдауға мүмкіндік береді:

$$q = \frac{1}{2} \rho v^2$$

Бұл жерде q - динамикалық қысым, ρ - ауа тығыздығы, v - жел жылдамдығы. Осы шаманың фасад панеліне әсер ететін қорытқы қысымға айналуы қысым коэффициенттері

арқылы жүреді, ал конструктивтік талдауда ең маңыздысы - сол қысымның түйінге жинақталу механизмі.

Материалдық қартаюды бағалауда лабораториялық жарық көздеріне экспозициялау әдістерін сипаттайтын ISO 4892-2 қолданылады: құжатта ксенон-доғалы шамдар арқылы жарық және ылғал әсерін модельдеу логикасы берілген [4]. Өрт қауіпсіздігі аспектісінде фасадта қолданылатын өнімдердің реакциясын классификациялау EN 13501-1 бойынша іске асады [5]. Бұл жерде мақала міндеті нақты бір өнімнің класын «ойдан шығару» емес, керісінше жобалық шешімнің қандай класты талап етуі мүмкін екенін және ол талаптың түйін шешіміне қалай ықпал ететінін ашу.

Өнімдерді конструктивтік қолданылуы бойынша нормалау үшін ағаш негізді панельдердің құрылысқа арналған сипаттамаларын беретін EN 13986 [6], жоғары қысымды декоративті ламинаттардың сыртқы қабырға және төбе әрлеуіне арналған бөлігін регламенттейтін EN 438-7 [7], сондай-ақ қатты ағаш қаптама және панельдеу өнімдерін сипаттайтын EN 14915 [8] дереккөз ретінде алынды. «Жинақ» логикасының құрылымдық қаңқасы CPR 305/2011 және EAD 090062-01-0404 құжаттарына сүйенеді.

Нәтижелер

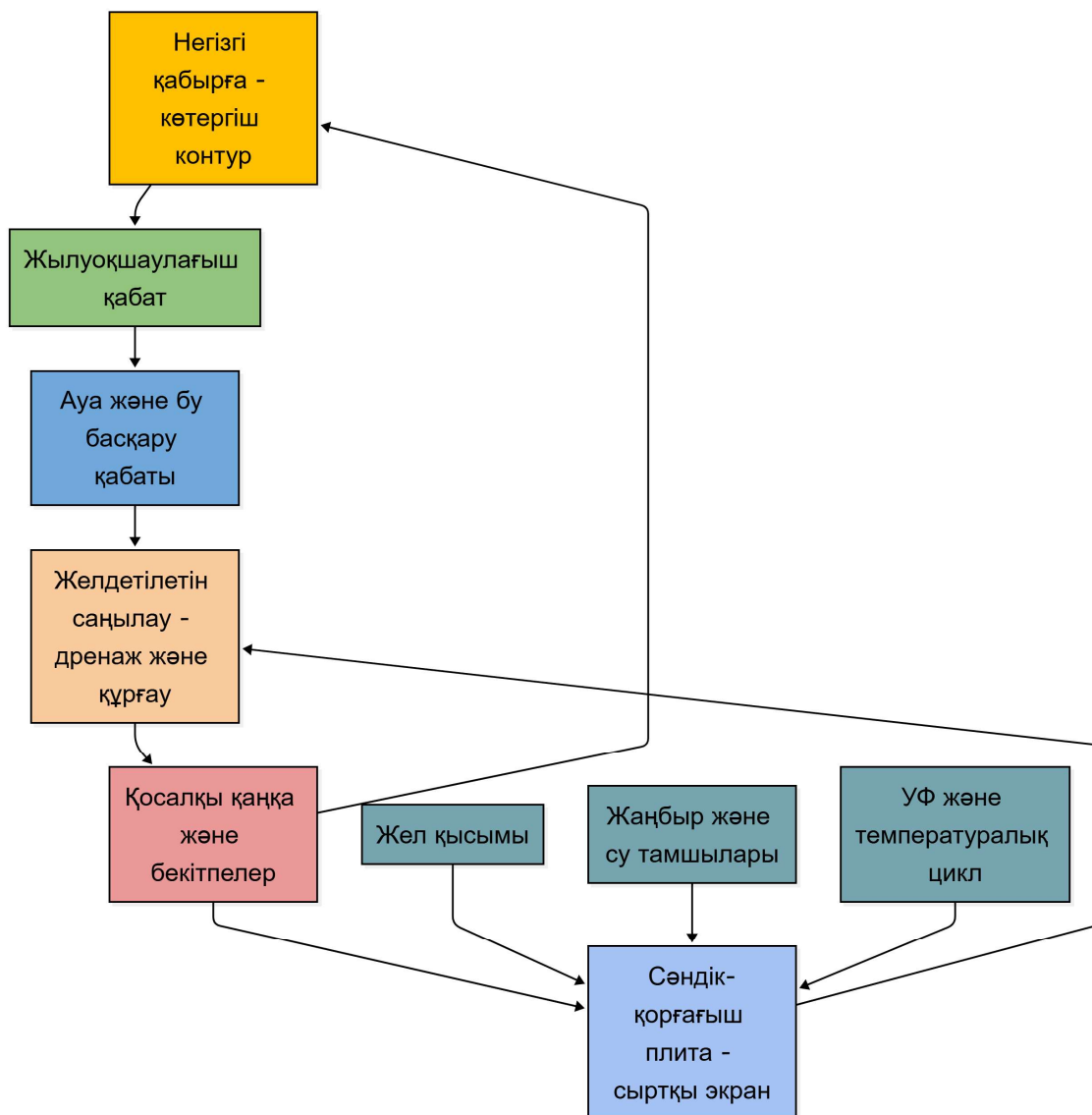
Фасад плитасын конструктив ретінде қарастырудың басты нәтижесі - ұзақмерзімділіктің өлшем бірлігі «плита» емес, «түйін». Бұл тезисті ашу үшін алдымен фасад қаптамасында жиі кездесетін өнім топтарын олардың конструктивтік рөлімен және дәлелдеу арналарымен бірге жүйелеу қажет. Төмендегі кесте «қайсысы жақсы» дегенді емес, қай өнім тобы фасадта қандай функция атқаратынын және ұзақ қызмет етуге қандай конструктивтік факторлар ықпал ететінін көрсетеді.

Кесте 1 – Ағаш композиттері негізіндегі фасад қаптамаларының конструктивтік типологиясы және дәлелдеу логикасы

Қаптама типі	Нормативтік тірек	Функционал рөлі (конструктив)	Ұзақмерзімділіктің шешуші шарты
Ағаш негізді панельдер (plywood, OSB, MDF және т.б.)	EN 13986 [6]	Қаптама немесе негіз қабаты, кейде желден қорғау қабатымен бірге жұмыс істейді	Жиек қорғанысы, су бұру, құрғау сценарийі
HPL/компакт-ламинат панельдері	EN 438-7 [7]	Сыртқы экран қабаты (gainscreen), атмосфералық әсерді бірінші қабылдайды	Деформацияға орын қалдыру, бекітпе тесіктеріндегі кернеуді басқару
Қатты ағаш қаптама және панельдеу	EN 14915 [8]	Сәндік қабат және қорғаныс, кейде жылу-ылғал режиміне сезімтал	Желдетілетін саңылау, күтім және жаңарту регламенті
Жинақ ретінде бағаланатын механикалық бекітілген қаптама	EAD 090062-01-0404 [2]	Қаңқа, бекітпе, панель және байланыстардың біріккен жүйесі	Байланыстардың жүктемені қауіпсіз беруі және тексерілетіндігі

Кесте 1-дің практикалық салдары айқын: фасадтағы «ұзақмерзімді плита» тіркесін ғылыми тілге аударғанда ол көбіне түйін арқылы дәлелденетін қасиеттер жиынына

айналады. Мұндай көзқарас ресми регламентпен де үйлеседі: CPR 305/2011 құрылыс өнімінің сипаттамасын жариялауды және сәйкестік дәлелін жүйелік түрде ұйымдастыруды талап етеді [1]. Сондықтан ұзақмерзімділік мәселесі тек материалға емес, жүйеге көшеді.



Сурет 1 - Желдетілетін rainscreen-фасадтың конструктивтік қабаттары және әсер ағындары

Бұл сызбада rainscreen логикасы «су кірмейді» деп емес, «су кірсе де басқарылатын жолмен ағып кетеді және қуыста құрғайды» деп оқылады. Ылғал менеджментінің көпқабатты табиғаты WBDG материалында дәл осы дефлексия, дренаж және құрғау қағидаларымен түсіндіріледі [13]. Сондықтан плитаның ұзақ сақталуы желдетілетін саңылаудың нақты жұмыс қабілетімен тікелей байланысты.

Фасадта ең жиі инженерлік қателік дәл осы байланыс аймағында болады: панель қатты бекітіледі де, температуралық қозғалыс пен ылғал циклінен туатын деформациялық кернеу бекітпе тесіктеріне жиналады. Бұл құбылысты формула арқылы емес, түйіндік қисын арқылы түсіндіру маңызды, алайда деформацияны бағалау үшін жобалық ойлау деңгейінде төмендегі өрнек қолданылады:

$$\Delta L = \alpha L \Delta T$$

Мұнда ΔL - ұзару, α - сызықтық кеңею коэффициенті, L - панель өлшемі, ΔT - температура айырмасы. Бұл теңдеу сан қою үшін емес, түйінге «қозғалысқа орын беру» міндетін дәл қою үшін керек, өйткені нақты α әр өндірушінің жарияланған құжаттарында әртүрлі болуы мүмкін.

Түйіндік тәуекелдерді жинақтап көрсету мақсатында төмендегі кесте ұсынылады. Ол жобалаушыға қай қауіп қай түйінмен басқарылатынын нақты көрсетеді.

Кесте 2 – Ұзақмерзімділік тәуекелдері және оларды конструктив арқылы басқару

Тәуекел тобы	Механизмі	Қай жерге жиналады	Конструктивтік жауап
Жел қысымы	Панель майысуы және бекітпе жүктелуі	Бекітпе тораптары, қаңқа	Жүктемені қаңқаға беру, есептік қадам, бекітпе схемасы (EN 1991-1-4 негізінде) [3]
Су және ылғал циклдері	Соқпалы жаңбыр, капиллярлық су, конденсат	Жіктер, жиектер, өтпелер	Дренаж бағыты, желдетілетін саңылау, су тоқтатпайтын деталь (vented cladding қағидасы) [12]
Климаттық қартаю	УФ, ылғал және температура әсерінен беткі деградация	Панель беті және қорғаныш қабаттары	Қызмет көрсету сценарийі, ауыстыру мүмкіндігі, экспозиция дәлелі (ISO 4892-2 логикасы) [4]
Өрт қауіпсіздігі	Материалдың реакциясы және түтін түзуі	Фасад жүйесі тұтас	Жобалық шектеулер және өнім класы EN 13501-1 бойынша [5]
Энергия тиімділігі	Нүктелік жылу көпірлері	Кронштейн, анкер, бекітпе	Бекітпе типін термиялық тұрғыда негіздеу, 3D модельдеу түсінігі [9]

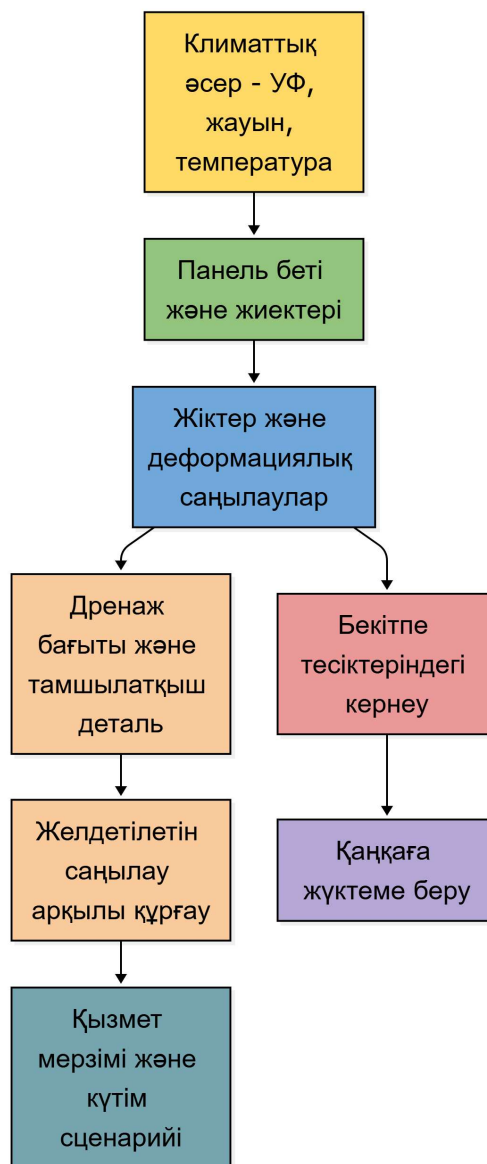
Кесте 2 көрсеткендей, ұзақмерзімділік туралы ғылыми тұжырым тек материалдың «беріктігімен» шектелмейді. Мысалы, ағаш-полимер композиттерінде ауа райының әсерінен визуал және химиялық өзгерістер жүретіні ғылыми деңгейде дәлелденген [11], ал бұл өзгерістерді басқару үшін конструктивте инспекция және ауыстыру мүмкіндігі болуы тиіс. Chen және авторлар WPC құрамындағы ағаш ұнын алдын ала өңдеу арқылы ауа райына төзімділік сипаттамаларына ықпал етуге болатынын көрсетеді [10], бұл болса «материалдық таңдау» түйіндік шешіммен бірге жүруі керектігін дәлелдейді: бірдей қаптама эстетикасы әртүрлі қызмет көрсету стратегиясын талап етуі мүмкін.

Қаптама жүйесін конструктив ретінде жобалауда «бекіту тәсілі» негізгі айнаымалыға айналады. Сондықтан шешім қабылдау матрицасы қажет, ол жобалаушыға эстетика, тексерілгіштік және қозғалыс еркіндігі арасындағы инженерлік сауданы ашық көрсетеді.

Кесте 3 – Бекіту тәсілдерін конструктивтік тиімділік тұрғысынан салыстыру

Бекіту тәсілі	Инженерлік артықшылық	Түйіндік әлсіз жер	Ұзақмерзімділікке әсері
Көрінетін механикалық бекіту	Инспекция және жөндеу жеңіл, ауыстыру жылдам	Тесіктер аймағында кернеу және су кіру жолы	Қызмет көрсету мүмкіндігі жоғары, бірақ герметикалық деталь талап етеді
Жасырын механикалық бекіту	Эстетика жоғары, бет тұтастығы сақталады	Монтаж дәлдігі және қозғалысқа орын қалдыру қиынырақ	Торап дұрыс шешілсе ұзаққа шыдайды, қателік бағасы жоғары
Жинақтық жүйе (kit)	Жүйелік дәлелдеу және компонент үйлесімі	Компонент тәуелділігі	Техникалық бағалау логикасына сәйкес келеді, жобалық тәртіп талап етеді

Бұл жерде «ең жақсы» тәсіл жоқ. Ұзақмерзімділік нақты ғимарат контекстінде анықталады: жел режимі, қабат биіктігі, түйіндердің қолжетімділігі, өрт талабы және күтім саясаты. Мұндай көпфакторлы таңдауды бір сызба арқылы да көрсету пайдалы, өйткені шешімнің жолын көрнекі етеді.



Сурет 2 - Түйіндік шешімнің логикасы: қозғалыс, жіктер және су бұру

Сурет 2-нің негізгі идеясы - бір ғана әлсіз түйін бүкіл жүйенің қызмет мерзімін қысқарта алады. Сондықтан «ұзақмерзімді плита» ғылыми тұрғыда түйіндердің қателікке төзімділігімен өлшенеді.

Талқылау

Конструктивтік көзқарастың ғылыми артықшылығы мынада: ол өндіруші дискурсында жиі кездесетін жалпы уәделерді өлшенетін және тексерілетін тілге аударады. Жүйе деңгейіндегі дәлелдеу EAD 090062-01-0404 құжатында нақты сипатталады, өйткені онда механикалық бекітілетін қаптамалар компоненттер және байланыстар жиынтығы ретінде қарастырылады [2]. Бұл тәсілдің шынайы құндылығы фасадқа қатысты тәуекелдерді бөлек-бөлек емес, бір жүйеде басқаруға мүмкіндік беруінде.

Қартаю туралы ғылыми деректер де осы жүйелік ойлауды қолдайды. WPC-тің ауа райында визуал және химиялық өзгерістерге ұшырайтыны Fabiу және әріптестері арқылы көрсетілген [11]. Мұндай өзгерістердің болуы фасад жобалауында «күтім және ауыстыру» сценарийін конструктивтің құрамына енгізуді талап етеді. Мұнда «қызмет көрсету» эстетикалық ұсақ-түйек емес, ұзақмерзімділіктің экономикалық механизмі ретінде көрінеді: инспекция мүмкін емес, ауыстыру қиын болса, қаптама тез «жоба тәуекеліне» айналады.

Екінші маңызды өлшем - бекітпелердің жылутехникалық салдары. Petresevics және Nagy көрсеткен нүктелік жылу көпірлері тақырыбы фасадтың тек сыртқы қабық емес екенін тағы да дәлелдейді: конструктивтік түйін жылу ағынына әсер етеді және бұл әсер энергия тиімділік талаптарымен қайшылыққа түсуі мүмкін [9]. Сондықтан ұзақмерзімділік ұғымы энергия, ылғал, механика және қауіпсіздік арасындағы теңгерімнің инженерлік нәтижесі ретінде қайта түсіндіріледі.

Фасадтық қаптама жүйесі — тек материалдық қабат емес, инженерлік конструктив, яғни сыртқы ортаның көпфакторлы әсерлеріне (жауын, жел, температура өзгерісі, ылғал) жауап беретін күрделі жүйе екенін түсіну қажет. Rainscreen cladding (желдетілетін экран) принципі осыны айқын көрсетеді: сыртқы экран + ауа саңылауы + оқшаулағыш + қаңқа сияқты қабаттардың үйлесімді жұмысы ғимараттың ұзақ мерзімді қызметіне тікелей әсер етеді.

Бұл жүйе сыртқы жаңбыр мен ылғалдың кірмеуіне ғана емес, сыртқы қабат арқылы өтетін судың қауіпсіз шығуына, бу диффузиясына, конвекцияға және температуралық циклдерге бейімделуге бағытталған. Мұндай тәсіл түйіндер мен байланыстардың инженерлік логикасын тартып, олардың ұзақ мерзімділігін қамтамасыз етеді.

Кейбір теориялар мен практикалық инженерлік көзқарастар rainscreen-ды «қос қабатты қоршау жүйесі» ретінде сипаттайды, онда желдетілетін саңылау немесе ауа қуысы қабаттары ішкі және сыртқы орталар арасындағы ылғалды басқаруға мүмкіндік береді. Бұл ылғалдың ауа қозғалысы арқылы табиғи түрде шығуына және кірген судың жоғалуына жағдай жасайды, соның арқасында қабырға жүйесінің қызмет мерзімі ұзартылады.

Архитектурада материалдың таңдалуы эстетикадан гөрі құрылымдық жауапты мінез ретінде бағалануы тиіс: климаты қатты жерлерде қалың ауа саңылаулары мен тиімді дренаж жүйелері әсіресе маңызды, өйткені олар ылғалдың қабырға жүйесіне енуін азайтады және қалыпты ауа ағынын қамтамасыз етеді.

Сонымен қатар, rainscreen жүйелері энергия тиімділігін жақсартады: жүйенің сыртқы бөлігінде ауа саңылауының болуы салқын ауа мен жылы ауаның арасындағы жылу алмасуды азайтады, бұл ғимараттың ішкі климатын тұрақтандыруға ықпал етеді. Бірқатар әдеби жұмыстар вентильденетін фасадтың энергетикалық, жекелік және акустикалық көрсеткіштерді жақсартатынын айқындайды.

Композитті плиталар осы конструктивтік жүйе ішінде маңызды рөл атқарады: олар сыртқы экран ретінде жаңбыр мен УФ-сәулелердің әсерін бірінші қабылдайды, бірақ олардың ұзақ мерзімділігі тек материалдық сипаттамаларға ғана емес, сонымен бірге тікелей жүйенің тиімділігін қамтамасыз етуге бағытталған конструктивтік шешімдерге байланысты.

Сондықтан минерал, металл немесе ағаш композиттерін таңдамас бұрын жобалаушы төмендегі негізгі инженерлік мәселелерді шешуі тиіс:

- ауа саңылауының дұрыс орналасуы және оның үздіксіздігі
- дренаж және конденсат шығару жүйесінің тиімділігі
- термиялық қозғалыстар үшін жіктердің беріктігі
- бекіту тәсілдерінің жүйелік интеграциясы
- ылғалдың түсу жолдарын алдын ала есептеу және басқару
- материалдардың ұзақ мерзімді климаттық сынақтан өтуі.

Қорытынды

Ағаш композиттері негізіндегі сәндік-қорғағыш плиталарды фасадта материал ретінде емес, конструктив ретінде қарастыру ұзақмерзімділіктің нақты механизмдерін ашуға мүмкіндік береді. Ұзақ қызмет етудің «ядрасы» плитаның атауында емес, rainscreen-қабаттың жұмыс қабілетінде: дұрыс желдетілу, дұрыс дренаж, қозғалысқа орын қалдыру,

бекіту тораптарының тексерілгіштігі, және өрт пен энергия талаптарын түйіндік деңгейде келісу. Нормативтік орта да осыны талап етеді: CPR 305/2011 және EAD 090062-01-0404 логикасы қаптаманы біртұтас жинақ ретінде бағалауға бағыттайды. Ғылыми әдебиеттер WPC тәрізді композиттердің климаттық қартаюға ұшырайтынын көрсетеді, сондықтан фасад конструктиві «қызмет көрсету және ауыстыру» сценарийін бастапқы жобалаудан-ақ көтеруі тиіс. Осы тұжырымдар негізінде фасад қаптамасын таңдаудағы басты критерий ретінде «түйіндік сенімділік индексі» қолдану ұсынылады: ол бекітпе схемасының инспекциялануын, деформациялық жіктердің дұрыстығын, су бұрудың үздіксіздігін және желдетілетін қуыстың құрғау қабілетін бір шешім рамкасына біріктіреді.

Сәндік-қорғағыш ағаш композиттері негізіндегі плиталарды фасадта материал ретінде емес, конструктивтік жүйенің құрамдас бөлігі ретінде қарастыру керек. Бұл жайт төмендегі себептермен расталады:

- Rainscreen принципі - сыртқы экранның, ауа саңылауының және басқа элементтердің үйлесімді жұмысына негізделген жаңбыр мен ылғалдан қорғану тәсілі.
- Ауа қозғалысы мен дренаж - ылғалды басқару және конденсатты шығару жүйесі ғимарат қабырғасының ұзақ мерзімділігін арттырады.
- Энергия тиімділігі - жүйелік конструктивтік тәсіл ғимараттың жылу және энергия көрсеткіштерін жақсартады.
- Дизайн мен инженерлік интеграция - плитаны таңдау эстетикалық элемент қана емес, ғимараттың функционалдық тұрақтылығын қамтамасыз ететін инженерлік шешім ретінде қарастырады.

Жалпы қорытынды ретінде айқын: ұзақмерзімділік пен сенімділікті қамтамасыз ететін фасадтық жүйе - бұл материалдардың ғана емес, конструктивтік келісім мен инженерлік дұрыс шешімдердің жиынтығы.

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Economic Sciences

FEATURES OF THE BUDGETING PROCESS

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Budgeting is a key management tool for modern companies building an effective planning system. The stability and development of an organization largely depend on how competently the budget formation process is organized and what principles underlie it. Plans may vary in detail, duration, and level of ambition, but their mandatory characteristics are realism, consistency, and alignment with the overall strategy of the enterprise.

Regardless of the scale of the business, its field of activity, or market position, a well-developed plan helps unite employees around common goals. The effectiveness of a company's work is determined by how harmoniously the plans of individual structural units are linked together. The personality of the manager also plays a significant role: their professionalism, exactingness, and authority have a significant impact on the successful implementation of the budgeting system.

At the same time, poorly drafted plans inevitably lead to negative consequences. Underestimated indicators, excessively long deadlines, or unreasonable targets undermine employee motivation, reduce trust in the management system, and raise doubts about the team's ability to achieve its goals.

The planning process must ensure that the company's strategic objectives are achieved within the set deadlines, and the manager must coordinate the actions of all participants, applying a systematic approach based on knowledge, experience, and the ability to translate strategic guidelines into clear and motivating actions for the team.

In addition, an effectively structured budgeting system increases the transparency of internal processes and allows for the timely identification of deviations from planned indicators. It serves as an early risk warning tool and helps management make informed decisions. Budgeting fosters a culture of responsibility, where each employee is aware of their personal contribution to the achievement of common goals. In a dynamic market, the budget becomes not only a financial document, but also an important element of strategic management. Companies that take a systematic approach to budgeting gain a sustainable competitive advantage and are able to adapt more quickly to changes in the external environment.

When preparing for planning, as well as during the planning cycle itself, it is extremely important to rely on fundamental management principles. These include competent goal setting, process organization, building a reliable primary accounting system, monitoring key indicators, managing deviations, as well as coordinating, stimulating, and motivating participants.

Planning should begin with an analysis of the basic patterns of the organization's functioning, an assessment of the quality of information flows, their structure, and level of detail. It is also necessary to take into account the financial capabilities of the enterprise, the position of the owners and management team, and, most importantly, the degree of agreement between them not only on the ultimate goals but also on the methods of achieving them. The more carefully organizational issues are resolved and the terms, approaches, functions, and general planning ideology are agreed upon, the more productive and predictable the process itself becomes.

Planning, implemented through a system of budgets, is an integral part of management activities, and budgeting is a practical tool that links strategy and operations. The effectiveness of

budget management directly depends on how consistently it is supported by management and how actively employees are involved in it. This determines the quality of management decisions, the speed of their implementation, and the overall level of coordination between departments.

Therefore, an important practical aspect is training employees in modern budgeting methods, teaching them the principles of organizational interaction, and implementing effective budget control procedures

In addition, developing a culture of planning and budgeting helps strengthen strategic discipline within the company, increases process transparency, reduces uncertainty, and creates an environment for more accurate forecasting. A systematic approach to training, regular professional development, and the establishment of uniform standards enable the company to adapt more quickly to changes in the external environment and achieve sustainable management results.

Budget management is a system of managing a company by responsibility centers through budgets, allowing it to achieve its goals by exercising budgetary powers and making the most effective use of resources.

Budgetary powers are the rights and obligations of budget management entities and other participants in the budget process to regulate budgetary relations and organize and implement the planning and control process.

It is customary to build a budget management system at an enterprise that includes the following processes:

- forming a financial structure and determining the budgetary powers of the participants in the process;
- developing and approving company budgets (including the distribution of budget limits by income and expense items);
- formation of contractual obligations within the framework of approved budgets, taking into account risk minimization and ensuring the security of the company's activities;
- execution of settlements within the framework of the formed contractual obligations and control over the execution of income and expense budgets and cash flow budgets; formation of a complete set of primary accounting documents (for income and expense parts);
- formation and provision of management reporting; analysis and decision-making.

The basic principles of budget management are reflected in a separate document—the budgeting policy—and are subsequently kept up to date. The policy must be revised when there are changes in the company's strategy, structure, and principles of interaction between departments. When drawing up any plan (or budget), the important question is: where to start? In budget management, this means streamlining management processes and creating a system for planning and control, management accounting, and budgeting.

The initial stage of work is based on the financial structure of the company (enterprise). Before analyzing (or building) the financial structure, it is necessary to define the concepts and its elements (subjects).

The subjects of budgeting (budget management) are the structural divisions, collegial bodies, and employees of the company who participate in the budget management process in accordance with their competence and area of responsibility.

The financial structure is the totality of financial responsibility centers in terms of financial accounting centers.

Budget structure is a hierarchy of operational, functional, and final budgets of an enterprise. A financial accounting center (FAC) is an accounting unit (object, project) for which consolidated information on income and expenses is accumulated in the accounting system.

The formation of a budgeting concept based on the principles of responsibility center management allows the company's financial structure to be the main mechanism for achieving the enterprise's financial goals.

Organizational hierarchy obviously exists in any company, but the principles of subordination may differ depending on industry or other characteristics of the business. The subjects of first-level CFOs are large entities—directorates, departments, services; functional structures—workshops, the day-to-day management of which is the responsibility of the relevant divisions.

After the financial structure has been formed, the next step is to define the powers and responsibilities of the participants in the process at all stages of budget management and to delineate areas of responsibility. The matrix of powers and responsibilities of budget management entities (Table 1) is used as an example.

Table 1 - Matrix of budget management entities

Name of budget entities Budget entities	Powers	Responsibilities
Owner	Requests for information, review of draft budgets, and decisions on their approval or rejection. Analysis of the company's consolidated budget and project budgets.	Approval of the company's strategy, formulation of tasks, and determination of executors for the formation and implementation of the strategic plan. Approval of the company's consolidated budget and project budgets.
Budget management	Analysis of the company's strategic goals and objectives, information for their formation and implementation	Decomposition of strategic goals and objectives for the Financial Accounting Center (FAC)
Finance Department	Coordination of the company's strategic goals and objectives. Analysis of information by the budget committee and owner.	Organization of the budget management process, formulation of requirements, rights, and obligations of budget management entities. Collection and analysis of data for the planning process. Development of a financial model for budgets. Formation of a draft consolidated budget, draft budgets for the Financial Accounting Center (FAC).
Head of the Central Finance Accounting Center	Analysis of key indicators for the Central Finance Unit. Provision of advisory and methodological assistance to the Finance Directorate and Budget Committee	Conducting task analysis and planning the project budget of the FAC. Justification of amounts under budget revenue and expenditure items. Approval of budgets for execution

The stages of budgeting at an enterprise are focused on key business objectives, which are determined for each company by market factors (market segment and share), production factors

(production structure, technologies used, resources), financial factors (sources of financing, opportunities for attracting loans), and social factors (satisfaction of consumer demand).

Strategic plans can be formulated in qualitative and quantitative terms, but it is important that they are fully understood by management and reflect the company's development goals. From a practical standpoint, agreeing on goals is the most important stage of planning, and functional managers should be involved in this process, as the company's goal is subsequently broken down into the goals of individual departments. It is during the process of agreeing on strategic goals that functional department heads develop coordinated methods for solving existing problems, evaluate tasks, and analyze constraints, opportunities, and risks.

PLANNING AND FORECASTING THE REDUCTION OF PRODUCTION COSTS

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One of the main indicators of a company's performance is the cost of production. This is the total amount of expenses incurred in monetary terms for the production and sale of goods. Thus, it determines the overall efficiency of production.

The economic content of production costs is compensation for incurred expenses and ensuring simple reproduction, production reserves, and labor for all elements produced at the expense of this element. Meanwhile, the most important elements of an enterprise's cost price are: depreciation, the cost of material resources consumed, and wages - the main statuses of these costs.

In addition, the enterprise simultaneously incurs other expenses: maintenance of social facilities, contributions to extrabudgetary funds - these expenses constitute additional expenses of the enterprise.

Cost determines the following important performance indicators: the level and dynamics of profit and profitability. The significance of cost is determined by the functions it performs.

1. Cost price is a wide range of product costs. The essence of this is that the cost price of products ensures the expenditure of production resources.

2. Cost price is the basis for forming the selling price, and its unaccounted conduct cannot serve as a basis for price formation.

3. Calculation of profit based on cost price, profitability of certain products, i.e., the feasibility of their production.

From the above, it is clear that the attitude to the cost price of products cannot be underestimated. The cost price is influenced by factors that are related and unrelated to the enterprise. For example, an enterprise is characterized by natural conditions, including the remoteness of the territory from sources of raw materials and consumers, the level of prices for raw materials, tariffs for fuel, equipment, electricity, and transport, etc.

The costs that make up the cost of production are grouped according to two main criteria: by initial cost elements; the occurrence and task with the nature of the load.

The grouping of economic elements is used when compiling a production cost estimate. The essence of this grouping is that each cost element is added to the total cost of production.

So, at the planning stage, the following cost elements are identified:

- material costs (deducted from non-returnable waste);
- labor costs;
- social insurance contributions;
- contributions to the Pension Fund;
- contributions to the Employment Fund;
- depreciation;
- and other expenses.

When planning production costs, it is necessary to know the main areas for reducing them in a broad sense. Systematic cost reduction is the main tool for improving the efficiency of enterprises. Financial support for unprofitable enterprises in a market economy is not the norm.

The main ways to reduce production costs in all sectors of the economy are as follows:

- use of scientific and technological advances;
- improvement of production and labor organization;
- regulation of economic processes by the state.

The implementation of scientific and technological progress is, on the one hand, the more or less efficient use of production capacity, raw materials, and resources, including fuel and energy resources, and, on the other hand, the implementation of new, efficient machines and new technological processes.

This is the main requirement when it comes to solving various economic issues. It is important not only how much product was produced, but also how much labor was invested in its production. This approach suggests that it is necessary to strive to obtain higher output from each part of raw materials with the cost of raw materials and materials or with the use of machines and mechanisms, to increase the revenue of each machine tool and technological processes, to reduce the cost of products, to increase the profits of enterprises, and to improve production efficiency.

If we try to summarize the main directions for finding and using internal reserves by enterprise teams, they can be divided into three groups.

Production efficiency is increased, firstly, by improving the use of fixed production assets, secondly, by more efficient use of working capital, and thirdly, by increasing the effectiveness of current labor costs.

As for the improvement of production and labor organization, this process, along with cost savings due to reduced losses, will be the same as in practice. The economic development of real labor savings at the present stage gives quite significant results compared to the savings of social labor. Currently, there are two main schools of thought on improving production organization: American and Japanese.

Government programs for scientific and technological progress and government standards play a role in reducing production costs. Reducing the cost of production is an objective picture of increased labor productivity, a specific form of economic and legal activity, in accordance with which production capacity is constantly reduced and real labor becomes increasingly productive. Indicators of cost reduction reflect the degree of labor savings in the past and present in line with the development of productive forces.

The main factors for reducing production costs are:

- improving the technical level of production;
- reducing material, fuel, energy, and labor intensity of production;
- improving management and work organization;
- improving technological processes, capacity, use of fixed assets, etc.

The company's cost planning is subject to its strategic objectives and is designed to solve the following tasks:

- 1) determining economically justified expenses for the implementation of plans: a) marketing, b) profit;
- 2) dynamic and flexible redistribution of expenses between types of activities and cost items;
- 3) elimination of inefficient spending.

Planning a company's expenses is part of its cost management system. Unlike revenues, which are largely determined by objective price factors, expenses depend to a large extent on subjective factors mediated by the company's own business organization.

Cost planning reflects the diverse interests of society, the region, customers, suppliers, related parties, and the company. Qualified planning requires combining and interrelating these interests within the framework of generally accepted norms, including legal ones.

When planning costs, the following principles must be observed: costs should be optimal, not minimal; the percentage increase in costs should be less than the percentage increase in the volume of activity; the increase in costs should be linked to the company's financial capabilities.

The optimal costs of a company include expenses corresponding to its level of development, stability, and market position. It is considered normal when they ensure not only production and sales, but also the appropriate quality of products and services, advertising, and customer service.

Costs are usually planned:

- by type of expense;
- by place of origin;
- by cost carrier.

Planning a company's costs involves several stages:

- economic analysis of past dynamics;
- justification of cost requirements by product type and activity, department, and time frame;
- calculation of costs by accounting item;
 - distribution of costs by cost centers and responsibilities;
 - monitoring and adjusting the plan.

Cost planning can be performed with or without the use of forecasts. The cost forecasting methodology is based on the general economic forecasting methodology discussed earlier. The following methods are used for cost forecasting:

- expert;
- empirical-statistical, including the use of the coefficient of elasticity of costs from the volume of activity, based on a moving average;
 - based on variable costs;
 - based on a reduction in costs per 1 tenge of activity volume;
- economic and mathematical, including correlation and factor analysis, extrapolation, and interpolation;
 - modeling, including the construction of a model based on the concept of marginal costs.

The following key factors are taken into account when forecasting costs:

- the ratio of fixed and variable costs;
- the volume of activity (marketing, sales, production);
- the structure of production (goods), cost intensity;
- the state of fixed capital;
- production technology;
- capital turnover and inventory status;
- mechanization and automation of labor;
- labor incentive system;
- labor productivity;
- consolidation of economic entities;
- forms of sales, organization of goods movement, and selection of product distribution channels;
 - system for controlling material, cash, and financial flows;
 - state of work with materials and packaging, etc.

Thus, essentially all of the company's organizational activities have an impact on costs: production, technological, managerial, financial, personnel, and others.

Long-term and medium-term cost planning is usually carried out using the reverse calculation method. In this case, the total amount of necessary costs is determined based on the estimated volume of activity and the current level of costs. The reverse calculation method can use the above-mentioned cost forecasting methods, of course, with subsequent interpretation of the results by specialists.

For short-term cost planning, the direct calculation method is usually used. It is based on determining the necessary expenses for each item, including the elements of complex items, based on activity plans: marketing, sales, production, etc.

The calculation of cost plan items has a number of features: the planned volume of activity is taken into account; standards, norms, rates, tariffs, prices, and other reasonable parameters are used; the company's legal documents are taken into account: concluded supply and lease agreements, collective agreements and employment contracts, bank loans and other loans, internal deductions, etc.

Kaspi.kz's IPO and Its Impact on Kazakhstan's Stock Market

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Abstract

Liquidity, accompanied by institutional involvement and international visibility, has always been on the lower side when it comes to discussing the capital market of Kazakhstan. In 2020, an initial public offering by Kaspi.kz—the leading fintech and e-commerce platform from Kazakhstan—made a significant turn raising almost USD 1 billion via dual listing on the London Stock Exchange and Astana International Exchange. This paper will try to look at the Kaspi.kz IPO as a transformative event that took place for both the firm and the Kazakhstani capital market. Through the application of an event-study methodology, abnormal stock returns, trading activity, and post-IPO performance are determined against LSEG market data, financial statements of issuers, as well as domestic market indicators. Kaspi.kz did generate very high positive abnormal returns accompanied by acceleration in revenue and net income post-listing. This picture goes a long way in reflecting what investor confidence in the company's digital ecosystem and operational model can do. Beyond firm-level analysis, the study shows that the IPO was able to act as a catalyst on a broader scale for market development in Kazakhstan. This event helped to improve general investor sentiment while increasing liquidity on AIX and apparently helping new brokerage account openings and subsequent listings which comprise major offerings like KazMunayGas. Essentially, the Kaspi.kz IPO proves how the successful listing of a domestic technology leader can spearhead capital-market modernization, fast-track strengthening international credibility, and work on investment behaviour transformation in emerging markets.

Introduction

For years, the capital market of Kazakhstan has faced a lack of depth, low liquidity, and a lack of recognition at an international level. The domestic market has been controlled by large state-owned enterprises and banks, which made it hard to gain the interest of private international investors. This made the IPO for Kaspi.kz in October 2020 even more remarkable. Kaspi.kz is a large platform offering fintech and e-commerce services in Kazakhstan. Their dual IPO at the Astana International Exchange and the London Stock Exchange was the largest by a Kazakh company since 2007, as well as the biggest IPO in the UK in 2020, raising approximately \$1 billion.

All over the world, the initial public offering (IPO) of Kaspi Company, the market leader in the provision of consumer loans, retail purchases, and payment transactions, and the Kazakhstan financial industry innovation leader and market disruptor, was one of the most awaited in 2021 primarily because of the strategic positioning of the company, which is a tech-driven national champion with enormous aspirations, advanced and prepared international competition, and the

expected company valuation of \$4 billion and above. Kaspi's IPO attracted international investors targeting Central Asia's fastest-growing digital economy. The company was able to prove to the world that Kazakhstan's companies can produce and meet global standards in the essential areas of business, global regulatory obligations, finance, and transparency. The IPO raised fundamental concerns among domestic investors regarding the potential of the IPO to alter the local Kazakhstan equity market and the potential of stimulating activities in the Kano.

This study is a comprehensive analysis of the valued financial performance, investor response and market impact of Kaspi.kz's IPO. The study aims to provide valid and verified answers to the following questions:

1. What was the financial performance of Kaspi.kz during the IPO and the immediately succeeding period?
2. What was the abnormal financial performance during the IPO period and how was the performance of the market during that period?
3. What was the impact of the IPO on the financial activities, investment appetite and motivation, and the positioning of the local financial market?

The report uses traded data from around the IPO period for Kaspi.kz and benchmark stocks, filtered through the event study methodology, to answer the questions at hand. It also utilizes other data sources and financial statements, including exchange data and macroeconomic indicators, to provide background to the findings. The research aims to provide insights into Kaspi.kz's valuation and investor interest, while also highlighting the IPO's symbolic and structural significance for Kazakhstan's developing capital market. Table 1 below details the key points in the Kaspi.kz IPO timeline:

Milestone	Date	Description
IPO Announcement	October 2, 2020	Intention to float disclosed
IPO Pricing Finalized	October 15, 2020	Shares priced at \$33.75
Trading Begins on LSE	October 15, 2020	Official listing on London Stock Exchange
Trading Begins on AIX	October 21, 2020	Listing begins on Astana International Exchange
Total Proceeds Raised	—	\$870 million
Initial Market Capitalization	—	\$6.5 billion

Table 1. Key milestones during IPO

1. Company Background and pre-IPO analysis

Kaspi.kz is a fintech and e-commerce “super app” company that by 2025 has grown into one of the most authoritative and famous businesses in Kazakhstan. Founded initially as a conventional bank in 2008, Kaspi.kz transformed itself in a way by creating a digital ecosystem, that offers payments, shopping on its marketplace and financial services through a single electronic platform. In the beginning of 2020, Kaspi.kz discovered that they became the most popular mobile app in Kazakhstan with audience of users of around 7.8 million per month. Users used mobile helper for everyday necessities like cashless payments, online purchases, peer-to-peer transfers and even services such as tax or ticket payments.

Kaspi.kz launched its IPO with a reliable foundation that reflects both financial capability and a diversified digital ecosystem. In 2019, revenue in Kaspi.kz's financial reporting indicated approximately \$1.3 billion. In that time, net income has a volume of \$515 million, yielding an outstanding net margin of nearly 40%. Although, the global economic crisis caused by COVID-19 was a small obstacle and Kaspi.kz continued to maintain its economic well-being. In the first nine months of 2020, it resulted in revenues of approximately KZT 741 billion, and net income of KZT

286 billion (Growth more than 50% year-on year). Accelerated growth of digital adaptation and high level of user involvement with the Kaspi.kz Super App in Kazakhstan, and this fact is considered as a powerful trigger. Kaspi.kz has shown sustainable rise across its three business segments payments, marketplace, and fintech leading up to its IPO. (Image 1). In many respects, it was caused by broader adaptation of modern technologies during the 2020 pandemic and quite active engagement with Kaspi's mobile app.

Payments Platform

Revenue up 85%, net income up 114% and net income margin expanded to 52.3

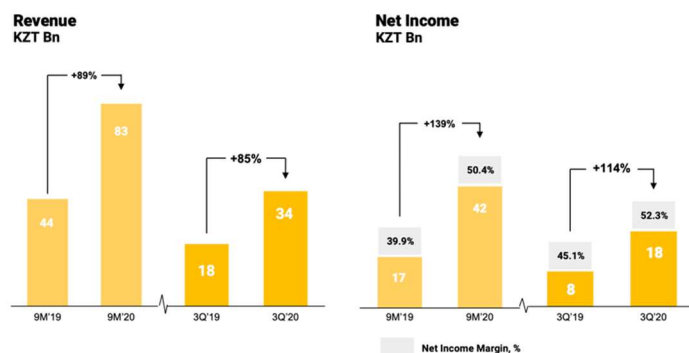


Image 1. Payments platform profit pre-IPO

The market segment kept pace and also recorded an excellent performance, The pandemic restrictions sped up the transition to digital retail, while Kaspi took advantage of its logistics network and the integrated payments system to gain market share. The continued margin levels indicate that the marketplace remains a very profitable and scalable revenue source. Fintech services were still the largest profit contributor to Kaspi in absolute terms; however, the growth was slower than in other segments. Revenue increased only by 18% year-on-year, while net income rose by 28% to KZT 123 billion, supported by a stable yield and a higher income margin of 35.9% (see Image 3).

Marketplace Platform

Revenue growth up 71%, net income up 71% and net income margin 59.1%

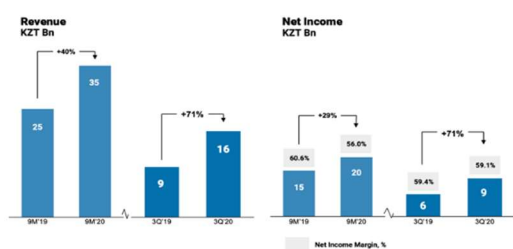


Image 2. Marketplace platform profit pre-IPO

Fintech Platform

Revenue up 6%, net income up 8% and net income margin expanded to 37.2%

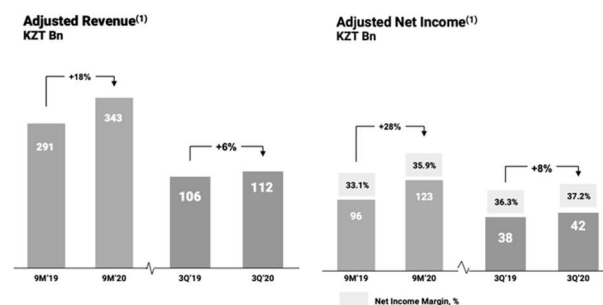


Image 3. Fintech platform profit pre-IPO

The importance of the IPO needs to be seen against the background of Kazakhstan's capital market. The domestic stock market, KASE, is a relatively small one and has little trading volume. In 2020, the KASE equity market was valued at approximately \$40–45 billion, but share trading totaled only about \$572 million for the year — a modest figure by global standards. For years, the market has been dominated by a handful of large players—mainly banks and resource companies—financed mostly by domestic institutions such as pension funds and commercial banks, with retail investors contributing only marginally. Information disclosure was at a low level, and very few local companies sought public listings. However, over the past couple of years,

Kazakhstan has been making efforts to upgrade its markets by establishing the Astana International Exchange (AIX) and facilitating IPOs of big firms (e.g., Kazatomprom in 2018). Nevertheless, new equity listings were still rare, and foreign investors had only a small presence on KASE by 2020.

In this instance, the IPO of Kaspi.kz was seen as a significant event for Kazakhstan. Apart from being a major liquidity event for the company's shareholders, it also served as a test case to determine whether an entrepreneurial Kazakh firm could attract the interest of international investors. The success could be a confidence booster for Kazakhstan's markets, making the country more attractive for foreign portfolio investment and encouraging other companies to consider doing IPOs. Hence, the offering was under a microscope both locally and internationally as a leading indicator of the country's investment climate.

2. IPO Process of Kaspi.kz

Kaspi.kz conducted its IPO in October 2020 on the London Stock Exchange (LSE), with a parallel listing of global depositary receipts (GDRs) on the Astana International Exchange (AIX). The process unfolded over several stages. After an initial attempt to list in 2019 was abandoned because of unfavorable market conditions Kaspi revived its IPO plans in late 2020. The company announced its intention to float in early October 2020, and the IPO prospectus was published on 15 October 2020. The offering was structured as a sale of existing shares by Kaspi's shareholders - no new capital was raised by the company.

- **Pricing and size:** The IPO was priced at \$33.75 per GDR, which was the top of the indicated price range (\$28.50–\$33.75). At this price, Kaspi.kz's market capitalization was about \$6.5 billion on the first day of trading. The offering comprised 25,764,894 GDRs sold by existing shareholders, raising roughly \$870 million in gross proceeds for the sellers

Notably, the IPO was targeted at institutional investors only. The final pricing was valued by price-to-earnings (P/E) multiple based on trailing earnings. The prospectus and underwriting analysis used a combination of valuation methodologies, including peer comparables (e.g. global fintech and emerging-market banking peers), discounted cash flow analyses, and consideration of recent fintech transactions, to a fair value range. Kaspi's management and bookrunners deliberately priced the deal to leave some upside for investors, given the uncertain market environment in 2020 and Kazakhstan's status.

- **Timeline:** Kaspi's road to IPO had some twists. The company had initially filed for a London listing in 2019 but pulled back after investors balked at a proposed \$5 billion valuation. By 2020, circumstances had changed Kaspi's growth accelerated and tech valuations climbed allowing management to revive IPO plans. After submitting updated documents and marketing to investors in early October 2020, Kaspi announced final pricing on Oct 14 at \$33.75 (top of range). Trading began on Oct 15, 2020, with conditional trading on the LSE's main market. In London, the GDRs were listed in the fintech sector, and Kaspi simultaneously maintained its primary share listing on KASE. Each GDR represented one ordinary share, and existing shareholders (including Goldman Sachs and Baring Vostok Capital) sold a portion of their holdings in the IPO. The LSE listing significantly broadened Kaspi's investor base beyond the few investors trading it on KASE.

- **Investor reaction:** The market's initial reaction to Kaspi.kz's IPO was positive. On the first day of trading in London the GDRs ended the debut day at \$41.50, which is 23% higher than the IPO. This strong first-day performance gave Kaspi.kz an approximate market value of \$8.0–8.4 billion by the close of day. Trading volume was also robust on the debut: investors who received IPO allocations saw immediate gains, and some shorter-term holders took profits, resulting in active turnover of shares on the LSE. by the end of the first week, the stock had stabilized in the low-\$40s per share, firmly above the IPO level. The Image 4 shows this trajectory: a sharp jump on the first trading day followed by a brief consolidation. The successful placement

and aftermarket performance signaled strong international investor appetite for Kaspi’s equity story.



Image 4. Kaspi’s stock price change after IPO

In the end, Kaspi.kz’s IPO itself effectively set a new benchmark for valuing Central Asian tech companies, given the scarcity of direct comparables. The extremely strong aftermarket performance suggested that the IPO was somewhat underpriced relative to the company’s true value this is a fact that benefited IPO investors and helped generate positive momentum.

3.Data and methodology of IPO analysis

To analyze the influence of Kaspi.kz’s IPO on both the company’s stock behaviour and the domestic market, we gathered a dataset from multiple sources share price data for Kaspi.kz’s GDR on the LSE (ticker KSPI) was obtained via LSEG Workspace, providing daily close prices, trading volumes, and relevant metrics beginning with the IPO data. For analysis at the market level, we obtained data from KASE index levels and trading .Period of sample primary covers 2020-2021, encompassing the IPO event: this contains several months before and after October 2020 to allow a before-and-after comparison .Furthermore, long-term data, up to 2025, was included where it needed to combine post-IPO performance. Key datasets and their sources are summarized in Table 2:

Data Series	Period	Frequency	Description	Source
Kaspi.kz GDR price (LSE)	Oct 2020 – Dec 2021	Daily	Closing price and volume of Kaspi GDR on LSE	LSEG / Bloomberg
KASE stock market index	Jan 2020 – Dec 2021	Daily	Index level of KASE (Almaty) stock market	KASE official reports
Kaspi.kz financials (pre-IPO)	2018 – 2020	Quarterly	Revenue, net income, etc. before IPO	Kaspi annual report, 2020

Table 2. Key data used

Using these data, we implemented an event study focusing on Kaspi.kz’s IPO. This report uses an event study method to appreciate how Kaspi.kz’s IPO altered its market performance and economic environment of the country of incorporation. The aim is to perform a comparison between what actually happened to Kaspi’s stock and financial results, and what would generally be expected based on behaviour that market had during the same timeframe. This enables to identify whether the IPO had a distinctive effect that exceeds ordinary fluctuations of market we focus on.

Our analysis have been separated into two parts:

1. Business achievements and operational results of Kaspi.kz during post-IPO timeframe. This comprises alterations in Kaspi.kz's stock price, financial performance, and main business indicators in the months after becoming publicly traded company.

2. Kazakhstani stock market reaction. The impact on trading activity and movement of the market index around the time of Kaspi's listing on the Kazakhstan Stock Exchange.

Despite the fact that Kaspi.kz was not appeared on the Kazakhstan Stock Exchange, the index is used as a benchmark to reveal investors' emotions and overall market patterns on the Kazakhstani capital market. Since the IPO was a very meaningful national financial event, this collation helps assess expanded domestic reactions and aftereffects on the local capital market.

Using these data, we accomplished the event study and comparative analysis. The event-study methodology follows generally accepted practice in finance, which means that we establish an accepted performance benchmark (market index), and then quantify excess returns around the event. In addition, we decided to examine statistical measures, such as volatility and mean returns, before and after IPO, and all these analytical considerations help to observe if there are notable differences.

4. Analysis & results

Following its October 2020 IPO Kaspi.kz saw great growth in terms of market performance and financial results. The stock's performance which went hand in hand with improved operational numbers confirmed investor confidence in the company's digital economy model and was a result of successful capital use.

Kaspi's shares performed well post issue. From the Bloomberg data which we have put up in the stock chart you will see that Kaspi's GDR price went up in the time following the IPO. Between July and November 2021 the price saw a rise from around 42,000 KZT to over 62,000 KZT. This equivalent to a 48% increase and shows that investors are very interested in Kaspi's long-term digital finance strategy.

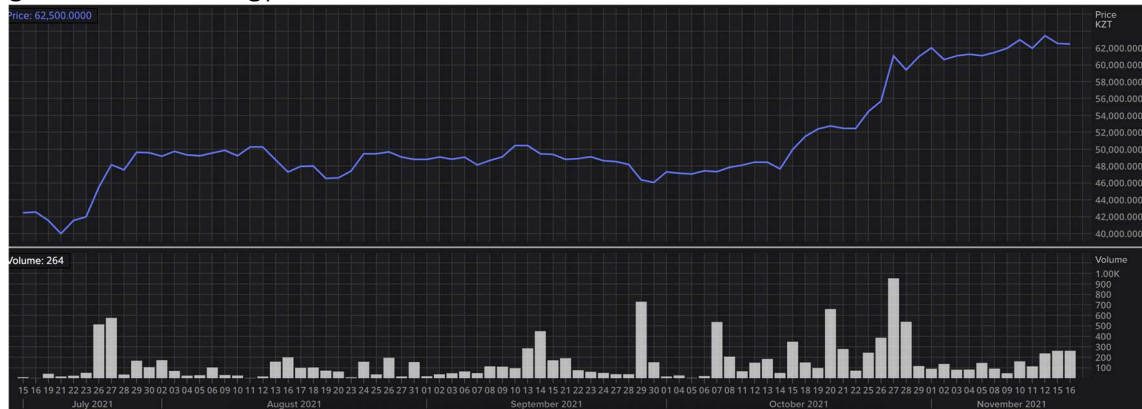


Image 5. Kaspi's share price in 2021.

This price rise at the same time we see higher trade volumes which mainly took off in Q4 2020 and early 2021 also of. Which show high demand and liquidity. Despite larger volatility in the global market. In the disease era, Kaspi's stock price still did well, supported by strong earnings and. Strategic growth in our digital transaction and marketplace segments.

First and foremost, Kaspi's profitability will determine its post-IPO financial health. According to the financial statements, net profit increased from 286 billion tenge in 2020 to 580 billion tenge in 2021, more than doubling. In 2022, the company continued to grow its revenue and, overcoming the initial post-IPO panic, showed steady growth.

The company's high profitability is considered the primary indicator of its success, contributing to a high return on equity (ROE). Calculations using equity and net income indicators for the post-IPO period show the following:

Year	Net income (bln KZT)	Equity (bln KZT)	ROE (%)
2020	286	370	77%
2021	580	742	78%
2022	700	766	91%

Both metrics point to how Kaspi has been able to convert investor capital into high Returns: one of the most productive digital transaction firms in the region. The ease with which it does so is one that few growing market companies can compare, particularly inside two years after its IPO. In broken down by segment, Kaspi's strategic spread that is also evident in these metrics. In 2021:

- Fintech remained by far the largest unit, in absolute profit terms (KZT 123 bln), accounting for 53% of total net revenue.
- Payments experienced amazing growth as net income which saw a higher increase to KZT 42 billion and edge margins.
- Marketplace too brought in which also net margins remained at over 18%.

A sign of Kaspi's success is it's transition from a lending focused fintech. Company which is a large tech corporation with a wide ecosystem.

Kaspi effect on Kazakhstan market: Kase Index Trends

At the time of Kaspi's initial public offering (IPO) which took place on international exchanges as in the case of. London Stock Exchange and Astana International Stock Exchange which also saw large scale. Symbolic and indirect effect on the Kazakhstani stock market. Analysis of Kazakhstan. Stock in 2020 from early to mid 2021 saw a steady but moderate. Growth that we see in the visual data which reports an increase in investors. Surety of Kazakhstani company stocks.



Image 6

KASE Index's day-to-day change

Although in the case of Kaspi shares they do not trade directly on the Kazakhstan Stock Exchange (KASE) which also reports that the assistant is to include a very short and neutral paraphrase which still which still conveys the same info as the original which isn't the case above. Here is a simpler version: Kaspi shares trade off of KASE. Initial public offering (IPO) may have been a signal of confidence which demonstrated the. Kazakh business sector. While Kaspi was not formally listed, and therefore not specifically represented on KASE, there may be the argument that Kaspi's IPO was a source of credibility, which raised the perception that Kazakhstani corporates are fundamentally strong. This in turn likely led to higher interest from retail investors, albeit not directly towards Kazakh stock; there may been a mild easing of trading activity and a slight increase in recognition of Kazakhstan in emerging market indices as a whole. Market analysts

remarked that the international recognition of Kazakh opportunities had “improved following the series of listings on major global exchanges,” of which Kazakhstani-listed Kaspi was considered a key example. There was indeed increased listing activity in Kazakhstan over the course of 2021–2022. The state oil producer Kaz Munay Gas (KMG), announced a sizable IPO in last 2022. Even Kaspi itself took an extra leap forth in January 2024, Kaspi.kz became the first locally based Kazakhstan firm in a secondary offering that listed in the United States for the first time, and raised \$1 billion. This again indicates how Kaspi’s IPO opened the doorway to further globalization that it demonstrated to foreign investors that Kazakh companies could meet global standards and produce solid returns.

5. Impact on KASE and Domestic Market

The IPO of Kaspi.kz was of great importance for the domestic Kazakh exchange market and for KASE. The IPO acted as a catalyst, attracting the interests of both domestic and foreign investors. The listing of the Kaspi.kz became a motivation to reevaluate the potential of the Kazakh stock market. This highlighted the local company's competitiveness at the international level and proved that enterprises not related to traditional energy (oil, gas and other mineral extraction) can attract significant investments. After the listing, the number of domestic brokerage accounts increased due to the increased interest in investing in the region. The number of accounts continues to grow exponentially to this day. As of September 1, 2024, the number of brokerage accounts reached 3,086,673. But this is not only Kaspi's merit, but this company has also served only as an example for many other Kazakhstani companies. So, in 2022, due to the IPO of KazMunayGas and the simplification of market entry, the number of brokerage accounts increased 4 times. As for the domestic AIX and KASE platforms, the effect of the IPO Kaspi.kz was completely different. The trading results on AIX show excellent results, for example, before the IPO Kaspi.kz Total trading volumes in September were estimated at 1.66 billion tenge, after the IPO in October, this figure reached 2.3 billion tenge, which gave an increase of an amazing 38.89%. This proves the increased interest of investors in the domestic stock exchange. This increase also increased the liquidity of the exchange, which began to attract foreign investors even more. While for KASE, the effects of the IPO were rather indirect and psychological. Foreign investors have gained confidence in Kazakhstani companies and the KASE index has an upward trend, as mentioned above. In conclusion, we can say that the IPO Kaspi.kz has positive effects on the domestic stock exchange and has both direct and indirect effects. In the eyes of investors, Kazakhstan's financial market has begun to inspire confidence and possess some potential. Also, an IPO Kaspi.kz It started a chain reaction of blogging, and other local companies also began considering IPOs, KazMunayGas as a living example, whose IPO further improved Kazakhstan's market situation.

6. Discussion and Lessons Learned

IPO Kaspi.kz it went far beyond the usual attraction of investments. For other companies considering an IPO, this highlighted the importance of complying with international financial standards and transparency in the financial system of domestic companies. It also showed that technology companies with their ecosystem and stable business model can attract significant investments. As for the local exchange, they have a lot of work to do in accordance with international standards, improving the quality of customer service (potential investors) and improving regulatory transparency and liquidity. After all, if things go badly with the stock exchange in Kazakhstan, even popular and large Kazakhstani companies will choose to issue their shares on international platforms rather than on domestic ones. For investors Kaspi.kz showed that companies from an unstable financial environment can generate income if they comply with international financial and listing standards, while supporting this with transparent financial indicators. This allows foreign investors to review the potential of the Kazakh market. This analysis has some limits. for example, the listing was released during COVID-19. A time when the market was notable for its unusual volatility and massive transition to digital technologies. So the shares

of Kaspi.kz were the most suitable investments at that time and the stock seemed very attractive in the eyes of investors. Therefore, the success of the Kaspi IPO can be overestimated. We also faced the limitations of public exchange data on KASE, so we could not fully analyze how the IPO Kaspi.kz it affected the Kazakhstan stock market (especially KASE). In conclusion, we can say that the IPO Kaspi.kz did not immediately change the position of the Kazakh stock market relative to the international stock exchange. But this started a chain reaction of blogging, which led to a steady growth trend in the Kazakh market. In the end, the company clearly showed in which direction the entire market of Kazakhstan should move.

7. Recommendations

For the increase of IPC activity and the development of the capital markets generally, there must be close cooperation among regulators, exchanges and all market participants. In particular, increased transparency should be a focus of ongoing reforms. All companies that think about going public should implement internationally accepted reporting standards, develop better corporate governance and submit more comprehensive financial information. To affect how foreign investors perceive risk associated with Kazakhstan promotion of independent board structures inclusive of ESG disclosure and the standardisation of practices between issuers and their investors will have a significant positive impact. For the continued expansion and development of the capital markets there will be a need for Kazakhstan to continue to create opportunities for increased market liquidity. Augmented market liquidity is currently one of the main factors deterring both issuers and investors. Key areas to raise liquidity in the capital markets include the establishment of market making on both KASE and AIX, expanding securities lending capabilities, and encouraging institutional investors to trade on the exchanges within their own country. Also, better access for retail buyers can grow through lower costs, easy steps to open accounts and efforts to teach about money.

The creation of incentives for domestic firms to undertake Initial Public Offerings (IPOs) may be done in the form of targeted policies, which could include reduced listing fees, tax incentives designed for maintaining a public company status and subsidized advisory support services extended toward small and medium-sized enterprises. The Government will also create a new simplified route to go public for high-growth technology companies by providing an avenue that would be able to replicate the existing conditions that made Kaspi.kz successful when it was launched. It is also essential to build credibility around the regulatory framework such that investors feel confident while investing in securities markets; hence, the securities laws and protection of minority shareholders have to be enforced consistently with a clear demonstration that the exchange operates under a rules-based regulatory oversight. In addition, as AIFC continues to grow, it will develop its legal infrastructure which is based on the principles of English Common Law via a regional competitive advantage, Kazakhstan would be positioning itself to gradually build a capital market ecosystem that is more dynamic, globally integrated and able to handle end-to-end IPOs on a more regular, higher quality basis.

8. Conclusion

Kaspi.kz's 2020 IPO has had a notable impact on the investors' behavior and stock performance of Kazakhstani companies as well as the overall capital markets in Kazakhstan. Apply an event study to calculate market data during that period soon after Kaspi's IPO. It turns out not surprising that this company produced very high positive abnormal returns with aftermarket demand for shares and increased share prices observed. This will validate the optimism expressed by investors between revenue growing strongly with expanding profit margins plus more than doubling net income post-going public by Kaspi. Kaspi.kz did not just perform a successful IPO. It has also transformed the thinking of investors about the potential that Kazakh companies could realize in international capital markets. In addition to all this, the Kaspi listing opened up for many people eyeing business opportunities in Kazakhstan, increased investor confidence in Kazakhstan

while at the same time raising their interest level when subsequent public offerings happened in Kazakhstan. Local fin-tech business leadership is proof through Kaspi.kz that growth and high profitability are very much attainable within the observance of international business practices. The Kaspi.kz's IPO is significant because of two major reasons. It is Kazakhstan's first IPO and it is also a validation of country's goal to rejuvenate its capital market, attract foreign investors and play more crucial role in the global financial system. It is the defining moment for the increment of the digital and financial ecosystems in the region, which will eventually develop the future of Central Asia.

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AZƏRBAYCAN ÜZƏRİNDƏN KEÇƏN ORTA DƏHLİZİN GEOİQTİSADI ÜSTÜNLÜKLƏRİ VƏ BEYNƏLXALQ TİCARƏTƏ TƏSİRİ

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Xülasə

Orta Dəhliz (Trans-Xəzər Beynəlxalq Nəqliyyat Marşrutu) Çin və Avropa arasında Azərbaycan üzərindən keçən yeni nəqliyyat dəhlizidir. Bu məqalədə Orta Dəhlizin geoiqtisadi üstünlükləri və qlobal ticarətə təsiri təhlil edilir. Araşdırma göstərir ki, Orta Dəhliz Şimal marşrutu ilə müqayisədə daha qısa və sürətlidir, Rusiya və İranı kənar keçərək sanksiya risklərini azaldır.^[1] Dəhlizin inkişafı Azərbaycan, Qazaxıstan, Gürcüstan və Türkiyə kimi tranzit ölkələrə yeni iqtisadi imkanlar açır, regional əməkdaşlığı gücləndirir və beynəlxalq ticarət əlaqələrini şaxələndirir.^[6] 2022-ci ildən etibarən Ukraynada müharibə fonunda Orta Dəhliz vasitəsilə yük daşımaları kəskin artmış, 2023-cü ildə 2,8 milyon tona çatmışdır ki, bu da əvvəlki illə müqayisədə 86% artım deməkdir.^[5] Bununla yanaşı, marşrutun tam potensiala çatması üçün infrastrukturun təkmilləşdirilməsi, rəqəmsal koordinasiya və sərhəd prosedurlarının sadələşdirilməsi tələb olunur. Nəticə etibarilə, Orta Dəhliz Azərbaycanın və ümumən regionun ticarət-tranzit mərkəzi kimi rolunu gücləndirərək qlobal ticarətdə yeni bir istiqamət formalaşdırır.

Açar sözlər: Orta Dəhliz, tranzit, Azərbaycanın geoiqtisadi mövqeyi, Bakı–Tbilisi–Qars, Ələt limanı, beynəlxalq ticarət.

Summary

The Middle Corridor (Trans-Caspian International Transport Route) is a new transport route connecting China and Europe via Azerbaijan. This article analyzes the geo-economic advantages of the Middle Corridor and its impact on global trade. The research indicates that the Middle Corridor is shorter and faster than the traditional Northern route, bypassing Russia and Iran and thus avoiding sanctions-related risks.^[1] The development of this corridor opens up new economic opportunities for transit countries like Azerbaijan, Kazakhstan, Georgia, and Turkey, enhances regional cooperation, and diversifies international trade links. Since 2022, amid the war in Ukraine, cargo shipments via the Middle Corridor have surged, reaching 2.8 million tons in 2023 – an 86% increase over the prior year.^[5] However, to realize the corridor's full potential, improvements in infrastructure, digital coordination, and streamlined border procedures are needed. In conclusion, the Middle Corridor is strengthening Azerbaijan's role (and that of the region) as a trade and transit hub, thereby creating a new pathway in global commerce.

Giriş

Qlobal geosiyasi gərginliklər və ticarət yollarındakı dəyişikliklər fonunda Asiya ilə Avropa arasında nəqliyyat əlaqələrinin yenidən formalaşdığı müşahidə olunur. Rusiya-Ukrayna müharibəsi və ona tətbiq edilən sanksiyalar nəticəsində ənənəvi Şimal dəhlizi (Rusiya üzərindən) üzrə yük axınları məhdudlaşdığı üçün region ölkələri alternativ marşrutlar axtarırlar. Bu şəraitdə Orta Dəhliz kimi tanınan Trans-Xəzər Beynəlxalq Nəqliyyat Marşrutu ön plana çıxmışdır. Orta Dəhliz Çin və Mərkəzi Asiyanı Xəzər dənizi üzərindən Azərbaycan və Gürcüstan vasitəsilə Türkiyə və Avropaya birləşdirən multimodal nəqliyyat dəhlizidir. Bu marşrut coğrafi baxımdan Şərqi Çin ilə Avropa arasında ən qısa yoldur və həm Şimal (Rusiya) dəhlizinə, həm də cənubdakı dəniz-Süveyş marşrutuna alternativ kimi

çıxış edir. Orta Dəhlizin inkişafı istiqamətində son illərdə Mərkəzi Asiyada yeni dəmir yolları çəkilmiş, 2017-ci ildə isə Bakı-Tbilisi-Qars (BTQ) dəmir yolu xətti istifadəyə verilmişdir. Orta Dəhlizin marşrut xəritəsi – Çin-Qazaxıstan sərhədindən başlayaraq Qazaxıstanı şərqdən qərbə keçir ardından Xəzər dənizini bərə vasitəsilə keçərək (Aktau-Kuryk limanlarından Bakı limanına) Azərbaycana daxil olur, oradan Gürcüstan üzərindən Türkiyəyə və Avropaya istiqamətlənir. Bu dəhliz hazırda 9 ölkəni birləşdirir və ümumilikdə 7min kilometrdən çox yol qət edir. Marşrutun təxminən 4,256km-i dəmir yolu, 508km-i isə Xəzər dənizi üzərindən bərə xətti olmaqla iki əsas hissədən ibarətdir [4]. Azərbaycan yerləşdiyi əlverişli coğrafi mövqə sayəsində Orta Dəhlizin əsas halqası kimi çıxış edir və ötən illərdə dəhlizin rəqabətqabiliyyətini artırmaq üçün ölkə daxilində bir sıra infrastruktur layihələri həyata keçirilmişdir [6]. Bu layihələr sırasında Bakı-Tbilisi-Qars dəmir yolu (təxminən 850 km uzunluğunda, 500 km-dən çoxu Azərbaycan ərazisində) mühüm yer tutur – BTQ 2017-ci ildə fəaliyyətə başlayaraq tarixi İpək Yolunun müasir dəmir yolu təcəssümünə çevrilmişdir [4].

Azərbaycan hökumətinin strateji hədəfi ölkəni bir Avrasiya nəqliyyat qovşağına çevirməkdir. 2018-ci ildə Ələt qəsəbəsində inşa edilən Bakı Beynəlxalq Dəniz Ticarət Limanı Orta Dəhliz boyunca yüklərin operativ şəkildə daşınmasına xidmət edir. Hazırda limanın illik yükaşıma qabiliyyəti 15 milyon ton yük və 100 min TEU konteyner təşkil edir. Liman ətrafında yaradılmış Ələt Azad İqtisadi Zonası isə logistika və istehsal sahələrinə investisiyaların cəlb olunmasına, həmçinin “Made in Azerbaijan” brendi altında yerli məhsulların qlobal bazarlara çıxışına şərait yaradır [4]. Bütün bu addımlar Orta Dəhlizin səmərəli fəaliyyətini təmin etməklə yanaşı, Azərbaycanın tranzit potensialını əhəmiyyətli dərəcədə artırır.

Orta Dəhlizin geoiqtisadi üstünlükləri Orta Dəhliz bir sıra mühüm geoiqtisadi üstünlüklərə malikdir ki, bu da onu alternativ ticarət marşrutu kimi cəlbəedici edir: **Daha qısa və sürətli marşrut:** Orta Dəhliz, Çin-Qazaxıstan sərhədindən Avropaya qədər olan məsafəni ənənəvi Şimal marşrutu ilə müqayisədə məsafəni təxminən 3 min km azaldır [2]. Nəticədə, yüklərin Asiyadan Avropaya daşınma müddəti əhəmiyyətli dərəcədə qısalmır. Xüsusilə, Bakı-Tbilisi-Qars dəmir yolunun işə düşməsi Asiya-Avropa yükdaşımanı zaman olaraq dəniz yolu ilə müqayisədə 50%-dən çox azalmasına imkan verib. [4] Məsələn, müasir şəraitdə Orta Dəhlizlə Çindən Avropaya yüklər optimal halda 10-15 gün ərzində çatdırıla bilər ki, bu da ənənəvi dəniz yolundan (təxminən 45-60 gün) dəfələrlə sürətlidir. [9]

Təhlükəsiz və sabit alternativ: Orta Dəhliz, hazırkı geosiyasi riskləri nəzərə aldıqda, daha sabit və təhlükəsiz marşrut kimi dəyərləndirilir. Şimal dəhlizi boyunca Rusiya üzərinə sanksiyalar və münaqişə riskləri, Cənubdakı Suez kanalı marşrutu boyunca isə Yaxın Şərqdəki gərginliklər (məsələn, Qırmızı dənizdəki hücumlar) nəticəsində logistika problemləri yaranır. Orta Dəhliz isə bu riskləri minimallaşdırır – marşrut nə Rusiya, nə də İran ərazisindən keçmir. Bu amil Şərq-Qərb ticarətində Orta Dəhlizi “etibarlı və təhlükəsiz yol” kimi xarakterizə etməyə əsas verir [1]. Dəhliz boyunca yerləşən ölkələr üçün də bu yol nisbətən sabit tranzit gəlirləri və iqtisadi imkanlar vəd edir.

Sanksiyalardan yayınma və rəqabət üstünlüyü: Dəhlizin Rusiya və İrandan yan keçməsi Qərb sanksiyalarına məruz qalmadan yük axınına həyata keçirməyə imkan yaradır [2]. Xüsusilə Avropa İttifaqı son dövrdə Orta Dəhlizə marağını artırmış, onu “Qlobal Qapı” (Global Gateway) təşəbbüsü çərçivəsində prioritet istiqamət elan etmişdir. Belə ki, Avropa Orta Dəhlizi Asiya-Avropa arasında sürətli və təhlükəsiz bağlantı kimi görür və tədarük zəncirlərinin şaxələndirilməsi üçün bu marşruta investisiyalar edir. Eyni zamanda, Yaponiya, Cənubi Koreya kimi ölkələr də Orta Dəhlizə maraq göstərərək ticarət yollarını şaxələndirməyə çalışırlar. [1]

Regional əməkdaşlıq və integrasiya: Orta Dəhliz sırf nəqliyyat layihəsi olmaqla yanaşı, iştirakçı ölkələr arasında siyasi-iqtisadi əməkdaşlığı gücləndirir. [6]. Dəhliz boyu yerləşən Azərbaycan, Gürcüstan, Qazaxıstan, Türkmənistan, Özbəkistan və Türkiyə kimi ölkələr ortaq mənafeələr naminə logistika, gömrük və investisiya sahələrində koordinasiyanı artırırırlar. Məsələn, 2022-ci ilin

noyabrında Azərbaycan, Qazaxıstan və Türkiyə 2022–2027-ci illər üçün Orta Dəhlizin inkişafına dair Yol Xəritəsi imzalayıblar[4]. Bu cür çoxtərəfli əməkdaşlıq Mərkəzi Asiya və Cənubi Qafqaz regionlarında iqtisadi integrasiyanı təşviq edir, nəqliyyat əlaqələrinin vahid sistem kimi fəaliyyətini təmin edir. Nəticədə, Orta Dəhliz “orta q maraqlar dəhlizi” kimi çıxış edərək regionda sabitlik və qarşılıqlı asılılıq yaradır.

Azərbaycan üçün strateji və iqtisadi faydalar: Orta Dəhlizin Azərbaycandan keçməsi ölkə üçün xüsusi üstünlüklər qazandırır. İlk növbədə, Azərbaycan bölgədə mühüm tranzit mərkəzinə çevrilir və beynəlxalq ticarət yollarında əhəmiyyətli mövqeyə yüksəlir. Bu, iqtisadiyyatın diversifikasiyasına töhfə verərək neft-qaz sektorundan kənar gəlirlərin artmasına şərait yaradır. Tranzit yüklərindən və əlaqəli logistika xidmətlərindən əldə olunan gəlirlər ölkənin ÜDM-nə müsbət təsir göstərir. İkincisi, Orta Dəhliz Azərbaycanın xarici investisiyalar üçün cəlbediciliyini artırır – dəhliz boyunca infrastrukturun inkişafı (yeni yollar, limanlar, anbarlar və s.) xarici sərmayələri cəlb etməklə yeni iş yerlərinin yaranmasına və iqtisadi aktivliyin artmasına səbəb olur[6]. Üçüncüsü, BTQ dəmir yolunun açılması ilə Azərbaycan birbaşa Türkiyə ilə dəmir yolu əlaqəsinə nail olub ki, bu da iki qardaş ölkə arasında ticarət və iqtisadi münasibətləri daha da möhkəmləndirir[4]. Nəhayət, Orta Dəhliz layihəsi Azərbaycanın geosiyasi çəkisini artırır – ölkə həm bölgə dövlətləri, həm də Çin və Avropa arasında etibarlı tərəfdaş və körpü rolunda çıxış edir. Ümumilikdə, Azərbaycanın Orta Dəhliz təşəbbüsündə aktiv iştirakı ona strateji, iqtisadi və geosiyasi baxımdan geniş imkanlar verir.

Orta Dəhlizin beynəlxalq ticarətə təsiri. Orta Dəhlizin fəaliyyəti qlobal ticarət axınlarına artıq real təsir göstərməyə başlamışdır. Xüsusən 2023-cü ildə isə bu rəqəm 2,8 milyon tona yüksəlmişdir ki, bu da illik ifadədə 86% artım deməkdir[5]. Aşağıdakı cədvəldə Orta Dəhliz üzrə yük daşımalarının dinamikası və proqnozu göstərilir:

il	Orta Dəhlizlə yük daşımalarının həcmi (milyon ton)
2022	1,5
2023	2,8
2024	4.5
2030 (potensial)	~11 [2]

Cədvəl 1: Orta Dəhliz üzrə illik yük daşımaları (faktiki və proqnoz göstəricilər).

Yuxarıdakı məlumatlar göstərir ki, Orta Dəhliz qlobal Çin-Avropa ticarətinin getdikcə artan bir hissəsini özünə cəlb edir. Hazırda Çin ilə Avropa arasındakı yükdaşımaların təxminən 96%-i dəniz yolu ilə, 4%-i isə Trans-Sibir (Şimal) dəhlizi ilə həyata keçirilir. Orta Dəhlizin səmərəli istismar edilməsi halında isə Mərkəzi Asiya və Cənubi Qafqaz ölkələrinin bu nəhəng ticarət dövryyəindən (illik ~\$600 milyard) gəlir əldə etmələri mümkündür[7]. Dünya Bankının hesablamalarına görə, doğru investisiya və islahatlar ilə 2030-cu ilədək Orta Dəhliz boyunca yük həcmələrini 3 dəfə artırmaq, tranzit vaxtını isə yarıya endirmək mümkündür. Bu halda, təkcə Çin-Avropa istiqamətində deyil, eləcə də Azərbaycan-Qazaxıstan-Gürcüstan regionu ilə Avropa arasında ticarət dövryyəsi nəzərəcarpacaq dərəcədə genişlənə bilər (məsələn, Orta Dəhliz ölkələrinin Avropa İttifaqı ilə ticarətinin 28%-dək artacağı proqnozlaşdırılır). [3]

Orta Dəhlizin beynəlxalq ticarətə təsirini bir neçə aspektdə qeyd etmək olar. Birincisi, bu dəhliz Asiya-Avropa ticarətinin coğrafi marşrutlarını şaxələndirir. Əgər əvvəllər əsas yük axını ya uzun dəniz yolu (Süveyş kanalı ilə) ya da Rusiya üzərindən dəmir yolu ilə gedirdisə, artıq üçüncü bir “orta” marşrut yaranmışdır. Bu isə qlobal tədarük zəncirlərinin dayanıqlığını artırır – bir marşrut bağlandıqda və ya gecikmələr yarandıqda alternativ yol kimi Orta Dəhlizdən istifadə etməklə ticarət dövryyəsinə saxlamaq mümkün olur. [3] İkincisi, Orta Dəhliz qlobal logistika şirkətlərinin və yük göndərənlərin diqqətini çəkir. Artan tələbat nəticəsində artıq bəzi şirkətlər (məsələn, Finlyandiyanın Nurminen Logistics) 2022-ci ildən etibarən Orta Dəhliz vasitəsilə Çin-Avropa yönümlü yeni konteyner marşrutları istifadəyə vermişlər[2]. Bu cür təşəbbüslər Orta Dəhlizin praktik olaraq işlək olduğunu

göstərərək onun etibarını yüksəldir. Üçüncüsü, Orta Dəhliz çərçivəsində yüksələn tranzit potensialı region ölkələrinin öz aralarındakı ticarətini də canlandırır. Yeni nəqliyyat bağlantıları Qazaxıstan, Azərbaycan, Gürcüstan kimi ölkələrə öz məhsullarını qarşılıqlı şəkildə daha asan ixrac etməyə şərait yaradır. Dünya Bankının məlumatına görə, Orta Dəhlizin inkişafı nəticəsində bu ölkələrin öz aralarındakı ticarət həcmi 37% arta bilər ki, bu da regional iqtisadi artımı təşviq edəcək bir amildir[3]. Bununla yanaşı, Orta Dəhliz beynəlxalq ticarətin coğrafi mərkəzliyini də qismən dəyişə bilər. Əgər keçmişdə Avrasiya ticarətinin tranzit mərkəzləri daha çox Rusiya və Şərqi Avropa idisə, Orta Dəhlizin yüksəlişi ilə Xəzər hövzəsi və Cənubi Qafqaz yeni bir tranzit qovşağına çevrilir. Bu, həmin regionlarda infrastrukturun inkişafına təkan verir, eyni zamanda global logistika xəritəsində Azərbaycan kimi ölkələrin rolunu ön plana çəkir. Məsələn, 2024-cü ilin ilk yarısında Orta Dəhliz vasitəsilə daşınan yüklərin həcmi 65% artaraq 2,1 milyon tona çatıb[5]. Bu artım tempinin davam etməsi, Azərbaycanın və qonşu ölkələrin beynəlxalq ticarətdəki payını daha da yüksəldəcək. Ümumilikdə, Orta Dəhliz beynəlxalq ticarət sistemində rəqabəti artıran, ticarət axınlarını optimallaşdıran və global iqtisadiyyatda yeni əlaqəlilik (connectivity) yaradan mühüm təşəbbüsdür.

Məhdudiyyətlər və perspektivlər Orta Dəhlizin imkanları böyük olsa da, onun tam potensialına çatması üçün həllini gözləyən bəzi məhdudiyyətlər mövcuddur. Hazırda bu dəhlizlə yük daşımalarının həcmi Trans-Sibir (Şimal) dəhlizi ilə müqayisədə aşağıdır illik təqribən 5-6 milyon ton civarında, halbuki Rusiya üzərindən Şərq-Qərb dəhlizi ildə 100 milyon tondan artıq yük daşıma gücünə malikdir. Həmçinin infrastruktur məhdudiyyətləri, xüsusilə də Xəzər dənizi üzərindən bərə və liman imkanlarının yetərsizliyi, Orta Dəhlizin buraxılış qabiliyyətini məhdudlaşdıran əsas amillərdəndir[1]. Məsələn, Aktau və Ələt limanlarında bərələrin sayının məhdud olması və yüklərin aşırılmasında gecikmələr tranzit vaxtını uzadır. Ümumiyyətlə, marşrut boyunca koordinasiyanın zəifliyi səbəbindən yüklərin çatdırılma müddəti bəzən 2 həftədən 1,5-2 aya qədər uzana bilər[2]. Bu kimi proqnozlaşdırılmayan gecikmələr bəzi yüklərin yenidən dəniz yolu ilə daşınmasına səbəb olur və Orta Dəhlizin rəqabət qabiliyyətinə mənfi təsir göstərir. Məhdudiyyətlərin aradan qaldırılması istiqamətində həm milli, həm də çoxtərəfli səviyyədə addımlar atılır. İlk növbədə, Orta Dəhliz boyunca “bir pəncərə” və vahid tarif sisteminin tətbiqi vacibdir. Hazırda marşrut üzərində müxtəlif ölkələrin fərqli gömrük prosedurları və tarif siyasətləri mövcuddur ki, bu da tranziti çətinləşdirir. Sevindirici haldır ki, artıq iştirakçı ölkələr arasında vahid tranzit tarifinin müəyyən edilməsi və operatorların fəaliyyətinin əlaqələndirilməsi üçün danışıqlar gedir. Azərbaycan və Qazaxıstan rəhbərliyi Orta Dəhlizin rəqəmsal koordinasiyası, elektron məlumat mübadiləsi və sərhəd keçidlərinin sürətləndirilməsi üçün birgə tədbirlər planı qəbul ediblər[3]. İkincisi, infrastruktur investisiyaları sürətlənir. Avropa Yenidənqurma və İnkişaf Bankının (EBRD) tədqiqatına görə, Orta Dəhlizin tam inkişafı üçün tələb olunan investisiyaların həcmi təqribən 18,5 milyard avro olaraq qiymətləndirilir[2]. Bu sərmayələr əsasən dəmir yolu xətlərinin təkmilləşdirilməsinə, limanlarda yükəşirmə gücünün artırılmasına, yeni bərə və gəmi parkının yaradılmasına yönəlməlidir.

Azərbaycan dövləti də öz növbəsində Orta Dəhlizin inkişafı üçün strateji addımlar atır. 2023-cü ildə Azərbaycanda 2024-2026-cı illər üzrə beynəlxalq nəqliyyat dəhlizlərinin tranzit potensialının artırılması və yükdaşımaların stimullaşdırılması ilə bağlı Fəaliyyət Planı təsdiqlənmişdir[4]. Bu plana uyğun olaraq, ölkə daxilində dəmir yolları və magistralın modernizasiyası, yeni logistika mərkəzlərinin qurulması və rəqəmsal tranzit sistemlərinin tətbiqi həyata keçirilir. Bakı-Tbilisi-Qars dəmir yolunun ötürücülük qabiliyyəti 2024-cü ildə 1 milyon tondan 5 milyon tonadək artırılmışdır[5]. Əlavə olaraq, Zəngəzur dəhlizi adlanan yeni bir dəhlizin açılması istiqamətində işlər aparılır. Bu layihə reallaşarsa, Azərbaycan öz əsas ərazisindən birbaşa Naxçıvan Muxtar Respublikası və Türkiyə ilə quru yolu əldə edəcək. 2023-cü ildə Kars-Naxçıvan dəmir yolu xəttinin inşası barədə Azərbaycan və Türkiyə arasında razılaşma əldə olunmuşdur – 224 km-lik bu xətt Orta Dəhlizin cənub qolunu təşkil etməklə yük axınlarının daha da səmərəli paylanmasına xidmət edəcək. Bu yolun inşasına 2025-ci ilin avqust ayında start

verilib.[4]. Beləliklə, Azərbaycan Orta Dəhlizin inkişafını həm mövcud marşrutun gücləndirilməsi ilə, həm də yeni bağlantılarla genişləndirilməsi yolu ilə təmin etməyə çalışır.Orta Dəhlizin tam potensialına çatması onun qlobal ticarətdəki payını əhəmiyyətli dərəcədə yüksəldə bilər. Hesablamalara görə, 2030-cu ilədək illik 10-15 milyon ton yükün bu dəhlizlə daşınması mümkündür[2]. Bununla yanaşı, Orta Dəhliz Şimal və Cənub dəhlizlərini tam əvəz etməyi deyil, onları tamamlayıcı alternativ kimi möhkəmlənməyi hədəfləyir. Yəni perspektivdə qlobal ticarət şəbəkəsi daha çoxmarşrutlu (multi-route) və çevik bir sistemə çevriləcək – burada Orta Dəhliz mühim rol oynayacaq. Bu dəhlizin uğuru isə əsasən iştirakçı dövlətlərin siyasi iradəsinə, qarşılıqlı əlaqələndirmə səylərinə və tələb olunan investisiyaların həyata keçirilmə sürətinə bağlı olacaq.

Nəticə

Yekun olaraq, Orta Dəhliz Azərbaycan üzərindən keçməklə Asiya və Avropa arasında yeni bir ticarət magistralı formalaşdırır. Bu dəhlizin geoiqtisadi üstünlükləri marşrutun qısalığı, sürətliliyi, təhlükəsizliyi və regional əməkdaşlığı təşviq etməsi onu qlobal ticarət sisteminin əhəmiyyətli bir elementi halına gətirir. Azərbaycan üçün Orta Dəhliz təşəbbüsü strateji əhəmiyyət daşıyır: ölkə tranzit həbina çevrilməklə həm iqtisadi dividendlər əldə edir, həm də beynəlxalq arenada mövqelərini möhkəmləndirir. Artan yük daşımaları və yeni investisiyalar sayəsində Orta Dəhliz bölgə iqtisadiyyatlarını canlandırır, Orta Asiya və Cənubi Qafqazı qlobal dəyər zəncirinə daha sıx inteqrasiya edir.Eyni zamanda, Orta Dəhlizin beynəlxalq ticarətə təsiri özünü göstərməkdədir – ticarət axınlarının coğrafiyası genişlənir, tədarük zəncirləri daha dayanıqlı və çevik olur. Gələcək illərdə tələb olunan infrastruktur və koordinasiya islahatları həyata keçirilərsə, Orta Dəhlizin tranzit gücü dəfələrlə artacaq, Asiya-Avropa marşrutu üzrə rəqabət daha da güclənəcəkdir.[3]Nəticə etibarilə, Orta Dəhliz XXI əsrin yeni İpək Yolu kimi Avrasiya məkanında sülh, sabitlik və iqtisadi inkişaf üçün mühüm platforma rolunu oynayacaq. Bu layihə, dəyişən qlobal şəraitdə formalaşmış geoiqtisadi reallıqdır və onun uğuru üçün çoxtərəfli əməkdaşlığın davam etdirilməsi vacibdir.

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Финансовая устойчивость банков: современные подходы и международный опыт

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Аннотация

В условиях растущей волатильности рынка, геополитической напряженности и стремительно развивающихся финансовых инноваций традиционных методов оценки банковской устойчивости уже недостаточно. Возрастающая сложность банковских операций и нормативных требований обуславливает необходимость использования количественных моделей, основанных на данных, для выявления уязвимостей на ранней стадии. Моделирование финансовой стабильности позволяет заинтересованным сторонам оценить не только текущее состояние банка, но и его способность противостоять внешним шокам, кризисам ликвидности или ухудшению кредитного качества – факторам, которые особенно актуальны в странах с развивающейся и переходной экономикой. МВФ (2023) [1] подчеркивает растущую сложность финансовых систем (развивающиеся классы активов, взаимосвязанные небанковские организации и всепроникающая геополитическая неопределенность), которую традиционные меры банковской устойчивости не могут адекватно отразить. В отчете Международного Валютного фонда утверждается, что расширенное стресс-тестирование, макропруденциальный надзор и модели риска, основанные на данных, являются важнейшими инструментами для мониторинга уязвимостей и повышения устойчивости в нестабильных условиях.

Введение

Финансовая устойчивость банков является центральным элементом стабильного функционирования любой экономической системы. Банки выполняют ключевые функции - трансформацию сбережений в инвестиции, обеспечение расчётов, управление рисками, поддержку денежно-кредитной политики государства. Поэтому их устойчивость влияет не только на отдельных участников рынка, но и на экономику в целом. Опыт глобального финансового кризиса 2007–2009 годов, пандемии COVID-19, турбулентности мировых рынков 2022–2025 гг. продемонстрировал особую важность способности банков выдерживать внешние шоки, сохранять платежеспособность и доверие клиентов.

В последние годы исследователи уделяют всё больше внимания изучению тех факторов, которые обеспечивают устойчивость банков - от достаточности капитала и качества активов до выбора бизнес-моделей, уровня цифровизации и макроэкономической

стабильности. В странах с развивающимися рынками, включая Казахстан, данная проблема особенно актуальна: экономика подвержена внешним шокам, значительная часть банковского сектора ранее сталкивалась с кризисами неплатежей и реструктуризациями.

Цель настоящей статьи провести литературный обзор современных исследований финансовой устойчивости банков, рассмотреть международные подходы и проанализировать ситуацию в банковском секторе Казахстана. В рамках этого анализа систематизируются существующие подходы к моделированию экономических взаимосвязей, оценивается степень эмпирической обоснованности полученных выводов, а также определяются направления для будущих исследований.

Объектом анализа выступают научные работы, в которых представлены эмпирические оценки и теоретические модели, описывающие основные вопросы в обеспечении финансовой стабильности банковской системы. Исследование основано на методах систематизации и критического анализа научной литературы, а также сравнительного изучения теоретических подходов и эконометрических инструментов.

При отборе источников приоритет отдавался публикациям в рецензируемых международных научных журналах, индексируемых в базах Scopus, Web of Science и других авторитетных библиографических системах.

Основная часть

Банки служат ключевыми посредниками в финансовых системах, мобилизуя сбережения, распределяя капитал и содействуя платежам. Нарушения стабильности банковского сектора, как это наблюдалось во время мировых финансовых кризисов, могут спровоцировать системные риски с широкомасштабными социально-экономическими последствиями. Таким образом, разработка эффективных инструментов оценки и мониторинга финансовой устойчивости банков является важнейшей задачей для обеспечения макроэкономического равновесия и защиты общественного доверия к финансовому сектору.

В таблице 1 приведены трактовки понятия «финансовая устойчивость коммерческого банка», заимствованные из российских источников и наиболее часто встречающиеся в учебно-практической литературе, посвященной банковской практике.

Таблица 1 - Трактовки понятия «Финансовая устойчивость коммерческого банка» [2]

Автор	Содержание или характеристика понятия «Финансовая устойчивость» коммерческого банка
Е.Г. Шершнева [3]	комплексная характеристика, отражающая состояние финансовых ресурсов коммерческого банка, которые обеспечивают все виды деятельности и позволяют сохранять платежеспособность, ликвидность, прибыльность
Г.Г. Фетисов [4]	способность банка выполнять свои обязательства перед клиентами, кредиторами и вкладчиками и обеспечивать потребности в краткосрочном и долгосрочном кредитовании в условиях взаимодействия изменяющихся внешних и внутренних факторов
О.И. Лаврушин [5]	характеристика, свидетельствующая о стабильном превышении доходов над расходами, свободном маневрировании денежными средствами и эффективном их использовании
И.Я. Лукасевич [6]	способность банка в динамичных условиях рыночной среды противостоять внешним и внутренним негативным факторам, обеспечить доверие юридических и физических лиц и защитить интересы акционеров
К.С. Тихонков [7]	способность реагировать на внезапные изменения и сохранять постоянную структуру банковского портфеля на протяжении длительного промежутка времени
Т.М. Ковалева [8]	такое состояние банка, которое обуславливает его динамическое развитие, позволяет выполнить свойственные банку функции и обеспечивает его равновесное состояние при негативном воздействии внутренних и внешних факторов
Источник: [2-8]	

Финансовая устойчивость банков является ключевой предпосылкой стабильности национальной экономики, так как банковский сектор выполняет системообразующие функции — трансформацию ресурсов, управление рисками, обеспечение платежного оборота и кредитование реального сектора (Хи, Ну, & Das, 2019) [9].

После кризисов 2008, 2015 и 2020 годов эта тема получила особое внимание научного сообщества и регуляторов. Новая реальность, характеризующаяся цифровизацией, глобальными шоками и усилением конкуренции, требует комплексного понимания факторов устойчивости банков. Крах крупных финансовых институтов, таких как Lehman Brothers, показал, в какой степени банковская нестабильность может перерасти в более широкие экономические и социальные кризисы. Кризис привел к сокращению мирового ВВП более чем на 2% в 2009 году и вызвал массовую безработицу, особенно в странах с развитой экономикой.

Исследования показали, что отсутствие адекватных систем раннего предупреждения и неэффективные инструменты мониторинга рисков в банковском секторе сыграли значительную роль в усилении системного риска и подрыве устойчивости финансовой системы (Laeven & Valencia, 2013)[10].

В ответ на подобные кризисы международные регулирующие органы, такие как Базельский комитет по банковскому надзору, ввели систему «Базель III», которая выделяет достаточность капитала, стресс-тестирование и стандарты ликвидности как ключевые инструменты повышения финансовой устойчивости банков. Эмпирические оценки показывают, что банки, соблюдающие требования «Базеля III», демонстрируют большую

устойчивость в периоды экономического стресса (BCBS, 2017)[11], подтверждая, что систематический мониторинг и моделирование показателей финансовой устойчивости вносят значительный вклад в макроэкономическую стабильность и институциональную устойчивость

Всемирный банк (2020)[12] подчёркивает, что трансформационные тенденции в сфере цифрового банкинга, финансовых инноваций и меняющихся рыночных структур требуют выхода за рамки традиционных систем надзора. В нём утверждается, что прогностические количественные модели лучше подходят для выявления возникающих рисков, особенно в развивающихся странах и странах с переходной экономикой, оценивая устойчивость к шокам ликвидности, кредитным спадам и операционным сбоям

В научной литературе встречается множество трактовок финансовой устойчивости банков, но большинство исследователей сходятся в том, что устойчивый банк способен:

1) выполнять обязательства перед вкладчиками и кредиторами;

В настоящее время оценка устойчивости коммерческого банка предполагает использование ряда отечественных и зарубежных методик

Таблица 2 – Зарубежная практика оценки устойчивости коммерческого банка [13; 14; 15; 16; 17; 18]

Методика оценки (страна)	Краткое содержание методики	Достоинства	Недостатки
Fim (США)	Позволяет выявить финансовые проблемы банков, возникающие между инспекционными проверками на основе текущей отчетности	Возможность прогнозирования банкротства банка, широкий охват анализируемых показателей, гибкость модели	Прогноз определяется только на 2 года
CAMEL (США)	Стандартизированная рейтинговая система, оценивающая деятельность банка по следующим шести компонентам: капитал, качество активов, ликвидность, чувствительность к рыночным рискам	Стандартизированность, широкий охват анализируемых показателей	Медленная адаптация к быстро изменяющимся внешним рыночным условиям, зависимость от объективности супервизоров, не предсказывает вероятность банкротства банка
BAKIS (Германия)	Предполагает расчет почти 50 показателей, характеризующих риски, принимаемыми на себя банками, на основе регламентированной отчетности банков. Оценка уровней показателей проводится на основе сравнительного анализа данных одного банка с показателями других банков, относящихся к одной группе	Стандартизация, оперативность оценки, выявление общих тенденций в финансовом секторе, широкий охват анализируемых показателей	Высокая трудоемкость, не учитываются системные сдвиги
ORAP (Франция)	Многофакторный программный комплекс для оценки конкретного финансового института. Определяет существующие проблемы в банке на основе всех компонент рисков, связанных с его деятельностью, с использованием	Использование большого спектра разносторонней информации, быстрота анализа, доступность данных для анализа	Не предсказывает вероятность банкротства

	количественной и качественной информации		
PATROL (Италия)	Система состоит из 5 компонент: достаточность капитала, прибыльность, качество кредитов, менеджмент, ликвидность	Быстрота анализа, используется как основание для выездных проверок	Не предсказывает вероятность банкротства
Источник: [13-18]			

2) сохранять положительный капитал и ликвидность;

Финансовая устойчивость банков — один из ключевых факторов доверия граждан к финансовой системе. В условиях экономической волатильности, смены процентных ставок и повышенной чувствительности клиентов к рискам особенно важно понимать, какие показатели отражают реальное состояние банка. Один из таких индикаторов — коэффициент срочной ликвидности [19].

Этот показатель помогает оценить способность казахстанских банков быстро и без потерь выполнять свои обязательства перед вкладчиками и кредиторами, особенно в ситуациях, когда деньги могут понадобиться «здесь и сейчас».

Если говорить простыми словами, коэффициент срочной ликвидности показывает, насколько банк обеспечен высоколиквидными активами — то есть активами, которые можно немедленно превратить в деньги без серьёзной потери стоимости.

Это своего рода финансовая «подушка безопасности» банка, отвечающая за то, сможет ли финансовая организация выполнить свои краткосрочные обязательства, если клиенты массово начнут снимать деньги или переводить средства.

Коэффициенты срочной ликвидности БВУ РК. Сентябрь 2025				
	Коэффициент срочной ликвидности (k4-1)	Коэффициент срочной ликвидности (k4-2)	Коэффициент срочной ликвидности (k4-3)	Выполнение пруденциальных нормативов
 ОТБАСЫ БАНК	169,3	42,1	23,2	Да
 VTB	135,8	35,8	11,6	Да
 BNK Commercial Bank	55,8	32,4	10,8	Да
 SHINHAN BANK KAZAKHSTAN	29,7	17,9	11,6	Да
 ZAMAN BANK	28,4	27,1	29,8	Да
 Eurasian Bank	21,7	5,0	2,0	Да
 ICBC	18,2	10,0	7,3	Да
 Bereke Bank	14,5	3,6	1,5	Да
 NURBANK	13,6	4,8	1,6	Да
 HOME CREDIT BANK	12,9	3,0	1,6	Да
 centercredit	12,8	4,4	1,9	Да
 KZIBank	11,4	4,4	2,8	Да
 FREEDOM BANK	11,4	5,9	2,5	Да
 BANK RBK	10,8	3,8	1,8	Да
 Alatau City Bank	8,4	3,5	2,1	Да
 中國銀行 BANK OF CHINA	7,0	4,0	3,7	Да
 ADCB	5,7	2,3	2,0	Да
 citibank	5,2	3,5	3,5	Да
 Kaspi.kz	4,3	2,0	1,4	Да
 KMF	4,1	1,6	1,4	Да
 forte	2,3	1,4	1,2	Да
 Altyn Bank	1,4	1,3	1,1	Да
 Halyk	1,3	2,3	1,0	Да
Ranking.kz на основе данных НБ РК				

Рисунок 1 – Коэффициенты срочной ликвидности банков второго уровня Республики Казахстан в сентябре 2025 года.

Источник: <https://ranking.kz/reviews/banking-and-finance/finansovaya-ustoychivost-v-tsifrah-analiz-likvidnosti-bankov-kazahstana.html>

Учитывая важность этого показателя, его регулирует Агентство Республики Казахстан по регулированию и развитию финансового рынка. По состоянию на 1 октября 2025 года все 23 БВУ РК выполняют пруденциальные нормативы, в том числе и по коэффициентам срочной ликвидности. То есть банки страны имеют достаточный запас ликвидности, что позволяет им обслуживать свои обязательства в полном объёме.

Среди всех БВУ РК самые высокие коэффициенты срочной ликвидности демонстрирует Отбасы банк: (k4-1) — 169,3, (k4-2) — 42,1, (k4-3) — 23,2. Такой результат объясняется уникальной системой жилищно-строительных сбережений: большая часть вкладов — долгосрочные и стабильные, поэтому фининститут не сталкивается с резким оттоком средств.

Кроме того, Отбасы банк поддерживает высокий объём ликвидных активов и ведёт консервативную кредитную политику. Это соответствует его основной миссии — улучшению жилищной обеспеченности граждан. Таким образом, высокий коэффициент срочной

ликвидности говорит об устойчивости и стабильности банка, его способности выполнять обязательства перед клиентами даже в стрессовых ситуациях.

Высокие значения коэффициентов срочной ликвидности наблюдаются и у следующих банков второго уровня:

Банк ВТБ Казахстан: (k4-1) — 135,8, (k4-2) — 35,8, (k4-3) — 11,6.

BNK Commercial Bank: (k4-1) — 55,8, (k4-2) — 32,4, (k4-3) — 10,8.

Шинхан Банк Казахстан: (k4-1) — 29,7, (k4-2) — 17,9, (k4-3) — 11,6.

Исламский банк Zaman Bank: (k4-1) — 28,4, (k4-2) — 27,1, (k4-3) — 29,8

Далее поясним важность обсуждаемого показателя.

1. Гарантия своевременных выплат клиентам

Высокие коэффициенты срочной ликвидности означают, что у банка достаточно «живых» денег и «быстрых» активов, чтобы рассчитаться по обязательствам в любой момент. Для вкладчиков и держателей карт это прямой показатель надёжности.

2. Индикатор устойчивости в стрессовых условиях

Наличие ликвидных активов особенно важно в периоды:

- всплеска спроса на снятие наличных;
- рыночной турбулентности;
- девальвационных ожиданий;
- нестабильности на внешних рынках.

Коэффициент показывает, готов ли банк пережить такие периоды без угрозы своей платёжеспособности.

3. Защита банковской системы страны

Для регулятора коэффициент срочной ликвидности — индикатор, помогающий предотвратить системные риски. Если банк не соблюдает норматив, это повод для усиленного надзора и корректирующих мер.

4. Прозрачность и доверие

Понимание того, что банк поддерживает высокую ликвидность, повышает доверие населения к финансовой системе — ключевому элементу экономической стабильности.

Как мы отметили ранее, все банки страны имеют достаточный объём ликвидных активов. Это ещё раз подтверждает: банковский сектор страны остаётся максимально стабильным и устойчивым.

3) эффективно управлять рисками [20];

Финансовая устойчивость относится к способности финансовой организации ускорять свои экономические процедуры, поглощать шоки и контролировать риски (Schinasi, 2004) [21]. После глобальной финансовой катастрофы 2007/2008 годов было проведено множество исследований, посвященных факторам, объясняющим финансовую устойчивость банков (Babar et al., 2019; Kim et al., 2020) [22]. Эти исследователи изучают множество внутренних факторов, таких как «риск ликвидности», «кредитный риск» и «операционный риск» (Ghenimi et al., 2017 [23]; Amara and Mabrouki, 2019 [24]; Khemais, 2019 [25]; Djebali and Zaghdoudi, 2020 [26]). Ниже приведены некоторые исследования, в которых была предпринята попытка объяснить финансовую устойчивость банков.

С точки зрения теории корпоративных финансов, ликвидность означает краткосрочная платёжеспособность фирм. Коммерческие банки обязаны держать достаточное количество ликвидных активов, которые можно легко обменять на наличные. В то время как неспособность компании выполнять свои краткосрочные обязательства провоцирует риск ликвидности. Исследование показало, что во время финансовой катастрофы 2008 года банки первыми столкнулись с финансовой нестабильностью и оказали влияние на другие банки (инвестиционные, накопительные и т.д.), а также на экономику (Mishra et al., 2012 [27]).

Gupta и Kashiramka (2020)[28] провели исследование, чтобы понять влияние создания ликвидности на финансовую устойчивость коммерческих банков в Индии.

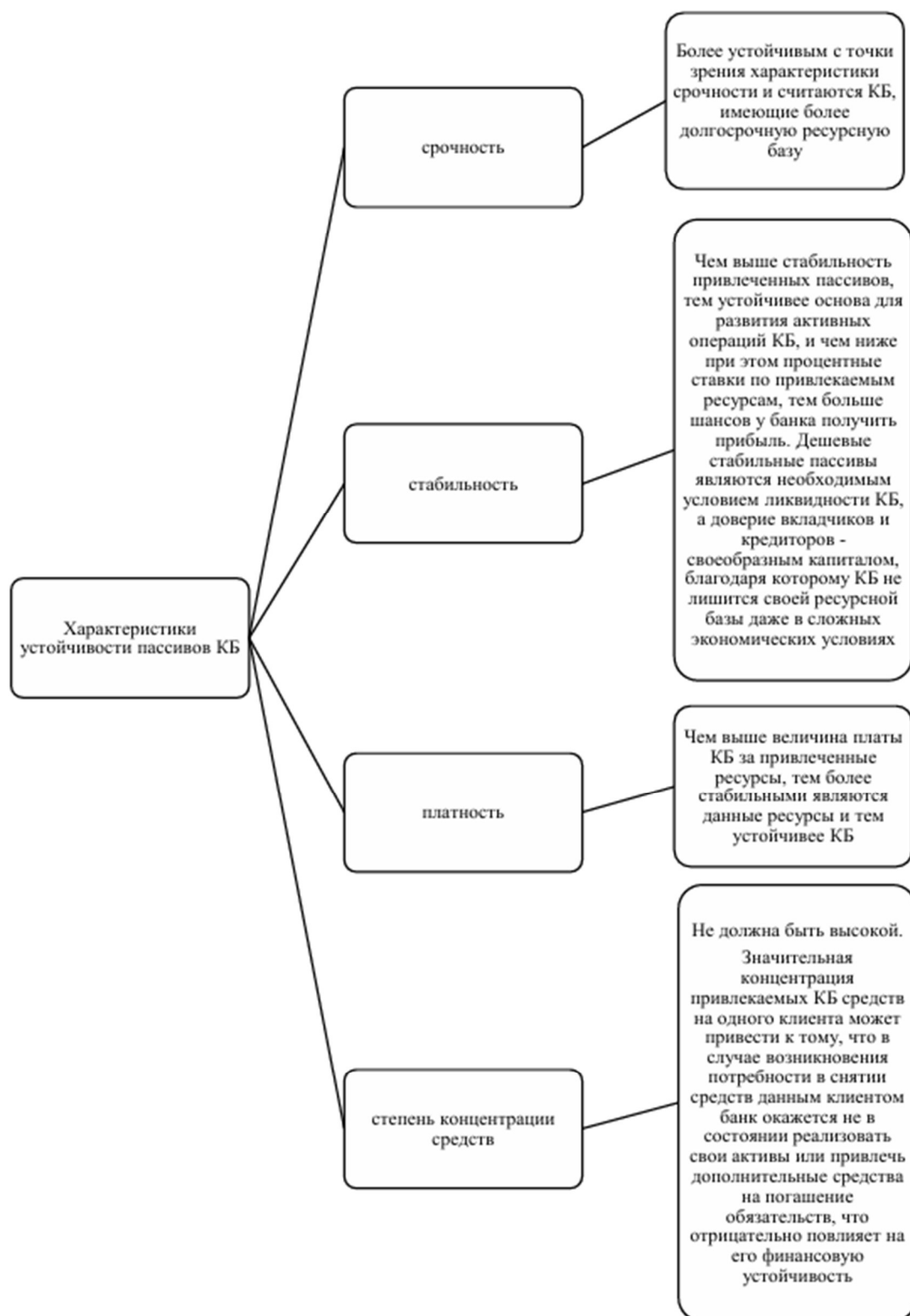


Рисунок 2 - Характеристики устойчивости пассивов коммерческого банка (КБ), традиционно используемые в международной практике

Источник: Патладзе З.А. Анализ мирового опыта обеспечения надежности функционирования коммерческих банков // Журнал экономических исследований. Vol. 8.

2022. Р. 59-78 [Анализ мирового опыта обеспечения надежности функционирования коммерческих банков Группа компаний ИНФРА-М - Эдиторум - Editorum](#) [35]

Это исследование показало, что «создание ликвидности укрепляет устойчивость банков». Помимо этого, многие исследования обнаруживают значительное негативное влияние риска ликвидности на финансовую устойчивость банков (Imbierowicz and Rauch, 2014 [29]; Mensi and Labidi, 2015[30]; Nakimi et al., 2017; Khemais, 2019 [31]).

В ходе обзора литературы мы обнаружили ряд противоречивых результатов, например, в работе Zaghdoudi (2019) [32], который обнаружил значительное положительное влияние риска ликвидности на устойчивость тунисских банков. Помимо этих результатов, аналогичные результаты были получены и в других исследованиях (Ali and Puah, 2018[33]). Однако в некоторых исследованиях влияние риска ликвидности на финансовую устойчивость не обнаружено (Amara and Mabrouki, 2019 [34]).

4) обеспечивать долгосрочную платежеспособность;

Во-первых, анализ мировой практики показывает, что достаточности собственного капитала традиционно рассматривается как важная составляющая обеспечения надежности функционирования коммерческих банков, поскольку собственный капитал КБ, являясь исходным источником банковских средств, определяет как уровень его ликвидности, так и уровень устойчивости его финансового положения.

Во-вторых, анализ мирового опыта обеспечения надежности функционирования коммерческих банков показывает, что в качестве важнейшей составляющей также рассматривается качество ресурсной базы, активов и пассивов. При этом именно привлеченные банком средства (пассивы КБ) составляют основную долю в структуре финансовых ресурсов коммерческого банка, а значит именно привлеченные средства служат основой для удовлетворения потребностей клиентов КБ (как юридических, так и физических лиц) в кредитных ресурсах.

Устойчивости пассивов коммерческих банков (далее-КБ), представленные на рисунке 2. Основными показателями, используемыми при анализе качества пассивов КБ в международной практике, являются:

- показатель эффективности использования КБ привлеченных средств;
- показатель эффективности исполнения КБ своих обязательств;
- показатель соотношения обязательств КБ и суммы его рискованных активов;
- показатель качества клиентской базы КБ;
- показатель уровня диверсификации клиентской базы КБ;
- показатель уровня стабильности ресурсной базы КБ и др.

В-третьих, анализ мирового опыта обеспечения надежности функционирования коммерческих банков показывает, что в качестве значимой составляющей обеспечения надежности рассматривается качество активов

При этом, согласно международной практике, решающее значение при оценке надежности функционирования КБ по его активам играет именно качество, а не количество активов. При этом при оценке финансовой устойчивости КБ как составляющей его надежности большое значение имеет определение в структуре активов доли проблемных и безвозвратных (безнадежных) активов.

Заключение.

Современные определения подчеркивают комплексность устойчивости. Финансовая устойчивость рассматривается не только как текущее состояние, но и как способность банка функционировать в условиях неопределённости, выдерживая негативные экономические, рыночные и политические шоки.

Таким образом, финансовая устойчивость — многомерная категория, включающая взаимодействие регулятивных, рыночных и управленческих факторов.

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Вопросы налогообложения на углеродные выбросы: мировой опыт проводимых реформ

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Аннотация

Статья посвящена анализу современных подходов к налогообложению углеродных выбросов и сравнительному обзору международной практики внедрения экологически ориентированных налоговых реформ. В работе рассматриваются ключевые модели углеродного ценообразования, включая углеродный налог и системы торговли выбросами, а также оценивается их эффективность в снижении парниковых газов и стимулировании технологической модернизации. Особое внимание уделено опыту стран Европейского союза, где действуют наиболее развитые механизмы регулирования углеродного следа. Проанализированы экономические, правовые и социальные последствия введения углеродных налогов, а также выявлены основные проблемы и барьеры, возникающие в процессе реформ. На основе международного опыта сформулированы рекомендации по совершенствованию национальной системы углеродного регулирования. Результаты исследования могут быть использованы при разработке климатической политики и формировании стратегий устойчивого развития.

Введение

В условиях нарастающих экологических вызовов и обострения глобальных климатических рисков вопросы сокращения парниковых газов приобретают приоритетное значение для международного сообщества. Одним из ключевых инструментов, направленных на достижение климатических целей, становится налогообложение углеродных выбросов, выступающее важным элементом экономического механизма регулирования воздействия на окружающую среду. Углеродные налоги, а также системы торговли квотами на выбросы формируют экономические стимулы для предприятия менять производственные модели, внедрять инновационные технологии и снижать углеродоёмкость продукции.

За последние десятилетия мировая практика демонстрирует существенное разнообразие подходов к созданию и реализации углеродных налоговых систем. Страны отличаются как правовыми рамками, так и структурой налогов, механизмами распределения поступлений, уровнем ставок и темпами реформирования. В этих условиях возрастает

необходимость систематического анализа существующих моделей регулирования, оценки их эффективности и выявления факторов, влияющих на успешность климатических реформ.

Особый исследовательский интерес представляет опыт Европейского союза, который считается одним из наиболее продвинутых регионов в сфере климатической политики. ЕС последовательно внедряет комплексные меры по снижению выбросов парниковых газов, сочетая углеродные налоги с функционированием крупнейшей в мире системы торговли выбросами — EU ETS. Реформы, проводимые в европейских странах, позволяют оценить преимущества и ограничения различных моделей, а также определить оптимальные параметры углеродного ценообразования.

Введение углеродного налогообложения вызывает не только экологические, но и социально-экономические последствия, требующие всестороннего анализа. Для государств, находящихся на этапе формирования климатической политики, изучение международного опыта становится важным шагом в разработке собственных механизмов регулирования выбросов и адаптации зарубежных практик с учетом условий национальной экономики.

Настоящее исследование направлено на рассмотрение вопросов налогообложения углеродных выбросов и анализ мировых реформ в данной сфере, с акцентом на европейский опыт как один из наиболее структурированных и применимых для последующего моделирования

Цель исследования состоит в комплексном изучении теоретических и практических аспектов налогообложения углеродных выбросов на примере стран Европейского союза, включая анализ действующих налоговых механизмов, систем торговли квотами и сопутствующих инструментов климатической политики. Исследование направлено на оценку эффективности этих инструментов в сокращении выбросов парниковых газов, стимулировании экологически ориентированных инноваций и формировании устойчивой экономической модели развития. Особое внимание уделяется выявлению институциональных, экономических и правовых факторов, определяющих успешность проводимых реформ в ЕС, а также определению возможностей применения наиболее результативных элементов европейского опыта в национальной практике регулирования углеродного следа.

Объектом анализа в данном исследовании выступают научные публикации и аналитические материалы, посвященные вопросам налогообложения углеродных выбросов и формированию механизмов углеродного ценообразования в различных странах мира. Особое внимание уделяется работам, содержащим эмпирические оценки эффективности углеродных налогов, описания теоретических моделей регулирования выбросов, а также исследованиям, анализирующим опыт реализации климатических и фискальных реформ.

Методологическая база исследования включает методы систематизации, критического анализа научной литературы и сравнительного изучения международных практик регулирования углеродных выбросов. В работе также используется анализ экономических и правовых подходов, применяемых в странах с различными моделями углеродного налогообложения.

При отборе источников предпочтение отдавалось публикациям в рецензируемых международных научных журналах, индексируемых в базах данных Scopus, Web of Science и других авторитетных библиографических системах, а также отчетам международных организаций (OECD, Всемирного банка, Европейской комиссии), содержащим актуальные данные и аналитические выводы по вопросам климатической политики.

Основная часть

В 2023 году уголь оставался крупнейшим источником выбросов, на его долю приходилось 41,1% выбросов, зафиксированных в базе данных, и наблюдался устойчивый рост с 2016 года. Хотя выбросы от угля выросли на 1,9% (258 млн тонн CO₂-э) по сравнению

с 2022 годом, наибольший относительный рост (6,5%, 82 млн тонн CO₂-э) наблюдался в цементной промышленности, что отражает расширение производства. В отличие от этого, выбросы от природного газа снизились на 3,7% (164 млн тонн CO₂-э), а выбросы от нефти остались стабильными с минимальным увеличением на 0,3% (73 млн тонн CO₂-э).

Обновление 2023 года включает в себя детализацию выбросов от сжигания угля в Китае, Российской Федерации, Чехии, Польше, Украине и Казахстане, которые ранее агрегировались на национальном уровне. Новые данные относят выбросы к отдельным компаниям в этих странах, крупнейшие из которых являются государственными. Это привело к тому, что государственные предприятия стали крупнейшим типом организаций в базе данных в 2023 году: на их долю пришлось 22,5 Гт CO₂-э, что эквивалентно 53% мировых выбросов CO₂ от ископаемого топлива и цемента в 2023 году. Для сравнения, на долю 99 частных компаний пришлось 10,2 Гт CO₂-э (24%), а на долю 2 государств — 1,1 Гт CO₂-э (3%).

База данных Carbon Majors отслеживает 1388 Гт CO₂-э совокупных исторических выбросов с 1854 года по конец 2023 года, приходящихся на 180 промышленных производителей. Доля CO₂ в этих выбросах эквивалентна 69% мировых выбросов CO₂ от ископаемого топлива и цемента с 1750 года. Более трети этих глобальных исторических выбросов CO₂ можно отнести всего к 24 компаниям¹.

На долю 20 крупнейших предприятий по объему выбросов углерода в совокупности пришлось 17,5 Гт CO₂-э в 2023 году, при этом на их выбросы CO₂ пришлось 42,7% мировых выбросов CO₂ от ископаемого топлива и цемента. В списке доминируют государственные предприятия, на долю которых приходится 16 из 20 крупнейших компаний, а также значительное присутствие китайских компаний, на восемь из которых в 2023 году приходилось 17,4% мировых выбросов CO₂ от ископаемого топлива и цемента. Угольные компании также занимают видное место: семь из них входят в топ-20, в том числе шесть из Китая и одна из Индии, что подчеркивает сохраняющуюся зависимость Азии от угля.

В 2023 году пять крупнейших государственных компаний — Saudi Aramco, Coal India, CNH Energy, National Iranian Oil Co. и Jinneng Group — были связаны с выбросами в размере 7,4 Гт CO₂-э (из которых 17,6% приходится на глобальные выбросы CO₂ от ископаемого топлива). Пять крупнейших частных компаний в 2023 году — ExxonMobil, Chevron, Shell, TotalEnergies и BP — были связаны с совокупными выбросами в размере 2,2 Гт CO₂-э (из которых 5,1% приходится на глобальные выбросы CO₂ от ископаемого топлива).

Анализ также показал, что большинство компаний в 2023 году были связаны с увеличением выбросов по сравнению с 2022 годом. В целом, 93 компании увеличили свои выбросы, 73 сократили, а 3 сохранили тот же уровень выбросов.

Экологические налоги. За последнее десятилетие экологическая устойчивость стала все более важным аспектом разработки налоговой политики. Некоторые налоги, классифицируемые как:

1) связанные с окружающей средой, такие как налоги на выбросы углерода, налоги на загрязнение воздуха или налоги на пластик, были разработаны специально для того, чтобы снизить негативные внешние эффекты, связанные с окружающей средой. Такие налоги направлены на включение ценовых сигналов в решения потребителей, тем самым применяя принцип «загрязнитель платит» для поощрения более экологичной экономической деятельности и потребительского выбора.

2) другие налоги первоначально были введены в качестве источника дохода, такие как:
- налоги на транспортные средства;

1 Carbon Majors: 2023 Data Update Available at SSRN: <https://carbonmajors.org/briefing/The-Carbon-Majors-Database-2023-Update-31397>

- акцизные налоги на топливо;
- налоги на авиабилеты, но по сути действуют как экологические налоги, поскольку они повышают цену экологически вредной деятельности или товара.

3) наконец, такие налоги, как налог на прибыль предприятий, в отдельных странах используют понятие «корпоративный подоходный налог» для предприятий (за исключением субъектов малого и среднего бизнеса, согласно классификационным признакам, применяемых в каждой стране) и НДС, все чаще включают экологические соображения для стимулирования внедрения и использования чистых технологий.

Налоги, связанные с охраной окружающей среды, применяются к налоговым базам, которые считаются имеющими существенное экологическое значение, таким как энергетика, транспорт, отходы, вода, выбросы или добыча ресурсов. В некоторых случаях существует прямая связь между налоговой базой и экологическим экстерналием. Например, налоговая ставка может определяться:

- 1) за грамм CO₂, выброшенный на километр пробега;
- 2) за тонну выброшенного загрязняющего вещества;
- 3) за тонну переработанного пластика;

4) в других случаях связь менее прямая и основана на косвенных показателях, например, на использовании расстояния поездки в качестве основы для расчета налогов на авиабилеты.

Заметным изменением по сравнению с предыдущими годами стало то, что ряд стран запланировали постепенное повышение акцизных налогов на топливо с целью увеличения своих доходов. В 2022 и 2023 годах политики ввели временные снижения акцизных налогов на топливо для автомобильного транспорта и потребление электроэнергии в жилом секторе, чтобы смягчить давление, связанное с ростом стоимости жизни. Начиная с 2024 года, ставки акцизных налогов на топливо снова начали расти, следуя заранее определенной восходящей траектории, которая, как ожидается, сохранится в ближайшие годы.

Как и в прошлом году, ряд стран повысили налоги на транспортные средства, чтобы увеличить доходы, сохраняя при этом относительное преимущество низкоуглеродных транспортных средств. Мобилизация доходов привела к повышению ставок налога на транспортные средства. Правительства продолжали постепенно отменять полные налоговые льготы для электромобилей (ЭВ). Однако относительное налоговое преимущество ЭВ часто сохранялось или даже усиливалось в странах, которые повышали ставки налога на транспортные средства на основе структуры налогообложения, учитывающей выбросы.

В других областях экологического налогообложения были внесены незначительные изменения, поскольку они по-прежнему обладают потенциалом как для получения доходов, так и для улучшения состояния окружающей среды. Авиационные налоги были усилены в трех европейских странах, причем в одной из них была принята налоговая структура, более тесно связанная с выбросами. Туристические налоги продолжали расти в двух странах. Однако другие экологические налоги, такие как налоги на загрязнение и отходы, в 2024 году остались практически без изменений.

Последние тенденции в ценообразовании на углеродные выбросы. Согласно исследованиям ОЭСР, в 2023 году 79% выбросов парниковых газов оставались без ценообразования в 79 странах, для которых ОЭСР рассчитывает эффективные углеродные ставки (ЭУВ), что сопоставимо с показателями прошлых лет. Ожидается, что доля выбросов с положительной ценой немного увеличится в 2024 году, поскольку правительства постепенно отменяют временные меры, связанные с энергетическим кризисом, а также в последующие годы в связи с запланированным расширением схем ценообразования на

углерод за пределы традиционных секторов (например, сельское хозяйство, морское судоходство).

Углеродный след некоторых видов деятельности (по данным Агентства защиты окружающей среды США):

Таблица 1 – Примеры углеродного следа по видам деятельности

	Вид деятельности	Подсчет выбросов парниковых газов
1	Сжигание 1 литра бензина	1,93 кг CO ₂
2	1 кВт·ч электроэнергии	0,59 кг CO ₂
3	Поездка в магазин (~24,1 км)	5,26 кг CO ₂
4	Стрижка газона (1 час работы бензиновой газонокосилки)	4,40 кг CO ₂
5	Просмотр телевизора (42" LCD) 4 часа	0,50 кг CO ₂
6	Сварить кофе (один кофейник)	0,14 кг CO ₂
7	Использование настольного компьютера (с CRT-монитором) 8 часов	0,95 кг CO ₂
8	Работа лампочки (75 Ватт) 4 часа	0,18 кг CO ₂
9	Полёт на самолёте (1000 км), 1 человек	124,04 кг CO ₂
10	Ежегодное использование холодильника	375,12 кг CO ₂
11	Использование автомобиля в течение года (19312,13 км @ 40 км/ч)	4 259,69 кг CO ₂
12	Ежегодное отопление/охлаждение дома	13 607,77 кг CO ₂
13	Ежегодный углеродный след среднестатистического американца	20 411,66 кг CO ₂
14	Средний углеродный след жителя Казахстана	14 360 т CO ₂ -
15	Средний по миру	5 000 т CO ₂ -
Источник: Что такое углеродный след и зачем определять его при проведении оценки компаний? URL: https://csd-center.kz/baza-znaniy/chto-takoe-uglerodnyy-sled-i-zachem-opredelyat-ego-pri-provedenii-ocen.html		

В настоящее время распределение коэффициентов выбросов (ECR) неоднородно по секторам, при этом в секторе автомобильного транспорта эти коэффициенты как минимум в четыре раза выше, чем в других секторах.

Однако меры, принятые странами в ответ на энергетический кризис, привели к значительному снижению чистых коэффициентов выбросов в строительстве, автомобильном транспорте и сельском хозяйстве, в то время как незначительное повышение явных цен на углерод увеличило чистые коэффициенты выбросов в промышленности и электроэнергетике. Различия в средних уровнях цен по секторам можно объяснить разницей в используемых инструментах ценообразования для учета выбросов, степенью охвата и разницей в потреблении топлива между секторами. Коэффициенты выбросов были заметно выше в секторах, в основном охваченных акцизными налогами на топливо, особенно в автомобильном транспорте. И наоборот, более низкие коэффициенты выбросов наблюдаются в секторах, в основном охваченных системами торговли выбросами (ETS), таких как электроэнергетика и промышленность.

Углеродные налоги были увеличены как по ставке, так и по налоговой базе, а акцизные налоги на топливо также начали снова расти. Следуя тенденции, начавшейся в 2023 году, страны еще больше ужесточили углеродные налоги, значительно повысив ставки в ряде стран. В 2025 году Исландия повысила ставку углеродного налога на 59%, хотя это было ниже

первоначально предложенного повышения на 100%. Ирландия повысит ставку углеродного налога с 56 до 63,50 евро за тонну CO₂-э, а в Словении налог на CO₂ вырос на 80% в сентябре 2024 года. Южная Африка увеличила углеродный налог со 159 до 190 рандов за тонну CO₂-э с 1 января 2024 года. В Норвегии углеродные налоги на выбросы от секторов, не входящих в систему торговли квотами на выбросы (ETS), и от шельфовой нефтедобывающей промышленности увеличились на 16%.

Помимо повышения ставок, расширяется сфера действия углеродного налога: несколько стран планируют распространить ценообразование на углеродные выбросы на новые сектора. Литва введет компонент CO₂ в акцизные налоги на топливо, а Дания объявила о введении углеродного налога на сельское хозяйство, который с 2030 года будет применяться к выбросам парниковых газов от сельскохозяйственной извести и животноводства. В рамках этой реформы Дания также увеличит и гармонизирует пошлины на фторсодержащие газы.

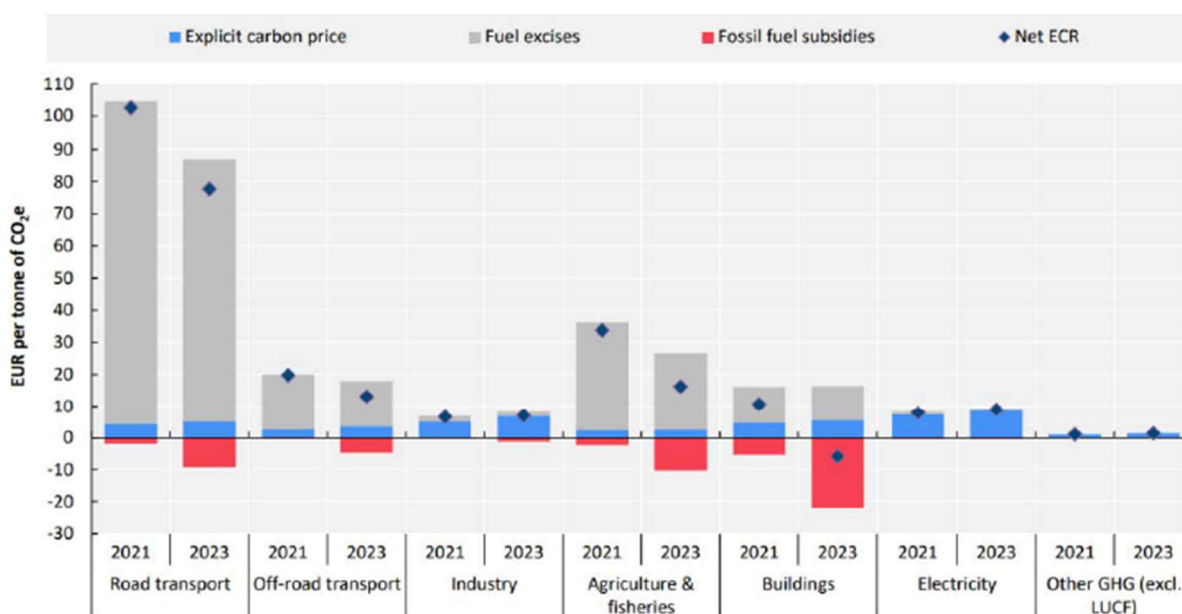


Рисунок 1 - Средние эффективные цены на углеродные выбросы и выбросы парниковых газов по секторам, 2021-2023 гг.

Примечание: Эффективные ставки выбросов углерода усреднены по всем выбросам парниковых газов в 79 странах, включая те выбросы, которые не охватываются ни одним инструментом ценообразования на углерод. Из-за ограничений в данных оценки субсидий на ископаемое топливо на 2023 год основаны на данных за 2022 год. Все ставки выражены в реальных евро 2023 года с использованием последних доступных данных об обменном курсе и инфляции ОЭСР; таким образом, изменения могут быть вызваны инфляцией и колебаниями обменного курса. Цены округлены до ближайшего евроцента. Выбросы парниковых газов представляют собой сумму выбросов CO₂, связанных с ископаемым топливом, рассчитанных на основе данных об энергопотреблении за 2021 год из отчета МЭА «Мировой энергетический баланс»², и других выбросов парниковых газов из отчета Climate Watch.

Источник: (OECD, 2022)³

² Greenhouse Gas Emissions from Energy Data Explorer Available at SSRN: <https://www.iea.org/data-and-statistics/data-tools/greenhouse-gas-emissions-from-energy-data-explorer>

³ OECD (2022), Pricing Greenhouse Gas Emissions from Energy Data Explorer: Turning Climate Targets into Climate Action, OECD Series on Carbon Pricing and Energy Taxation, OECD Publishing, Paris,

Налог на выбросы углерода в сельском хозяйстве в Дании. В 2021 году на выбросы, не связанные с энергетикой, в сельском хозяйстве и лесном хозяйстве приходилось 27% от общего объема выбросов парниковых газов в Дании, включая примерно 80% выбросов метана и закиси азота (Экспертная группа по реформе «зеленого» налогообложения, 2022)⁴. Для решения этой проблемы политики ввели схему ценообразования на углерод, направленную на сокращение выбросов CO₂-э в этих секторах на 30% к 2030 году

Процесс внедрения. Для разработки системы ценообразования на углеродные выбросы правительство назначило группу экспертов для подготовки рекомендаций, которые затем обсуждались с заинтересованными сторонами, включая сельскохозяйственный сектор, климатические организации и другие группы интересов. В июне 2024 года Трехстороннее зеленое соглашение установило схему ценообразования на углеродные выбросы парниковых газов в сельском хозяйстве. К ноябрю 2024 года было достигнуто политическое соглашение о реализации схемы на основе этих рекомендаций. Соглашение было достигнуто, среди прочего, путем объединения углеродного налога с перераспределением доходов за счет субсидий для фермеров. Налоговая администрация будет контролировать реализацию, рассчитывая выбросы с использованием проверенных данных о деятельности — в первую очередь, отчетов о навозе и поголовье скота, предоставляемых фермерами, — в сочетании с коэффициентами выбросов⁵.

Эффективные цены на углерод. Эффективный налог на углерод будет установлен на уровне 40 евро за тонну CO₂-э для выбросов от животноводства и 100 евро за тонну CO₂-э для выбросов от сельскохозяйственной извести. Для поддержки перехода налоговые поступления будут реинвестированы в субсидии, в том числе на богатые углеродом низменные почвы (5 евро за тонну CO₂-э), сокращение использования удобрений на полях (100 евро за тонну CO₂-э) и лесовосстановление (60 евро за тонну CO₂-э)⁶.

Норвегия решила ввести сниженный налог на CO₂ на минеральную продукцию для международного судоходства в размере 500 норвежских крон за тонну CO₂, хотя его внедрение зависит от соблюдения правил государственной помощи. Норвегия также расширила свою базу углеродного налога, включив в нее выбросы от дальнего морского рыболовства

Ценообразование на выбросы от международного судоходства. Международный морской транспорт отвечает за 3% глобальных выбросов парниковых газов (ПГ), но до недавнего времени оставался в значительной степени свободным от климатических норм. В настоящее время на потребление топлива или выбросы в этом секторе не распространяются акцизный налог на топливо, углеродный налог или система торговли выбросами (ETS). Однако был согласован ряд региональных и международных инициатив, направленных на внедрение механизмов и правил ценообразования на углерод в ближайшие годы.

Переговоры о ценообразовании на углерод для мирового судоходства. Международная морская организация (ИМО) возглавляет обсуждение глобальных правил для судоходной отрасли. Стратегия ИМО 2023 года изложила план перехода к

<https://doi.org/10.1787/e9778969-en> Available at SSRN: https://read.oecd-ilibrary.org/en/publications/pricing-greenhouse-gas-emissions_e9778969-en.html

⁴ Expert Group for Green Tax Reform (2022), Green Tax Reform - Final Report, Available at SSRN: <https://skm.dk/media/tng1b4r/green-tax-reform-final-report.pdf>.

⁵ Proposal for a green tax reform Executive summary and policy recommendations Date: 30/06/2022 Available at SSRN: https://financien.belgium.be/sites/default/files/beoess/20220630%20Executive%20summary%20and%20policy%20recommendations_eng_final.pdf

⁶ Green Tax Reform REPORT February 2024 Available at SSRN: <https://skm.dk/media/tng1b4r/green-tax-reform-final-report.pdf>

низкоэмиссионному топливу и возобновляемым источникам энергии и достижения нулевых выбросов в морском транспорте к 2050 году. Она также устанавливает промежуточные цели по сокращению выбросов как минимум на 20% к 2030 году и на 70% к 2040 году по сравнению с уровнем 2008 года (ИМО, 2023)⁷.

В апреле 2025 года Комитет по защите морской среды утвердил проект правил для системы нулевых выбросов ИМО. Эти правила вводят новый стандарт топлива для судов и механизм ценообразования на выбросы углерода, превышающие установленные целевые показатели. Стандарт топлива будет включать два целевых показателя снижения интенсивности выбросов парниковых газов (GFI): базовый показатель и показатель прямого соответствия. Целевые показатели основаны на выбросах парниковых газов за весь жизненный цикл судового топлива и будут постепенно ужесточаться, начиная с 2028 года.

Глобальный механизм ценообразования на углеродные выбросы будет представлять собой штраф за каждую тонну CO₂-эквивалента, выброшенную сверх целевых показателей GFI. На отчетный период 2028–2030 годов цена установлена на уровне 100 долларов США за тонну выбросов, находящихся между базовым и прямым целевым показателем, и 380 долларов США за тонну выбросов, превышающих базовый целевой показатель. Ожидается, что эта система будет приносить около 11–13 миллиардов долларов США в год. Полученные средства будут направлены на поддержку инноваций и смягчение негативных последствий для уязвимых государств.

Соглашение еще должно быть официально принято в октябре 2025 года и вступить в силу в 2028 году для всех крупных судов (валовой вместимостью более 5000 тонн).

Региональная инициатива по ценообразованию на углеродные выбросы в ЕС. С 2024 года Европейская система торговли выбросами (EU ETS) включает выбросы парниковых газов от всех крупных судов (валовой вместимостью более 5000 тонн) (Европейская комиссия, 2025)⁸. Система применяется к: (i) 50% выбросов от рейсов, начинающихся или заканчивающихся за пределами ЕС, (ii) 100% выбросов от рейсов между портами ЕС и выбросов, образующихся во время нахождения судов в портах ЕС. Для облегчения постепенного перехода судоходные компании будут обязаны сдавать квоты только на часть своих выбросов в течение переходного периода, с 40% подтвержденных выбросов в 2025 году до 100% в 2027 году.

Для увеличения доходов ряд стран запланировали повышение акцизных налогов на топливо, начиная с 2025 года. Эстония введет ежегодное повышение ставки налога на бензин на 5% с 2025 по 2028 год, после периода без изменений с 2018 года. Новая Зеландия планирует ежегодное повышение акцизных сборов на автомобильный бензин и дорожных сборов на дизельное топливо, начиная с 2027 года. Латвия повысила акцизные сборы на топливо, природный газ и нефтяной газ, используемый для отопления, в 2025 году, в то время как Литва ввела небольшое повышение акцизных ставок на дизельное топливо, уголь и кокс, а также новый компонент налога на выбросы углерода в рамках своей реформы «зеленого» налогообложения. В Израиле реформы акцизного налога на топливо направлены на более точное отражение ценообразования на выбросы углерода. В течение шести лет, начиная с 2025 года, ставки акцизного налога на уголь, сжиженный нефтяной газ, мазут, нефтяной кокс и природный газ будут постепенно расти, достигнув примерно 55 евро за тонну CO₂-э к 2030 году. В свою очередь, Швеция снизит акцизные налоги на бензин и дизельное топливо.

⁷ IMO (2023), IMO Strategy on Reducing GHG Emissions from Ships, <https://www.imo.org/en/OurWork/Environment/Pages/2023-IMO-Strategy-on-Reduction-of-GHG-Emissions-from-Ships.aspx>.

⁸ European Commission (2025), Reducing emissions from the shipping sector, https://climate.ec.europa.eu/eu-action/transport/reducing-emissions-shipping-sector_en

Льготы и сниженные ставки акцизных сборов на топливо в целом остались без изменений. Однако Латвия отменила освобождение от акцизного сбора на нефтепродукты, используемые в производстве электроэнергии и когенерации.

В ряде стран были **скорректированы налоговые ставки в сельскохозяйственном и лесном секторах**, которые традиционно пользуются льготными ставками, возвратом налогов или освобождением от уплаты налогов. В Нидерландах налог на выбросы CO₂ для тепличного садоводства будет вводиться поэтапно, более постепенно, чем планировалось изначально. Швеция продолжит применять сниженные ставки акцизного налога на топливо для сельского хозяйства, лесного хозяйства и аквакультуры, в то время как Германия постепенно отменяет возврат налога на дизельное топливо для сельского хозяйства и лесного хозяйства с 2024 по 2026 год.

В одной стране были изменены тарифы на водород и электроэнергию. Нидерланды введут сниженную налоговую ставку на водород с 2026 года, установив ее ниже, чем ставка на природный газ, который в настоящее время облагается налогом на том же уровне. Ожидается, что эта сниженная ставка сохранится и после 2030 года для стимулирования инвестиций. Кроме того, Нидерланды увеличили налог на электроэнергетику, а Швеция отозвала предложение о введении сниженной налоговой ставки на электроэнергию, используемую в системах улавливания и хранения углерода (CCS).

Субсидии на производство возобновляемой энергии привели к корректировке налоговой политики в двух странах. В Южной Африке правительство повысило пороговое значение для проектов возобновляемой энергетики в рамках Инициативы по развитию встроенной генерации с 15 мегаватт до 30 мегаватт, чтобы компенсировать потери от углеродного налога. Тем временем в Нидерландах схема нетто-учета для пользователей небольших солнечных панелей будет постепенно отменена начиная с 2027 года, что приведет к увеличению поступлений от акцизного налога на электроэнергию.

Реформы налогообложения в транспортной сфере были обусловлены как стремлением к увеличению доходов, так и экологическими целями. Реформы налогообложения транспортных средств в ряде стран были мотивированы как стремлением к увеличению доходов, так и целями экологической политики. Латвия повысила ставки налога на эксплуатацию транспортных средств на 10% для всех автомобилей, а Венгрия повысила налог на автотранспортные средства. Кроме того, Венгрия и Латвия значительно повысили налоги на служебные автомобили: на 20% с 2025 года и на 10% с 2027 года соответственно. Южная Африка повысила налог на выбросы вредных веществ для легковых автомобилей, а Армения повысила ставки экологического налога.

Таблица 2 - Изменения в налогообложении, связанном с потреблением энергии и выбросами (на 2025 финансовый год)

Наименование налога (налогового платежа или сбора)	Снижение темпов/Сужение базы	Повышение ставок/Расширение базы
Акцизный налог на топливо - общий	Швеция	Израиль, Литовская Республика
Акцизный налог на топливо - прочее	Нидерланды	
Акцизный налог на топливо – сельское хозяйство и лесное хозяйство	Ирландия	Германия
Акцизный налог на топливо – энергетическая промышленность		
Акцизный налог на топливо - транспорт	Новая Зеландия	Дания (дизельное топливо), Новая Зеландия
Акцизный налог на топливо - промышленность		Нидерланды, Латвия
Акцизный налог на электроэнергию и водород	Нидерланды	Нидерланды (гибрид), Новая Зеландия (гибрид), Швеция. Южно-Африканская Республика (гибрид)
Углеродный налог (Carbon tax)	Нидерланды	Дания, Израиль, Ирландия, Литовская Республика. НидерландыНорвегия, Словения, Южно-Африканская Республика
Источник: OECD (2025), Tax Policy Reforms 2025: OECD and Selected Partner Economies, OECD Publishing, Paris, https://doi.org/10.1787/de648d27-en . ⁹		

В некоторых странах были приняты **компромиссные решения относительно различных видов налогов на транспортные средства**, чтобы ограничить общую налоговую нагрузку на водителей. Дания повысила акцизный налог на дизельное топливо, пропорционально снизив при этом текущий налог на дизельные автомобили и дорожный налог на грузовые автомобили. Словакия снизила налоги на грузовые автомобили в рамках более широкой инициативы, которая включала повышение платы за проезд по автомагистралям и снижение налогов на автомобили для отдельных категорий транспортных средств.

Ряд стран **корректируют налогообложение электромобилей (EV)** по мере перехода к более экологичному автопарку. Нидерланды постепенно отменяют освобождение от налога на транспортные средства для легковых автомобилей с нулевым уровнем выбросов: было объявлено о введении 40-процентного снижения налога в 2026 году, которое будет постепенно уменьшаться до 2031 года. Другие транспортные средства с нулевым уровнем выбросов, включая автобусы, потеряют налоговую скидку начиная с 2026 года. В Финляндии, где электрификация автопарка уже идет полным ходом, правительство увеличило

⁹ OECD (2025), Tax Policy Reforms 2025: OECD and Selected Partner Economies, OECD Publishing, Paris, <https://doi.org/10.1787/de648d27-en>

налогообложение электромобилей и подключаемых гибридов (PHEV), повысив базовый налог и налог на мощность двигателя для этих транспортных средств. Венгрия отменила освобождение от налога на транспортные средства для гибридных автомобилей, сохранив налоговые льготы исключительно для полностью электрических транспортных средств. Между тем, Новая Зеландия не продлила освобождение от платы за пользование дорогами (RUC) для электромобилей, а это значит, что с апреля 2024 года электромобили (BEV) облагаются налогом в размере 76 новозеландских долларов за 1000 километров, а подключаемые гибриды (PHEV) — в размере 38 новозеландских долларов за 1000 километров. В свою очередь, Ирландия ввела в июле 2025 года подход к налогу на регистрацию транспортных средств для коммерческого транспорта, основанный на уровне выбросов, с более низкой ставкой в 8% для транспортных средств с выбросами CO₂ менее 120 граммов на километр.

Было проведено незначительное реформирование, направленных на переход к налогообложению дорожного использования. Литва переходит от системы, основанной на виньетках, к электронной системе взимания платы за проезд для грузовых автомобилей, где плата взимается в зависимости от количества пройденных километров.

Несколько европейских стран **повышают налоги на авиаперевозки**, при этом одна из них усиливает связь с экологическими издержками. Германия повысила ставки авиационного налога, а Нидерланды введут дифференциацию в зависимости от расстояния, облагая налогом магистральные рейсы дальнего направления по более высоким ставкам. Чтобы скорректировать свой сбор с пассажиров воздушного транспорта (APD) в соответствии с инфляцией цен на билеты, Великобритания запланировала повышение APD, начиная с более высоких ставок на рейсы неэконом-класса в 2025 году, за которыми последует повышение по всем категориям тарифов в 2026-2027 годах. Кроме того, APD для больших частных самолётов увеличится на 50%, а с 2027-2028 годов ставки будут округляться до ближайшего пенни. Напротив, Швеция отменила свой налог на авиаперевозки, что свидетельствует о расхождении с более широкой тенденцией к увеличению сборов, связанных с авиацией.

Заключение.

Анализ последних реформ в сфере углеродного налогообложения в Европейском союзе показывает, что за последние три года ЕС значительно ускорил переход к более строгой и комплексной системе регулирования выбросов парниковых газов. Европейская климатическая политика, опирающаяся на стратегические документы Еврокомиссии и инициативы государств-членов, демонстрирует последовательное расширение мер углеродного ценообразования как ключевого инструмента достижения климатической нейтральности к 2050 году.

Во-первых, реформирование налоговых систем в странах ЕС характеризуется усилением роли углеродных налогов как важнейшего фискального механизма климатической политики. Материалы экспертных групп по зелёной налоговой реформе (Дания, Бельгия и др.) подтверждают, что европейские государства активно внедряют поэтапное повышение ставок углеродного налога, расширяют охват отраслей и усиливают стимулирующее воздействие налоговой системы на предприятия. Уделяется внимание перераспределению поступлений в пользу поддержки низкоуглеродных технологий и смягчения нагрузки на социально уязвимые группы.

Во-вторых, происходят структурные изменения в ключевых секторах экономики, ранее частично исключённых из механизмов регулирования. Согласно стратегиям ИМО и Европейской комиссии, значительным направлением реформ стало включение морского транспорта в систему углеродного ценообразования ЕС. Это отражает стремление создать

единый, всеобъемлющий механизм сокращения выбросов во всех сегментах экономики, включая международные транспортные цепочки.

В-третьих, отчёты OECD за 2022–2025 годы свидетельствуют о том, что ЕС остаётся мировым лидером в интеграции налогового регулирования с климатическими целями. Европейские государства демонстрируют пример эффективного сочетания углеродного налога, системы торговли квотами EU ETS и дополнительных фискально-регуляторных инструментов. Комплексный характер европейских реформ позволяет не только обеспечивать сокращение выбросов, но и формировать устойчивую модель экономического развития, основанную на инновациях и технологической модернизации.

Таким образом, опыт ЕС за последние три года показывает переход к более высокому уровню зрелости климатической фискальной политики. Налоговые реформы становятся структурным элементом экономической стратегии, а углеродное ценообразование — центральным инструментом трансформации производственных цепочек и стимулирования низкоуглеродного развития. Этот опыт может служить ориентиром для стран, стремящихся сформировать эффективную систему регулирования углеродных выбросов, основанную на сочетании экономических стимулов, технологических инноваций и социальной справедливости..

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Капитал нарықтарының Қазақстан Республикасының экономикалық дамумен өзара байланысы

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Түйін

Бұл мақалада Қазақстан Республикасының капитал нарықтарының елдің экономикалық дамуымен өзара байланысы жан-жақты талданады. Капитал нарығы — ұлттық экономиканың маңызды бөлігі ретінде инвестиция тарту, қаржы ресурстарын тиімді бөлу және экономикалық өсуді қамтамасыз ету құралы болып табылады. Зерттеуде қор және облигациялық нарықтардың дамуы, олардың экономикалық тұрақтылыққа және жеке сектор белсенділігіне ықпалы қарастырылады. Сонымен қатар, капитал нарығын жетілдірудің институционалдық және нормативтік негіздері мен болашақтағы даму бағыттары талқыланады.

Кіріспе

Қазіргі заман экономикасының даму бағыттарын қарастырғанда, капитал нарықтарының рөлі мен ықпалына назар аудармай өту мүмкін емес. Капитал нарығы – бұл елдің қаржы жүйесінің ең маңызды буыны, оның тұрақтылығы мен тиімділігі жалпы экономикалық дамуға тікелей әсер етеді. Әлемдік тәжірибе көрсеткендей, дамыған капитал нарығы бар мемлекеттерде инвестициялық белсенділік жоғары, кәсіпкерлік орта кеңінен дамыған және инновациялық жобаларды жүзеге асыруға мүмкіндік мол.

Қазақстан үшін де бұл мәселе ерекше мәнге ие. Өйткені тәуелсіздік алғаннан кейінгі алғашқы онжылдықтарда ел экономикасы негізінен шикізаттық бағытқа тәуелді болды. Ал қазіргі кезеңде экономикалық әртараптандыру мен тұрақты өсімді қамтамасыз ету мақсатында қаржы нарықтарын, соның ішінде капитал нарығын жетілдіру басты стратегиялық басымдықтардың бірі болып саналады.

Осы мақаланың **мақсаты** капитал нарығының заманауи зерттеулеріне әдеби шолу жасау, халықаралық тәсілдерді қарастыру және Қазақстанның банк секторындағы жағдайды талдау. Осы талдау шеңберінде экономикалық қатынастарды модельдеудің қолданыстағы тәсілдері жүйеленеді, алынған тұжырымдардың эмпирикалық негізділік дәрежесі бағаланады, сонымен қатар болашақ зерттеулердің бағыттары анықталады.

Талдау объектісі-банк жүйесінің қаржылық тұрақтылығын қамтамасыз етудегі негізгі мәселелерді сипаттайтын эмпирикалық бағалар мен теориялық модельдер ұсынылған ғылыми жұмыстар. Зерттеу ғылыми әдебиеттерді жүйелеу және сыни талдау әдістеріне, сондай-ақ теориялық тәсілдер мен эконометрикалық құралдарды салыстырмалы зерттеуге негізделген.

Дереккөздерді іріктеу кезінде Scopus, Web of Science базаларында және басқа да беделді библиографиялық жүйелерде индекстелген рецензияланған халықаралық ғылыми журналдардағы жарияланымдарға басымдық берілді

Негізгі бөлігі

Капитал нарығы тек бағалы қағаздармен сауда алаңы емес, ол — экономикалық даму динамикасын көрсететін күрделі экожүйе. Ол арқылы ресурстар тиімді бөлініп, артық капитал өнімді салаларға бағытталады. Осы тұрғыдан алғанда, Қазақстан Республикасының капитал нарығы мен экономикалық даму көрсеткіштері арасындағы байланыс мәселесін зерттеу бүгінгі таңда аса өзекті.

Қаржы нарықтарының экономикалық өсумен байланысын зерттейтін зерттеулер үнемі ондаған түрлі жұмыстарға сілтеме жасайды¹⁰, дегенмен бұл тақырып бойынша теориялық және эмпирикалық зерттеулердің көптігі жалпы қорытынды туралы экономикалық кәсіптегі келіспеушіліктермен ғана салыстырылады. Кейбіреулер дамыған қаржы жүйесі индустриаландырудың негізгі шарты деп санайды (Гершенкрон, 1962)¹¹ және ұзақ тарихта қаржы нарықтарының экономикалық өсуге қосқан үлесі "маңызды" болды (Стиглиц, Дж., 2010)¹², "кілт" (Шумпетер, 1912)¹³ немесе тіпті "байыпты талқылау үшін тым айқын" (Миллер, 1998)¹⁴.

Қаржылық даму мен экономикалық өсімнің арасындағы байланысты теориялық зерттеуді алғаш рет 1912 жылы Шумпетер жасаған. Осы теорияға негізделген зерттеулер негізінен екі гипотезаға сәйкес (ұсыныс пен сұранысқа негізделген) қаржылық даму мен өсу арасындағы байланысты түсіндіруге тырысты¹⁵. «Ұсынысқа негізделген» гипотезаға сәйкес, қаржы жүйесі капиталдың өсуін және технологиялық дамуға қажетті қаражатты қамтамасыз ете отырып, өсу процесін жеделдетеді¹⁶.

Басқалары қаржы нарықтарының экономикалық дамудағы маңызы академиялық пікірталастарда өте асыра айтылған деп санайды (Робинсон, Дж., 1952¹⁷ ; Лукас, 1988). Басқалары, тиісті ережелерсіз, қаржы шамадан тыс өсіп, тек жалдау құралына айналуы мүмкін (Зингалес, 2015), тіпті болашақ қаржылық дағдарыстардың тұқымын себетін күшті күшке айналуы мүмкін (Шуларик пен Тейлор, 2012; Миан мен Суо, 2014), Бұл ұзақ мерзімді өсу мен қоғамдық әл-ауқатқа теріс әсер етеді. Левин (2005) кәсіби консенсустың ең жақын ұқсастығын көрсетеді: "біз сұраққа нақты жауаптардан алыспыз: қаржы өсуді тудырады ма, егер солай болса, қалай?"

Капитал нарығының экономикалық мәні және оның құрылымдық элементтері. Капитал нарығы- ұзақ мерзімді инвестицияларды тартуға және қаржы ресурстарын тиімді

¹⁰ Қаржы және экономикалық өсу әдебиеттеріне егжей-тегжейлі шолуды Руссо (2003), Левин (2005) және Бек (2008, 2012) және басқалардың еңбектерінен табуға болады

¹¹ Gerschenkron, A. (1962). *Economic Backwardness in Historical Perspective* ñ A Book of Essays. Harvard University Press, Cambridge, MA

¹² Stiglitz, J. (2010). Financial innovation: Against the motion that Önancial innovation boosts economic growth. *The Economist* February 23 ñMarch

¹³ Schumpeter, J. (1912). *Theorie der wirtschaftlichen Entwicklung*. Dunker & Humblot, Leipzig. *The Theory of Economic Development* translated by R. Opie. Harvard University Press: Cambridge, MA, 1934

¹⁴ Miller, M. (1998). Financial markets and economic growth. *Journal of Applied Corporate Finance* 11, 8ñ14

¹⁵ Ayadi R. et al. Financial development, bank efficiency, and economic growth across the Mediterranean // *Economic and social development of the Southern and Eastern Mediterranean countries*. –Springer, Cham, 2015. – С. 219-233

¹⁶ Сыздықова А.О.(2021), Нахипбекова С., Масадиков Х., Тилеуова С. Қаржылық даму мен экономикалық өсу арасындағы байланысты талдау: өтпелі экономикалы елдер мысалында / Экономика: стратегия и практика, № 1 (16), 2021 г. / 143-154
https://doi.org/10.51176/JESP/vol_16_issue_1_T11
https://esp.ieconom.kz/jour/article/view/299?locale=kk_KZ URL:

¹⁷ Robinson, J. (1952). *The Rate of Interest and Other Essays*. MacMillan, London

бөлуге арналған механизм. Ол экономикалық жүйеде «айналымдағы қан» қызметін атқарады, яғни жинақталған қаржы құралдарын нақты секторға бағыттап, экономиканың өсуін қамтамасыз етеді.

Нарықтың негізгі элементтеріне келесілер жатады:

Қор нарығы – акциялар, облигациялар және басқа да бағалы қағаздар айналысатын орта;

Деривативтер нарығы – тәуекелдерді басқаруға арналған қаржы құралдары;

Институционалдық инвесторлар – зейнетақы қорлары, сақтандыру компаниялары, инвестициялық қорлар;

Биржалық инфрақұрылым – Қазақстан қор биржасы (KASE), «Астана» халықаралық қаржы орталығы (AIFC), клирингтік ұйымдар және депозитарийлер.

Капитал нарығының дамуы ұлттық экономиканың сапалық деңгейін көрсетеді. Егер нарық тиімді жұмыс істесе, кәсіпорындар мен жеке сектор банктерден тыс қосымша қаржы көздерін тарта алады, ал инвесторлар өз қаражатын тиімді салаға орналастырып табыс табады.

Қазақстан капитал нарығының қалыптасу кезеңдері Қазақстанның капитал нарығы тәуелсіздік алғаннан кейінгі экономикалық реформалармен қатар қалыптасты. 1990-жылдардың басында қаржы жүйесі нарықтық қатынастарға бейімделіп, алғашқы қор биржасы құрылды. 1993 жылы Қазақстан қор биржасы (KASE) ресми түрде жұмысын бастады. Алғашқы жылдары нарықтағы белсенділік төмен болды, себебі бағалы қағаздар мен инвестиция мәдениеті халық арасында кең тарамаған еді. 2000-жылдардан бастап мемлекеттік саясат қаржы секторын реформалауға бағытталды. Зейнетақы жүйесінің реформасы, банктік сектордың тұрақтануы және институционалдық инвесторлардың пайда болуы капитал нарығын жандандыруға негіз қалады. 2018 жылы «Астана» халықаралық қаржы орталығының (AIFC) ашылуы жаңа кезең бастады. Ол ағылшын құқығына негізделген ерекше құқықтық алаң ретінде халықаралық инвесторлардың сенімін арттырды. AIX биржасында Kaspi.kz, Freedom Holding, Kazatomprom сияқты ірі компаниялардың IPO өткізуі — отандық нарықтың әлемдік деңгейге шығуының нақты белгісі ¹⁸.

Капитал нарығы мен экономикалық даму арасындағы өзара байланыс Капитал нарығы мен экономикалық даму өзара тығыз байланыста. Бұл байланыс екі бағытта жүреді. Біріншіден, капитал нарығы экономикалық дамуға тікелей әсер етеді, себебі инвестициялардың көбеюі өндіріс көлемін арттырады, жаңа жұмыс орындарын ашады, салық түсімдерін өсіреді. Екіншіден, экономикалық өсім капитал нарығының кеңеюіне ықпал етеді, себебі халықтың табысы артқан сайын олар қаржы құралдарына инвестиция салуға бейім болады. Қазақстанда соңғы жылдары ЖІӨ көлемі мен қор нарығы капитализациясының арасында оң тәуелділік байқалады. 2015 жылдан 2024 жылға дейінгі аралықта бағалы қағаздар нарығының капитализациясы шамамен екі есеге өскен, ал шетелдік инвесторлардың қатысу үлесі 30%-дан асқан. Бұл ел экономикасының тартымдылығы артып келе жатқанын көрсетеді ¹⁹.

Нарықтың қазіргі жағдайы және негізгі көрсеткіштер 2020 жылдан кейінгі кезең Қазақстанның капитал нарығы үшін күрделі сынақ болды. COVID-19 пандемиясы әлемдік қаржы нарықтарына үлкен соққы берді, бірақ сонымен қатар жаңа цифрлық мүмкіндіктердің дамуына жол ашты. Электронды сауда алаңдары мен онлайн-инвестиция

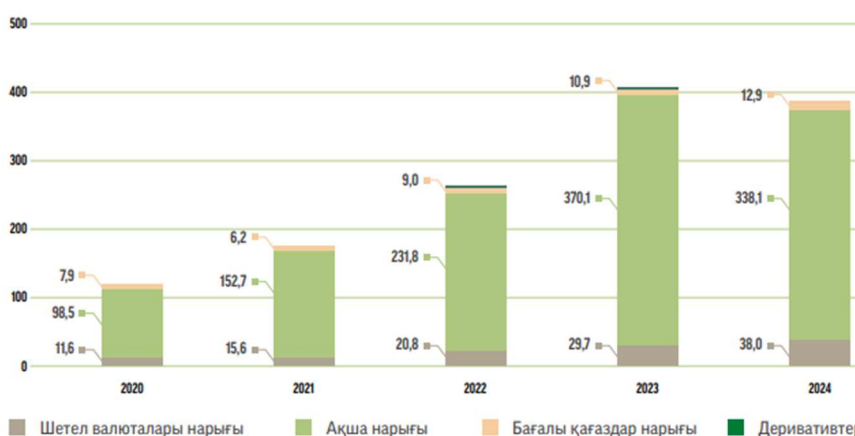
¹⁸ «Астана» халықаралық қаржы орталығының қызметі туралы Жылдық есеп 2023, 77 бет URL: https://aifc.kz/wp-content/uploads/2024/09/aifc_kaz_final-1.pdf

¹⁹ OECD (2023), Insights on the Business Climate in Kazakhstan, OECD Publishing, Paris, <https://doi.org/10.1787/bd780306-en>
URL: https://www.oecd.org/en/publications/insights-on-the-business-climate-in-kazakhstan_bd780306-en/full-report.html

платформаларының кеңеюі жеке тұлғалардың нарыққа қатысуын арттырды. 2024 жылдың қорытындысы бойынша барлық нарықтағы саудасаттықтың жалпы көлемі 389,1 трлн теңгеге дейін 5,3% төмендеді:

KASE-дегі сауда-саттықтың негізгі көлемі ақша нарығына тиесілі, онда сауда-саттық көлемі 2024 жылы 338,1 трлн теңгеге дейін 8,6% қысқарды. Валюталық своп операцияларының көлемі 76,6 трлн теңгеге дейін 20,6% ұлғайды. Валюта нарығында сауда-саттық көлемі 38,0 трлн теңгеге дейін 28% өсті, оның ішінде доллар/теңге валюта жұбы бойынша сауда-саттық көлемі 47,3%, рубль/теңге жұбы бойынша 2 есе, юань/теңге жұбы бойынша 89,2% өсті.

Бағалы қағаздар нарығындағы сауда-саттық көлемінің өсуі корпоративтік борыштық бағалы қағаздар нарығын қамтамасыз етті, онда сауда-саттық көлемі 4,3 трлн теңгеге дейін 98,7% немесе 2,2 трлн теңгеге өсті. Сондай-ақ KASE Global секторында сауда-саттық көлемінің 46,6%-ға дейін 27,5%, туынды бағалы қағаздар секторында 2,8 млрд теңгеге дейін 49,9% өсуі байқалады.



1-сурет. Сауда-саттық көлемінің секторлар бойынша динамикасы, трлн теңге

Ескерту: KASE тобының жылдық есебі 2024, 114 бет, (6-сурет, 56 бет)
 URL: https://kase.kz/files/reports/KASE_meeting_2024_kaz.pdf

Бұл ретте акциялар нарығында, мемлекеттік бағалы қағаздар, халықаралық қаржы ұйымдарының облигациялары, инвестициялық қорлардың бағалы қағаздары, репо және туынды құралдар нарығында белсенділіктің төмендегені байқалды:

1-кесте. KASE қор биржасындағы сауда-саттық динамикасы, млрд теңге

	2020	2021	2022	2023	2024	изм. 2024 к 2023
Бағалы қағаздар нарығы	7 878,2	6 218,2	8 980,5	10 923,6	12 913,8	+1 990,2
♦ Акциялар	238,4	422,8	307,3	333,6	298,2	-35,4
♦ Kase Global	-	6,4	25,8	36,5	46,6	+10,0
♦ Корп. борыштық БҚ	2 691,2	1 980,8	2 488,8	2 187,3	4 347,2	+2 159,9
♦ МБҚ	4 650,7	3 575,9	6 004,3	8 013,0	7 952,9	-60,2
♦ ХҚҰ облигациялары	274,2	155,4	126,9	337,1	254,4	-82,7
♦ Инвест. қорлардың БҚ	20,3	38,1	8,8	14,3	11,9	-2,4
♦ Туынды БҚ	3,4	38,8	18,4	1,8	2,8	+0,9
Шетел валюталары нарығы	11 606,9	15 567,8	20 798,1	29 710,7	38 018,3	+8 307,5
Ақша нарығы	98 501,0	152 653,6	231 834,4	370 075,4	338 136,8	-31 938,6
♦ Репо операциялары	88 568,9	141 631,4	202 635,7	306 582,7	261 555,5	-45 027,2
♦ Валюталық своп операциялары	9 932,1	11 022,1	29 198,6	63 492,7	76 581,3	+13 088,6
Деривативтер нарығы	<0,1	<0,1	7,9	29,4	<0,1	-29,4
♦ Фьючерстер	<0,1	<0,1	7,9	29,4	<0,1	-29,4
Сауда-саттық көлемінің БАРЛЫҒЫ	117 986,1	174 439,6	261 620,8	410 739,2	389 068,9	-21 670,30

Ескерту: KASE тобының жылдық есебі 2024, 59 бет, (2-кесте, 60 бет)
 URL: https://kase.kz/files/reports/KASE_meeting_2024_kaz.pdf

Қазіргі таңда KASE мен AIX биржаларында 200-ге жуық эмитент тіркелген. Қор нарығының жалпы капитализациясы елдің ЖІӨ-нің шамамен 25–30%-ын құрайды. Бұл көрсеткіш әлі де төмен болғанымен, жыл сайын өсіп келеді.

Сонымен қатар, зейнетақы активтерінің бір бөлігі енді отандық бағалы қағаздарға бағытталуда. Бұл капиталдың ішкі нарықта айналымда болуына ықпал етуде. Мемлекет те өз облигацияларын орналастыру арқылы нарықтың өтімділігін арттырып отыр.

Талдау және тәжірибелік мысалдар. Капитал нарығының экономикалық дамуға ықпалын нақты мысалдар арқылы көруге болады.

Мысалы 1: «Эйр Астана» IPO-сы (2024). 2024 жылы әуетасымалдау саласының өкілі – Эйр Астана акцияларының алғашқы IPO-сы өткізілді. KASE-де акциялар 49,2 млрд теңге көлемінде орналастырылды, бұл – жай акцияларды орналастырудың жалпы көлемінің 76%. Сұраныс көлемі KASE-де орналастыруға ұсынылған акциялар көлемінен 2,5 есе асып түсті. Эйр Астана акцияларын орналастыру бағасы 1 073,83 теңге болды. KASE-дегі IPO-ға 29 мың жеке инвестор қатысты, олар 46,4 млрд теңге сомасына 36,8 мың өтінім берді, бұл – KASE-ге берілген өтінімдердің жалпы көлемінің 38,5%. Бұл ретте институционалдық инвесторлардан

банктер, брокерлер және сақтандыру ұйымдары атынан 70,6 млрд теңгеге өтінім түсті, бұл – қабылданған өтінімдердің жалпы көлемінің 58,6%²⁰.



2-сурет. 2024 жылғы 09 ақпаннан 31 желтоқсанға дейінгі Эйр Астана акцияларының бағасы мен сауда-саттық көлемінің динамикасы

Ескерту: KASE тобының жылдық есебі 2024, 114 бет, (11-сурет, 61 бет)
URL:https://kase.kz/files/reports/KASE_meeting_2024_kaz.pdf

IPO нәтижесінде жеке адамдардың шоттарына 24,3 млрд теңге сомасында бағалы қағаз түсті, бұл – KASE-ге орналастыру көлемінің 49,4%, ал институционалдық инвесторлар берген қанағаттандырылған өтінімдер көлемі – 24,9 млрд теңге немесе орналастыру көлемінің 50,6%. 01 наурызда Эйр Астана жай акциялары KASE Индексінің өкілдік тізіміне енгізілді. Қайталама нарықта сауда-саттық басталған күннен бастап Эйр Астана акцияларымен жасалған саудасаттық көлемі – 20 млрд теңге

Мәміле саны екі есеге жуық өскен, қайталама акциялар нарығындағы ең белсенді инвесторлар – бөлшек инвесторлар.

Мысалы 2: «Kaspi.kz» IPO-сы (2020). Цифрлық банкинг және финтех бағытын дамытқан компанияның IPO-сы қазақстандық капитал нарығының халықаралық аренада мойындалуына жол ашты. Бұл оқиға елдің цифрлық экономикасын қолдауға серпін берді. Осы екі мысал көрсеткендей, капитал нарығы арқылы компаниялар қосымша ресурстарға қол жеткізіп, өздерінің экономикалық тиімділігін арттыра алады. Бұл өз кезегінде жалпы ішкі өнімнің өсуіне үлес қосады.

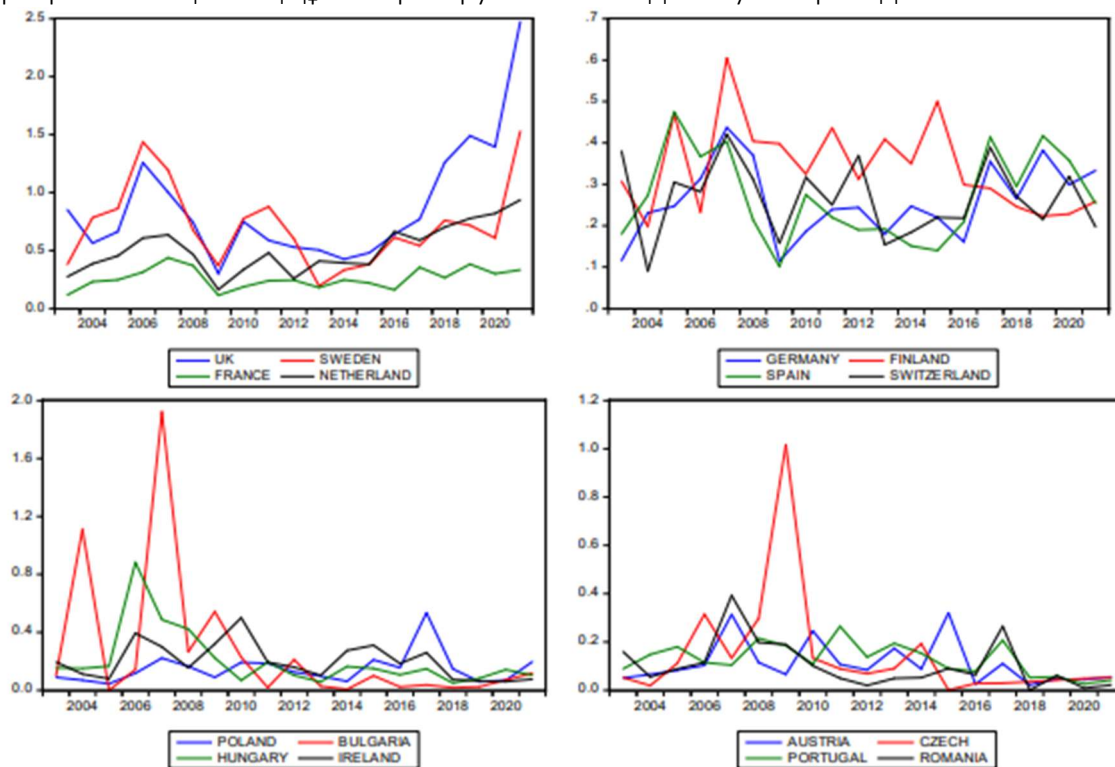
2024 жылдың қорытындысы бойынша Kaspi.kz АҚ жай акциялары 19,6% өсті. Kaspi.kz АҚ-тың шоғырландырылған таза пайдасы 2023 жылы 588,8 млрд теңгеден 848,8 млрд теңгеге дейін 44,1% өсті. Бұл ретте, компанияның 2024 жылғы тоғыз айдағы шоғырландырылған таза пайдасы 600,8 млрд теңгеден 740,4 млрд теңгеге дейін ұлғайды. 2024 жылғы 19 қыркүйекте Fitch Ratings компанияға “BBB-” деңгейінде компанияның ұзақмерзімді дефолт рейтингін берді, болжам “Тұрақты”. 2024 жылғы 22 мамырда акционерлер 2024 жылдың бірінші тоқсанында бір акция үшін 850 теңге есебінен жай акциялар бойынша дивиденд төлеу туралы шешім қабылдады. 21 тамызда акционерлердің кезектен тыс жалпы жиналысы 2024 жылдың екінші тоқсаны үшін бір акцияға 850 теңге мөлшерінде жай акциялар бойынша

²⁰ KASE тобының жылдық есебі 2024, 114 бет, (11-сурет, 61 бет)
URL:https://kase.kz/files/reports/KASE_meeting_2024_kaz.pdf

дивиденд төлеу туралы шешім қабылдады. 19 қарашада компания акционерлері 2024 жылдың үшінші тоқсаны үшін бір акцияға 850 теңге мөлшерінде дивиденд төлеу туралы шешім қабылдады²¹.

Халықаралық салыстырмалы талдау

Private equity (PE)- бұл бүкіл әлемде қолданылатын инвестициялық әдіс және әр түрлі елдердегі жеке меншік капитал қызметінің үлесі айтарлықтай ерекшеленеді, мұнда инвесторлар инвестицияның құнын арттыруға және пайда табуға тырысады.



3-сурет. «Жеке капитал инвестицияларының ЖІӨ-дегі пайыздық үлесінің» динамикасы, 2003-2021 жж.

Ескерту: Eviews эконометрикалық пакет көмегімен дереккөзі негізінде авторлармен құрастырылған World Bank Open Data. – 2022. – URL: <http://www.worldbank.org/>.

Рахматуллаева Д.Ж., Какижанова Т.И., Андабаева Г.К. (2023), Еуропалық Одақ және Қазақстандағы жеке капиталдың детерминанттарын бағалау //Қазақ экономика, қаржы және халықаралық сауда университетінің жаршысы, 2023 – №2 (51), 206-241 бет DOI [10.52260/2304-7216.2023.2\(51\).26](https://doi.org/10.52260/2304-7216.2023.2(51).26)

URL: <http://vestnik.kuef.kz/web/uploads/file-vestnik/2cbde6a57920bc4104491ec9b4d1caca.pdf>

Басқа дамыған және дамушы елдер үшін деректердің ашық болмауына байланысты зерттеуге қажетті панельдік деректер Ұлыбритания, Швеция, Франция, Нидерланды, Германия, Финляндия, Испания, Швейцария, Польша, Болгария, Венгрия, Ирландия, Австрия, Чехия, Португалия, Румыния сияқты жекелеген елдер бойынша жиналған²².

Пандемия мен Украинадағы әскери қақтығыстың теріс әсеріне байланысты көптеген Еуропаның дамушы елдері өсу әлеуетін тежейтін капитал тапшылығына тап болды. Жалпы Еуропадағы компаниялар банктік қаржыландыруға көбірек сүйенген. Алайда, зерттелінген

²¹ KASE тобының жылдық есебі 2024, 114 бет, (65 бет)

URL: https://kase.kz/files/reports/KASE_meeting_2024_kaz.pdf

²² Рахматуллаева Д.Ж., Какижанова Т.И., Андабаева Г.К. (2023), Еуропалық Одақ және Қазақстандағы жеке капиталдың детерминанттарын бағалау //Қазақ экономика, қаржы және халықаралық сауда университетінің жаршысы, 2023 – №2 (51), 206-241 бет DOI [10.52260/2304-7216.2023.2\(51\).26](https://doi.org/10.52260/2304-7216.2023.2(51).26)

URL: <http://vestnik.kuef.kz/web/uploads/file-vestnik/2cbde6a57920bc4104491ec9b4d1caca.pdf>

еуропалық елдер бойынша статистикалық талдау бұл үрдістің 2000-шы жылдардың басынан бастап өзгере бастағанын көрсетті- нәтижесінде РЕ көлемі 2006 дейін жыл сайын өсе бастап, кейін өсу деңгейі 2008 жылдардағы жаһандық қаржы дағдарысының әсерінен төмендеді (3-суретте 2009 жылы Еуропаның барлық қарастырылған елдерінде жеке инвестициялардың күрт төмендеуі байқалады).

Қаржы дағдарысынан кейін еуропалық жеке капитал нарығы тез қалпына келді және 2017 жылы Еуропадағы жалпы жеке капитал көлемі дағдарысқа дейінгі деңгейден небәрі 4%-ға төмен –71,7 миллиард еуроға жетті, бұл белсенді еуропалық жеке капиталдың жалпы құнын 640 миллиард еуроға көтерді . Сол кездегі еуропалық зерттеулер бизнесті қаржыландырудың тікелей инвестициялар сияқты баламалы көздерінің нысандарын қолдану – Еуропаны қажетті капиталмен қамтамасыз ету мәселесінің әлеуетті шешімі болып табылатынын растады. 2020-2021 жылдардағы пандемия дағдарысының салдарынан жеке капитал нарығында қайтадан теріс үрдіс орын алып (3-сурет), 2021 жылы Испания, Швейцария, Венгриядан басқа зерттелініп отырған елдерде жеке капитал үлесінің артуы байқалады.

Негізгі мәселелер мен даму тежегіштері. Капитал нарығының әлеуетіне қарамастан, Қазақстанда оны толық іске асыруға бірқатар факторлар кедергі келтіреді:

Ақпараттың жеткіліксіздігі мен қаржылық сауаттылықтың төмендігі. Көптеген азаматтар бағалы қағаздар нарығын тәуекелі жоғары сала деп қабылдайды. Нарық өтімділігінің әлсіздігі. Эмитенттер саны аз болғандықтан, сауда белсенділігі төмен.

Шағын және орта бизнес қатысуының шектеулігі. Көптеген кәсіпорындар IPO-ға шығу рәсімін күрделі деп санайды.

Институционалдық инвесторлардың инвестициялық саясатының шетелге бағытталуы. Бұл ішкі капитал айналымын баяулатады.

Мемлекет тарапынан бұл мәселелерді шешу үшін бірнеше бастама қолға алынған: салықтық жеңілдіктер енгізу, электронды инвестициялық платформалар құру, қаржы сауаттылығын арттыру бағдарламалары және AIFC шеңберінде жеңілдетілген листинг талаптарын қолдану.

Капитал нарығының экономикалық тұрақтылыққа ықпалы. Капитал нарығының дамуы экономикалық тұрақтылықтың маңызды факторы болып табылады. Себебі, нарықтағы әртараптандырылған қаржыландыру тетіктері экономиканы сыртқы күйзелістерден қорғайды. Банктік несиелеуге тәуелділік азайған сайын, кәсіпорындар үшін жаңа қаржы көздері пайда болады.

Мысалы, әлемдік дағдарыстар кезінде дамыған капитал нарығы бар елдер экономикалық құлдыраудан тез шыға алады, себебі нарықта ұзақ мерзімді қаржы ресурстарының қоры бар. Қазақстан да осы бағытта жүріп келеді. Мемлекеттік облигациялар мен корпоративтік бағалы қағаздардың рөлін арттыру елдің қаржы жүйесін теңгерімді етуге мүмкіндік береді.

Болашаққа көзқарас және даму бағыттары. Қазақстан капитал нарығын дамыту жөніндегі 2030 жылға дейінгі тұжырымдамасында бірнеше стратегиялық бағыт белгіленген:

- нарық капитализациясын ЖІӨ-нің кемінде 50%-ына жеткізу;
- жеке инвесторлардың үлесін 15%-ға дейін арттыру;
- шағын және орта бизнеске арналған жаңа қаржы құралдарын енгізу;
- экологиялық (жасыл) және исламдық қаржы құралдарын кеңейту.

Сонымен қатар, цифрлық технологиялар (fintech), блокчейн және жасанды интеллект негізіндегі сауда платформалары капитал нарығының жаңа деңгейге көтерілуіне ықпал етеді. Бұл бағыттар ел экономикасының инновациялық дамуына серпін бермек²³.

Жалпы алғанда, капитал нарығы мен экономикалық даму өзара бір-бірін толықтыратын және күшейтетін құбылыстар. Қазақстан жағдайында бұл байланыс әсіресе маңызды, себебі экономиканы әртараптандыру және тұрақты өсу жолына түсу үшін қаржы нарығының тиімді жұмыс істеуі қажет.

Капитал нарығы арқылы мемлекет пен жеке сектор жаңа қаржы көздеріне қол жеткізіп, экономикалық белсенділікті арттыра алады. Ал халықтың инвестициялық мәдениеті мен сенімін нығайту осы жүйенің тұрақты дамуының кепілі болып табылады.

Сондықтан алдағы уақытта Қазақстан үшін капитал нарығын дамыту тек қаржы секторының міндеті емес, жалпы ұлттық экономикалық саясаттың негізгі басымдығы болуға тиіс. Бұл елдің жаһандық экономикадағы орнын күшейтіп, экономикалық тәуелсіздігін нығайтады.

Зерттеу нәтижелері көрсеткендей, капитал нарығы мен экономикалық даму арасындағы байланыс көпқырлы сипатқа ие. Капитал нарығы дамыған сайын, инвестициялардың көлемі артып, өндірістік қуаттар жаңартылады, ал кәсіпкерлік белсенділік күшейеді. Бұл өз кезегінде экономикалық өсу мен жұмыспен қамту деңгейіне оң әсер етеді.

Қазақстанда соңғы жылдары капитал нарығын нығайту бағытында айтарлықтай қадамдар жасалды. «Астана» халықаралық қаржы орталығының құрылуы, KASE биржасының жаңғыртылуы және цифрлық инвестициялық платформалардың пайда болуы елдің қаржы инфрақұрылымын жаңа деңгейге көтерді. Сонымен бірге, институционалдық инвесторлардың белсенділігі мен шетелдік капиталдың тартылуы экономикалық дамуға қосымша импульс берді.

Дегенмен, шешуді қажет ететін мәселелер де бар. Нарықтың өтімділігі әлі де төмен, эмитенттер саны аз, ал халықтың қаржылық сауаттылығы жеткіліксіз. Осы олқылықтарды жою үшін білім беру бағдарламаларын кеңейтіп, шағын және орта бизнеске капитал нарығына шығуға қолайлы жағдай жасау маңызды. Сондай-ақ, экологиялық (жасыл) облигациялар мен исламдық қаржы құралдарын енгізу нарықтың жаңа бағыттарын аша алады.

Қорытынды

Капитал нарығының тұрақты дамуы ел экономикасына ұзақ мерзімді тұрақтылық береді. Ол банктік несиелеуге балама қаржыландыру көзі болып, дағдарыс жағдайында экономиканың тепе-теңдігін сақтауға мүмкіндік береді. Сонымен қатар, халықтың жинақтарын өнімді инвестицияларға бағыттау арқылы ішкі капитал айналымын жандандырады.

Болашақта Қазақстанның алдында тұрған басты міндет — капитал нарығын аймақтық деңгейде бәсекеге қабілетті ету. Ол үшін халықаралық стандарттарға сай заңнамалық және институционалдық орта қалыптастыру, шетелдік инвесторлармен ынтымақтастықты кеңейту және қаржы технологияларын барынша пайдалану қажет.

Қорытындылай келе, капитал нарығы Қазақстанның экономикалық жүйесінде тек қосымша инвестициялық құрал емес, елдің ұзақ мерзімді стратегиялық дамуының өзегіне айналуы тиіс. Егер мемлекет, бизнес және қоғам бірлесе әрекет етсе, Қазақстан алдағы жылдары Орталық Азиядағы жетекші қаржы орталығы мәртебесіне жетіп, экономикасын жаңа сапалық деңгейге көтере алады.

²³ Бекенова, Л. С. Қаржы нарығының инфрақұрылымы және оның даму бағыттары. // Қазақ экономикасы журналы. – 2023. – №4. – Б. 45–53.

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Бюджетные отношения и межбюджетные связи в зелёных финансах (green finance)

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Аннотация

Парижское соглашение 2015 года обязало правительства принять меры по сокращению выбросов парниковых газов и ограничению изменения климата. Правительства подтвердили это обязательство в рамках программ восстановления после пандемии, стремясь «восстановить лучше, чем прежде» за счет амбициозных «зеленых» инвестиций. Выполнение обязательств по борьбе с изменением климата и реализация обещаний в области «зеленых» инвестиций потребуют быстрых экономических, социальных и технологических преобразований, а также новых бюджетных рамок для их поддержки.

В современных бюджетных рамках правительства обычно вводят для себя финансовые ограничения, чтобы сдержать краткосрочные соблазны в погоне за долгосрочной устойчивостью. Можно ли применить передовые методы институционального проектирования, помогающие правительствам придерживаться фискальных правил, к выполнению экологических обещаний?

Введение

Переход к устойчивой модели экономического развития в условиях усиливающихся климатических рисков предъявляет новые требования к системе публичных финансов. В мировой практике формируется комплекс инструментов зелёных финансов, направленных на стимулирование экологически ориентированных инвестиций, повышение прозрачности бюджетных расходов и интеграцию климатических целей в процесс государственного управления. Одним из ключевых направлений такого перехода становится внедрение механизмов зелёного бюджетирования (green budgeting), позволяющего оценивать экологические последствия государственных программ, формировать стимулы для «зелёных» инвестиций и обеспечивать долгосрочную устойчивость фискальной политики (OECD, 2024; 2022).

В условиях декарбонизации экономики роль бюджетных отношений и межбюджетных связей существенно возрастает, поскольку экологическое регулирование требует координированных действий на центральном и региональном уровнях. Как отмечают Расуханов (2019) и World Bank (2022a), эффективное межбюджетное взаимодействие позволяет учитывать территориальные особенности, выравнивать бюджетную обеспеченность и направлять ресурсы на экологические и климатические проекты с наивысшим социальным эффектом. В этом контексте межбюджетные трансферты становятся не только инструментом фискального выравнивания, но и механизмом стимулирования зелёных инвестиций, включая поддержку энергоэффективности, низкоуглеродной инфраструктуры и климатической адаптации.

Когда страна ставит экологическую устойчивость и «зелёный» рост в приоритет, механизмы бюджетного и межбюджетного финансирования становятся критически важными: они позволяют привлекать, координировать и направлять ресурсы государства (и иногда публики) на проекты, связанные с экологией, климатом, возобновляемой энергетикой и устойчивым развитием.

Тем не менее, традиционное бюджетное устройство и межбюджетные механизмы далеко не всегда «заточены» под зелёные цели, что порождает проблемы при реализации «зелёной» политики.

Объектом анализа в данном исследовании выступают научные публикации, международные отчёты и аналитические материалы, посвящённые вопросам организации бюджетных отношений и функционирования межбюджетных связей в контексте развития зелёных финансов. Особое внимание уделяется работам, рассматривающим механизмы зелёного бюджетирования, подходы к оценке экологической эффективности государственных расходов, а также исследованиям, анализирующим роль фискальных институтов и межуровневого управления в стимулировании экологически ориентированных инвестиций. В рамках анализа используются источники, содержащие теоретические модели бюджетного регулирования, эмпирические оценки влияния межбюджетных трансфертов на реализацию климатической повестки, а также международный опыт внедрения зелёных финансовых инструментов и климатически ориентированных бюджетных реформ.

Методологическая база исследования включает методы систематизации, критического анализа научной литературы и сравнительного изучения международных практик организации бюджетных отношений и межбюджетных связей в сфере зелёных финансов. В работе также используются подходы институционального и системного анализа, позволяющие оценить влияние фискальных институтов, механизмов межуровневого управления и бюджетных процедур на развитие зелёного бюджетирования и стимулирование экологически ориентированных инвестиций. Особое внимание уделяется изучению методик оценки экологической эффективности государственных расходов, подходов к климатической отчётности и инструментов интеграции климатических целей в бюджетный процесс.

При отборе источников предпочтение отдавалось публикациям в рецензируемых международных научных журналах, индексируемых в Scopus и Web of Science, а также аналитическим материалам и отчётам международных организаций, включая ОЭСР, Всемирный банк и профессиональные институты финансового контроля. Эти документы содержат актуальные данные и аналитические выводы о практике внедрения зелёного бюджетирования, реформ межбюджетных отношений, климатически ориентированных фискальных механизмов и развитии зелёных финансовых инструментов в странах с различными моделями государственного управления.

Основная часть

Практика ОЭСР — «зелёное бюджетирование» (green budgeting)

OECD продвигает концепцию «green budgeting» — интеграции климатических и экологических целей в весь бюджетный цикл: от планирования и подготовки бюджета, до исполнения и отчётности²⁴.

Одной из таких практик стало назначение независимых контролирующих органов для проверки соответствия бюджетных планов кодифицированным фискальным целям (Мартинс и Коррейя, 2021)²⁵. Независимые фискальные институты (НФИ), такие как независимые парламентские бюджетные управления и фискальные советы, могли бы быть

²⁴ Green budgeting <https://www.oecd.org/en/topics/green-budgeting.html?utm>

²⁵ Martins, P. and L. Correia (2021), "Fiscal institutions: different classifications and their effectiveness", Eurasian Economic Review, Vol. 11/1, pp. 159-190, <https://doi.org/10.1007/s40822-020-00155-0>.

назначены для мониторинга многих практических аспектов реализации «зеленых бюджетов», которые меняют подход правительств к подготовке и представлению своих фискальных планов для достижения экологических целей. Самостоятельно или в сотрудничестве с другими независимыми органами, такими как климатические советы, достоверный беспристрастный анализ, предоставляемый НФИ, обеспечил бы парламентам и общественности необходимую информацию для оценки вариантов климатической политики и привлечения правительств к ответственности за их «зеленые» обязательства.

Эти усилия по координации борьбы за более экологичное будущее прекрасно выглядят на бумаге. И они прекрасно выглядели на бумаге с момента первой встречи в 1995 году Конференции сторон Рамочной конвенции ООН об изменении климата. Однако, как и в случае с другими коллективными действиями, усилия по борьбе с изменением климата сдерживаются рядом проблем, связанных с выбором общественного мнения:

1. Проблема общего ресурса, когда отдельные страны чрезмерно используют ограниченные ресурсы для максимизации собственной выгоды за счет других стран. Практика стран Европейского Союза становится примером также при проведении региональной политики, когда отдельные территории (земли в Германии, субъекты Федерации в России, области в Казахстане и т.д.) начинают использовать финансовые ресурсы за счет донорства других внутри одной страны.

2. Проблема безбилетника, когда отдельные страны могут воспользоваться ответственным «зеленым» управлением других стран в сокращении глобальных выбросов, чтобы избежать ущерба собственному экономическому процветанию.

3. Межвременная иллюзия, когда часть электората не до конца понимает компромисс между текущими выбросами и будущим глобальным потеплением, и будущие поколения избирателей не могут голосовать в интересах раннего предотвращения.

4. Конкуренция между политическими агентами, которая возникает, когда правительства не предвидят полных политических издержек бездействия в отношении климата из-за неопределенности выборов, поэтому они откладывают введение строгих мер до следующих правительств.

В своих влиятельных работах о том, как бюджетные правила и институты влияют на фискальные результаты, Потерба (1996)²⁶ предложил два механизма, посредством которых правила могут помочь правительствам преодолеть эти проблемы общественного выбора и придерживаться своих целей:

1. Любые правила (нормативные и законодательные документы, международные меморандумы и/или соглашения) обеспечивают объективный критерий, по которому законодатели, СМИ и общественность могут оценивать предложения правительства и их реализацию, что повышает репутационные и электоральные издержки неэффективного управления.

2. Любые правила (нормативные и законодательные документы, международные меморандумы и/или соглашения) позволяют политикам избегать политических последствий корректирующих мер, особенно в рамках законов с механизмами автоматического обеспечения соблюдения.

Признавая эти проблемы и потенциал самоограничений для их преодоления, правительства обязуются и обязуются перед будущими правительствами придерживаться рамочных правил различной степени жесткости в стремлении к достижению экологических целей. Например, правительства Колумбии, Франции, Италии и Люксембурга разработали

²⁶ Poterba, J. (1996), "Do Budget Rules Work?", in A.Auerbach (ed.), *Fiscal Policy: Lessons From Empirical Research*, National Bureau of Economic Research, Cambridge, MA, pp.53-86.

национальные стратегии по сокращению выбросов углерода для выполнения своих обязательств по Парижскому соглашению. В случае Италии это приняло форму национальной долгосрочной стратегии по достижению «климатической нейтральности», требующей от правительств сокращения выбросов на 40% к 2050 году, а оставшиеся выбросы парниковых газов должны быть компенсированы за счет улавливания, хранения и повторного использования углекислого газа (CO₂)²⁷.

Дания, Мексика, Норвегия и Швеция приняли более формальные законы о климате. В случае Дании цели были закреплены в Законе о климате, который устанавливает пятилетний целевой показатель по сокращению выбросов парниковых газов в Дании на 70% к 2030 году по сравнению с 1990 годом и достижению климатической нейтральности к 2050 году в соответствии с правилами учета выбросов ООН. Некоторые страны реализуют свои целевые показатели по выбросам с помощью углеродных бюджетов. Углеродные бюджеты устанавливают лимит выбросов на секторальной основе на многолетний период.

Для содействия выполнению климатических обязательств страны включают экологические аспекты в свои бюджетные планы в рамках развивающейся практики, получившей название «зеленое бюджетирование». Зеленое бюджетирование помогает центральным органам власти понимать и расставлять приоритеты в политических решениях для достижения экологических целей. Оно включает в себя такие практики, как:

1. Экономическое и фискальное прогнозирование с учетом климатических изменений.

Специалисты по бюджетному планированию все чаще стремятся учесть, как климатические инициативы, такие как ценообразование на углеродные выбросы, влияют не только на государственную казну, но и как меры по смягчению последствий изменения климата влияют на экономику и отражаются на бюджете. Кроме того, планировщики все более тщательно учитывают влияние неконтролируемого изменения климата на экономические и фискальные показатели, например, принимая во внимание экономические потери прибрежных регионов, оценивая увеличение затрат на техническое обслуживание государственных активов в результате экстремальных погодных условий или оценивая дополнительные расходы на поддержку отраслей и домохозяйств, пострадавших от климатических катастроф, таких как лесные пожары. Эти подходы были реализованы как в среднесрочных стратегических планах, так и в долгосрочном анализе фискальной устойчивости.

2. Требования к отчетности и раскрытию информации в сфере «зеленой» экономики

обязывают правительства предоставлять информацию о климатическом и экологическом воздействии рассматриваемых в бюджете и других политических документах мер, а также учитывать климатические риски в среднесрочных и долгосрочных прогнозах. Все чаще международные организации по бухгалтерскому учету в государственном секторе и агентства по стандартизации также обновляют свои рекомендации, призывая правительства сообщать о стоимости инициатив по смягчению последствий изменения климата и адаптации к ним, необходимых для перехода к целям экологической устойчивости (Chartered Institute of Public Finance and Accountancy, 2021)²⁸. Кроме того, поскольку все больше институциональных и частных инвесторов вынуждены выделять часть портфелей с фиксированным доходом на «зеленые» или ESG (экологические, социальные и управленческие) облигации, правительства выпускают суверенные ESG-облигации для удовлетворения спроса. Эти долговые обязательства должны содержать достаточно

²⁷ OECD (2022), OECD Journal on Budgeting, Volume 2022 Issue 3, OECD Publishing, Paris, <https://doi.org/10.1787/dedebeca-en>.

²⁸ Chartered Institute of Public Finance and Accountancy (2021), Evolving Climate Accountability: A Global Review of Public Sector Environmental Reporting, <https://www.cipfa.org//media/Files/Publications/CIPFA-Report-Evolving-Climate-Accountability.pdf>.

информации для оценки соответствия ESG-нормативным актам, таким как стандарт «зеленых» облигаций ЕС.

3. Оценка и анализ экологической политики включают климатические и экологические аспекты в существующие рамки выбора отдельных политик для получения доходов, расходов и регулирования. Это включает как предварительную оценку воздействия, так и постфактумную оценку программ. Экологические аспекты включают нерыночную деятельность, связанную с парниковыми газами и экологическим разрушением, в частности, истощение природного капитала, такого как места обитания диких животных, общественные зеленые зоны и качество воздуха. Оценки различаются по сложности: от сравнения положительных и отрицательных экологических внешних эффектов новой гидроэлектростанции до оценки более широкого экономического воздействия ее строительства на энергетические рынки, рабочие места и рост.

Например, в Дании исследователи из Датского научно-исследовательского института экономического анализа и моделирования, независимого государственного учреждения, разрабатывают модель «GreenREFORM» для оценки воздействия политики по сокращению выбросов парниковых газов с учетом ее финансовых затрат и влияния на количество рабочих мест, рост ВВП, доходы и другие экономические факторы (OECD, 2021)²⁹.

4. «Зеленая бюджетная маркировка» - это процедура переориентации фискального планирования путем присвоения политическим мерам статуса «позитивных», «негативных» или «нейтральных» в соответствии со списком экологических целей. Например, при подготовке бюджета Франции программы расходов и налоговые льготы маркируются в соответствии с их воздействием на окружающую среду. Эта информация позволяет законодателям во французском парламенте оценить, как принятые меры будут способствовать выполнению Францией климатических обязательств до их утверждения. Методология маркировки была разработана в рамках междисциплинарного сотрудничества между Генеральной инспекцией финансов и Генеральным советом по экологии и устойчивому развитию (Министерство экономики, финансов и восстановления, Франция, 2020)³⁰. В ЕС, чтобы помочь государствам-членам начать разработку собственных методологий маркировки, Европейская комиссия разработала два предварительных списка бюджетных статей, классифицируемых как «зеленые» или «коричневые».

5. Обзоры «зеленого» налогообложения проводятся правительствами или независимыми комиссиями для оценки того, как налоговая система страны может быть скорректирована таким образом, чтобы учитывать цену негативных экологических внешних эффектов, одновременно повышая экономическую эффективность (так называемый **«двойной дивиденд» реформы «зеленого» налогообложения**). Обзоры «зеленого» налогообложения проводились, например, Комиссией по «зеленой» фискальной политике в Соединенном Королевстве (Экинс и др., 2009)³¹.

Для смягчения последствий изменения климата всем государственным учреждениям потребуется «значительный сдвиг» в сторону учета интересов планеты в государственной политике, особенно в том, как планируется привлекать и расходовать государственные средства. Факторы, которые сделали международные финансовые институты эффективными в поддержке фискальных правил, могут также сделать их эффективными в поддержке этого

²⁹ OECD (2021), Introductory note on integrating climate into macroeconomic modelling: Drawing on the Danish Experience, OECD, Paris, https://www.oecd.org/gov/budgeting/integrating_climate-into-macroeconomic-modelling.pdf.

³⁰ Ministry for the Economy, Finance and the Recovery, France (2020), Report on the Environmental Impact of the Central Government Budget, <https://www.budget.gouv.fr/documentation/file-download/8632>.

³¹ Ekins, P. et al. (2009), The case for green fiscal reform: Final report of the UK Green Fiscal Commission, https://westminsterresearch.westminster.ac.uk/item/90wyv/the-case-for-green_fiscal-reform-final-report-of-the-uk-green-fiscal-commission.

перехода к «зеленому» бюджетированию. Кроме того, существует множество климатических и экологических рисков, связанных с финансовым планированием, на которые международные финансовые институты не только имели бы основания направлять свое внимание, но и где любая оценка, не являющаяся всесторонней, может оказаться недостаточной для выполнения их мандата

В ходе бесед с экспертами по бюджету и международными финансовыми институтами (МФИ), работающими в настоящее время над «зеленым» анализом, ОЭСР определила четыре области, представленные в Таблице 1, в которых МФИ могли бы поддерживать «зеленый» переход либо по запросу заинтересованных сторон, либо благодаря своей автономии в проведении самостоятельного анализа. Для каждой области ниже перечислены и описаны конкретные виды деятельности, которые МФИ уже осуществляют или которые могли бы быть естественным образом расширены за счет основных функций в рамках их мандата по экономическому и фискальному анализу

Международные финансовые институты (МФИ) значительно различаются по широте и глубине своего мандата, а также по имеющимся ресурсам: от небольших учреждений, таких как Шведский фискальный совет, где работает всего несколько сотрудников и публикуется один ключевой доклад в год, до крупных учреждений, таких как Бюджетное управление Конгресса США, где около 250 сотрудников ежегодно публикуют большое количество докладов по широкому кругу политических вопросов, стоящих перед Конгрессом. Поэтому ОЭСР также попыталась классифицировать каждую деятельность по двум основным уровням, отражающим совместимость с текущими мандатами и интенсивность необходимых экспертных знаний и ресурсов. Существует несколько других потенциальных областей, не охваченных здесь, которые пересекаются с другими агентствами, занимающимися исследованиями или аудитом климата, и потребуют значительных изменений в мандатах, а также специальных ресурсов и нетипичных экспертных знаний.

Таблица 1 - Четыре области и связанные с ними мероприятия, в рамках которых международные финансовые институты могли бы поддержать «зеленый бюджет».

	Основные виды деятельности «зеленого» бюджетирования по уровням	Уровень 1	Уровень 2
1	Мониторинг соблюдения принципов «зеленого» бюджетирования		
1.1	Проверка соблюдения требований к отчетности и раскрытию информации в области «зеленых» технологий	+	
1.2	Проверка соответствия бюджетных планов достижению целевых показателей по климату, выбросам парниковых газов и экологическим показателям		+
1.3	Оценка «утечек» — «экспорта» углеродоемкого производства в другие страны для достижения внутренних целевых показателей по выбросам		+
1.4	Проверка соответствия финансовых результатов целевым показателям «зеленых» инвестиций	+	
2	Экономическое и фискальное прогнозирование и сценарный анализ с учетом климатических и экосистемных факторов для бюджетных планов		
2.1	Анализ и оценка обоснованности внутренней и глобальной политики и базовых показателей выбросов для бюджетного планирования	+	
2.2	Анализ макроэкономических и фискальных предположений планирования и оценка рисков, которые изменение климата и потери экосистем представляют для перспектив	+	
2.3	Предоставление альтернативных макроэкономических прогнозов, сценариев и других предположений планирования, учитывающих экологические факторы		+
2.4	Предоставление альтернативных фискальных прогнозов, сценариев и других предположений планирования, учитывающих экологические факторы		+
2.5	Предоставление долгосрочного анализа фискальной устойчивости с учетом изменения климата и экосистемных факторов		+
3	Расчет затрат и оценка программ с учетом экологических аспектов		
3.1	Проверка обоснованности и полноты правительственных смет затрат Оценка финансовых затрат на экологические инициативы	+	
3.2	Оценка экологических внешних эффектов во всех сметах затрат		+
3.3	Оценка прямых распределительных и социальных последствий экологических инициатив	+	
3.4	Оценка макроэкономического воздействия экологических инициатив		+
3.5	Проведение анализа затрат и выгод (чистая выгода и соотношение цены и качества) экологических инициатив, включая их экономическую эффективность		+
3.6	Моделирование и мониторинг программ ценообразования на углерод, таких как торговые схемы и налогообложение		+

	углеродных выбросов, и оценка воздействия экологической политики на энергетические рынки.		
4	Общие исследования по вопросам климата, экосистем и экономики замкнутого цикла (зеленой экономики)		
4.1	Подготовка аналитических записок по темам, связанным с экономическими и фискальными последствиями изменения климата и утраты экосистем	+	
4.2	Оценка влияния изменения климата на экономику		+
4.3	Оценка влияния изменения климата на государственные финансы		+
4.4	Оценка влияния экономической деятельности в частном и государственном секторах на изменение климата		+
	Источник: OECD (2022), OECD Journal on Budgeting, Volume 2022 Issue 3, OECD Publishing, Paris, https://doi.org/10.1787/dedebeca-en		

Международные финансовые институты (МФИ) значительно различаются по широте и глубине своего мандата, а также по имеющимся ресурсам: от небольших учреждений, таких как Шведский фискальный совет, где работает всего несколько сотрудников и публикуется один ключевой доклад в год, до крупных учреждений, таких как Бюджетное управление Конгресса США, где около 250 сотрудников ежегодно публикуют большое количество докладов по широкому кругу политических вопросов, стоящих перед Конгрессом. Поэтому ОЭСР также попыталась классифицировать каждую деятельность по двум основным уровням, отражающим совместимость с текущими мандатами и интенсивность необходимых экспертных знаний и ресурсов. Существует несколько других потенциальных областей, не охваченных здесь, которые пересекаются с другими агентствами, занимающимися исследованиями или аудитом климата, и потребуют значительных изменений в мандатах, а также специальных ресурсов и нетипичных экспертных знаний

Уровень 1. Анализ, который должны проводить международные финансовые институты в рамках комплексной финансовой проверки. Эта работа не потребует нового мандата, если иное прямо не запрещено действующим мандатом. Она может быть выполнена аналитиками широкого профиля и может потребовать ограниченного обобщения внешних исследований в области естественных и социальных наук. Она не потребует координации с другими независимыми организациями, но может извлечь пользу из их вклада, если таковой имеется.

Уровень 2. Анализ, который более крупные МФИ могли бы рассмотреть возможность внедрения в рамках своей гибкости в отношении самостоятельной работы или, если им будет предоставлен явный мандат на проведение экологического анализа, должны рассмотреть возможность его внедрения и привлечь для этого специализированный персонал. Эта работа потребует перепрофилирования внешних экологических исследований из физических и социальных наук для решения конкретной задачи (например, применение результатов метаанализа эластичности выбросов парниковых газов к ценам на энергоносители для новой программы ценообразования на углеродные выбросы или пересчет анализа климатических сценариев в соответствии с собственными прогнозами МФИ) либо путем найма специалистов в штат, либо с помощью внешних консультантов. Другие независимые организации могут проводить аналогичный анализ, и их следует уведомить о плане работы МФИ в качестве профессиональной вежливости, проконсультировать в ходе анализа, или же анализ должен проводиться в рамках совместного проекта.

В отчёте 2024 г. говорится, что среди стран-членов OECD значительная часть уже внедрила механизмы green budgeting: они учитывают экологические последствия расходов, выделяют климатические приоритеты в бюджетах, и — по возможности — создают прозрачность и подотчётность в расходах на «зелёные» цели³².

Таким образом, бюджетная система — не просто инструмент социально-экономической политики, но и механизм, через который государство может направлять средства на устойчивое развитие, экологические проекты, «зелёную» инфраструктуру и климатическое адаптивное строительство. Это показывает: при наличии политической воли и институционального дизайна, бюджет + межбюджетные отношения могут активно использоваться для финансирования зеленых целей.

Опыт Astana International Financial Centre (AIFC). В Казахстане, как отмечают исследователи, развивается так называемый «инвестиционно-бюджетный подход» к стимулированию green finance: государство через бюджетные средства, государственные гарантии, со-финансирование и — при участии частного сектора — пытается «катализировать» инвестиции в «зелёные» проекты³³.

AIFC, через свой «Green Finance Centre», призван содействовать развитию «зелёного» рынка — в том числе «зелёных облигаций», устойчивых инвестиций и механизмов смешанного финансирования³⁴.

В 2025 году Казахстан сообщил, что часть государственных бюджетных ресурсов переориентирована на «приоритетные области развития», включая региональную инфраструктуру, модернизацию энергетической и коммунальной инфраструктуры — что, при соответствующем «зелёном» фокусе, может являться основой для green investments через бюджетные и межбюджетные механизмы³⁵.

При этом, как указывают эксперты, одна из проблем — что в существующем бюджетном / правовом кодексе нет обязательного прописывания «зелёных» приоритетов: экологические/климатические инициативы могут финансироваться, но не системно и не всегда приоритетно³⁶. Этот пример показывает, что даже при наличии государственных институтов и заинтересованности, важно, чтобы бюджетный и законодательный каркас (Budget Code, правила финансового распределения) были адаптированы для устойчивых/зеленых инвестиций.

Почему без межбюджетных связей и системного green budgeting реализация green finance затруднена

1. Децентрализация без финансовых ресурсов, и как результат, бюджеты местных органов власти не могут реализовать «зелёные» проекты. В обычных межбюджетных системах (особенно в федеративных или децентрализованных государствах) региональные

³² OECD (2024), Green Budgeting in OECD Countries 2024, OECD Publishing, Paris, <https://doi.org/10.1787/9aea61f0-en>.

³³ Magzumova, L., Bulakbay, Z., & Auyezova, K. (2025). An investment-budget approach to stimulating green financing. ECONOMIC Series of the Bulletin of the L N Gumilyov ENU, (3), 242–258. <https://doi.org/10.32523/2789-4320-2025-3-242-258>

<https://bulecon.enu.kz/index.php/main/article/view/1149>

³⁴ https://en.wikipedia.org/wiki/Astana_International_Financial_Centre

³⁵ Budget 2026: Government reallocates 1.4 trillion tenge to priority development areas 22 October 2025, 13:30 <https://primeminister.kz/en/news/budget-2026-government-reallocates-14-trillion-tenge-to-priority-development-areas-30640>

³⁶ Kazakhstan: Strengthening Public Finance for Inclusive and Resilient Growth - Public Finance Review - Overview

Report/<https://documents1.worldbank.org/curated/en/099713202282422335/pdf/IDU15c61946a1a153142771b1ff1d0f0745dcae7.pdf>
<https://documents.worldbank.org/en/publication/documents-reports/documentdetail/099057102282440191/idu18abfcc0a1106d14eee1ace011ff55c80e795>

и местные бюджеты либо получают трансферты, либо сами формируют доходную базу. Если при этом «зелёные» полномочия (например, энергетика, экология, инфраструктурная модернизация, устойчивое развитие) передаются на региональный/местный уровень без соответствующей доли доходов или трансфертов — регионы часто остаются без ресурсов на их реализацию.

В контексте green finance это означает, что даже при центральной экологической стратегии, регионы могут быть неспособны реализовать проекты «зелёной» инфраструктуры без надлежащей финансовой базы.

2. Неустойчивость бюджетных приоритетов и отсутствие «зелёного» законодательного закрепления. Без системного green budgeting и постоянного выделения бюджетных средств на «зелёную» трансформацию, расходы на экологию/устойчивое развитие могут быть легко отодвинуты в пользу срочных социально-экономических задач. Как видно из исследований в Казахстане, хотя существуют попытки бюджетно-инвестиционного подхода, отсутствие обязательной нормы в Budget Code мешает эффективному планированию и мониторингу green finance. В отсутствие прозрачности и долгосрочной бюджетной стратегии, эффективность и устойчивость «зелёных» вложений серьёзно снижается.

3. Необходимость координации между уровнями бюджета — центральный, региональный, местный — особенно для инфраструктурных, экологических и климатических проектов. Многие «зелёные» проекты — в энергетике, водоснабжении, городской инфраструктуре, транспорте — имеют мультиуровневый характер: требуют участия и ответственности на федеральном, региональном и муниципальном уровнях. Без механизмов межбюджетных трансфертов и распределения полномочий, реализация таких проектов становится крайне сложной. Пример OECD показывает: страны, которые успешно внедряют green budgeting — как правило, имеют продуманные бюджетные системы, которые учитывают климатические приоритеты на всех уровнях.

Проблемы, ограничения и риски при интеграции green finance в межбюджетную систему:

- Бюджетный федерализм часто ориентирован на социальные услуги, здравоохранение, образование, административные расходы — «зелёные» цели могут рассматриваться как второстепенные, особенно при дефиците³⁷.

- Без чёткого правового закрепления приоритетов, «зелёные» проекты могут конкурировать с другими задачами за бюджетные ресурсы — и выигрывают не всегда.

- Проблемы координации: разные уровни власти, разные приоритеты, слабая институционализация зелёных инициатив → проекты могут «зависнуть», быть непродуманными, или финансироваться фрагментарно.

- Риск того, что «зелёные» инициативы станут «популизмом» — выделение средств без долгосрочной стратегии, контроля, устойчивой отчетности и мониторинга.

Почему важно развивать зелёную бюджетную архитектуру и межбюджетные механизмы. «Зелёное бюджетирование» позволяет сделать экологические и климатические приоритеты частью стандартного бюджетного процесса, а не «одноразовыми» инициативами. Это повышает устойчивость зелёных инвестиций и их интеграцию в экономическую политику.

Межбюджетные связи (трансферты, субвенции, совместное финансирование) дают возможность распределить бремя «зелёных» затрат: центральный бюджет - стратегическое планирование, крупные проекты; региональные/местные - реализация, управление, адаптация на местах.

³⁷ Расуханов Ю.Ш. (2019) Межбюджетные отношения и бюджетное регулирование в современной экономике // Экономика и социум, № 11(66), 2019 URL: <https://sciup.org/mezhbjudzhetye-otnosheniya-i-bjudzhethoe-regulirovanie-v-sovremennoj-jekonomike>

Такой подход может привлечь частные инвестиции: государственные гарантии, софинансирование, обеспеченная бюджетная база обеспечивают снижение рисков и делают «зелёные» проекты более привлекательными. Именно это подчёркивается в исследованиях, например, для Казахстана³⁸.

В условиях климатических вызовов, устойчивой урбанизации, модернизации инфраструктуры — бюджетные и межбюджетные механизмы остаются ключевым «опорным каркасом» для green finance, особенно в развивающихся и переходных экономиках.

Заключение.

Бюджетные отношения и межбюджетные связи - это не просто «технический» элемент финансового устройства государства, это фундаментальная часть, через которую «зелёные» финансы (green finance) могут стать устойчивыми, масштабными и системными.

Страны, которые намерены реализовать климатические и экологические цели, должны:

- интегрировать «зелёное бюджетирование» (green budgeting) в законодательство и бюджетный процесс;
- обеспечивать трансфертами и межбюджетными механизмами финансирование зелёных проектов на региональном и местном уровнях;
- координировать бюджетные, инвестиционные и регуляторные инструменты - так чтобы государственные, региональные и частные ресурсы работали совместно.

Примеры, такие как опыт стран OECD, а также попытки ввести инвестиционно-бюджетные подходы в Казахстане, показывают, что такой путь возможен - но требует институционального усилия, дисциплины, прозрачности и устойчивой стратегии.

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Почему частные рынки часто не обеспечивают эффективного уровня общественных благ в зелёных финансах (green finance)

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Аннотация

В статье рассматриваются причины, по которым частные рынки часто не способны обеспечить эффективный уровень общественных благ в сфере зелёных финансов. Анализ базируется на международных исследованиях и практиках, включая работы OECD (2016), CCICED (2015), Fedotova (2020), CPI (2015), а также исследования по поведенческим аспектам инвестиций в зелёные технологии (Knobloch & Mercure, 2016) и моделированию социальных и экономических переходов (Holtz et al., 2015). Особое внимание уделяется экономическим, институциональным и правовым факторам, ограничивающим эффективность рыночного механизма в предоставлении экологических и климатических общественных благ, а также инструментам государственного вмешательства, включая зелёное бюджетирование, зелёные инвестиционные банки и фискальные стимулы. В статье обобщается международный опыт и рассматриваются примеры развития рынка зелёного финансирования в Казахстане, что позволяет выявить ключевые барьеры и возможности для повышения эффективности финансирования общественных экологических благ. Полученные выводы имеют практическое значение для формирования стратегий государственной политики и механизмов стимулирования зелёных инвестиций, направленных на достижение устойчивого и климатически ориентированного развития.

Введение: природа общественных благ и зелёных инвестиций.

Общественные блага — это товары или услуги, которые характеризуются двумя ключевыми свойствами: неисключаемостью (нельзя эффективно запретить кому-либо их потребление) и неконкурентностью (потребление одним человеком не уменьшает доступность для другого)³⁹.

Инвестиции в экологические проекты, устойчивую инфраструктуру, снижение загрязнения, энергоэффективность — это, по сути, попытка создать общественные блага (чистый воздух, устойчивую экосистему, инфраструктуру, снижающую климатические риски), пользу от которых получают многие, включая тех, кто не участвовал в оплате. Это и есть область «зелёного» финансирования⁴⁰.

³⁹ <https://www.jove.com/business-education/v/17437/important-public-goods>

⁴⁰ Федорова Е. П. Роль государства в решении проблем развития «зеленого» финансирования // Финансовый журнал. 2020. Т. 12. № 4. С. 37–51. DOI: 10.31107/2075-1990-2020-4-37-51 //

Однако, в ряде случаев частный рынок - инвесторы, фонды, банки - не обеспечивает адекватного (социально оптимального) объёма таких инвестиций. Ниже - почему так происходит

Объектом анализа в данном исследовании выступают научные публикации и аналитические материалы, посвящённые вопросам предоставления общественных благ в сфере зелёных финансов и роли частных рынков в обеспечении эффективного уровня этих благ. Особое внимание уделяется работам, раскрывающим причины, по которым частные рынки часто не способны самостоятельно достигать оптимального объёма экологических и климатических общественных благ, а также исследованиям, анализирующим инструменты государственного вмешательства, включая зелёное бюджетирование, зелёные инвестиционные банки и фискальные стимулы. В рамках анализа используются источники, содержащие теоретические модели рыночных и государственных механизмов финансирования зелёной экономики, эмпирические оценки эффективности зелёных финансовых инструментов, а также международный опыт реализации климатических и финансовых реформ.

Методологическая база исследования включает методы систематизации, критического анализа научной литературы и сравнительного изучения международных практик предоставления общественных благ в сфере зелёных финансов. В работе используется анализ экономических, институциональных и правовых подходов, применяемых в различных странах для стимулирования зелёных инвестиций и обеспечения климатических и экологических общественных благ. Особое внимание уделяется исследованиям, объясняющим, почему частные рынки часто не обеспечивают эффективный уровень общественных благ в зелёных финансах, а также анализу инструментов государственного вмешательства, включая механизмы зелёного бюджетирования, зелёные инвестиционные банки и фискальные стимулы.

При отборе источников предпочтение отдавалось публикациям в рецензируемых международных научных журналах, индексируемых в базах данных Scopus, Web of Science и других авторитетных библиографических системах, а также аналитическим отчетам международных организаций (OECD, CCICED, CPI), содержащим актуальные данные и выводы о практике стимулирования зелёных инвестиций и обеспечении экологических общественных благ. Дополнительно учитывались исследования по поведенческим аспектам инвестиций в зелёные технологии (Knobloch & Mercure, 2016), моделированию социальных и экономических переходов (Holtz et al., 2015), а также национальные примеры развития рынка зелёного финансирования, включая опыт Казахстана (Forbes Казахстан, 2022; Balabin, 2022; Fedotova, 2020).

Основная часть.

Основные причины рыночного провала в зелёном финансировании

1. Проблема «free rider» и недостаток стимулов

Поскольку выгоды от экологических, климатических, инфраструктурных общественных благ (например, чистый воздух, устойчивое водоснабжение, климат-устойчивая инфраструктура) распространяются на всех, частные инвесторы не могут легко «эксклюзивно» захватить большую долю этих выгод. То есть если фирма инвестирует в экологическую инфраструктуру, часть выгод достанется всем — включая тех, кто не участвовал в инвестициях. Это делает «возврат на инвестиции» для частника менее привлекательным, особенно если инвестиции дорогие, долгосрочные и с неопределённой

отдачей. Этот классический рыночный провал описан в теории экономики общественного сектора

Как следствие -private markets склонны недоинвестировать в такие проекты, либо вовсе избегать их, если нет внешнего принуждения, субсидий или гарантий от государства или международных институтов.

2. Высокие риски и неопределённость доходности «зелёных» проектов

По данным OECD (в докладе «Green Investment Banks: Scaling up Private Investment in Low-carbon, Climate-resilient Infrastructure») существует целый ряд барьеров, препятствующих широкому привлечению частного капитала в низкоуглеродную и климат-устойчивую инфраструктуру (LCR-infrastructure):

- нерегулярность и непоследовательность климатической / энергетической политики;
- неблагоприятные регуляторные сигналы;
- недостаток подходящих финансовых инструментов, которые бы обеспечивали привлекательность для инвесторов (инвестиционный класс, ликвидность, приемлемый срок, прогнозируемые риски)⁴¹.

Без стабильных, надёжных правовых и рыночных условий инвесторы не готовы вкладывать средства в проекты с длительным горизонтом окупаемости и неопределённой доходностью — даже если они социально полезны.

Кроме того, отсутствие объективной, прозрачной информации о рисках, ожидаемых выгодах и экологическом эффекте таких проектов дополнительно отпугивает инвесторов⁴².

3. Поведенческие и институциональные барьеры

Даже если проект экономически целесообразен, фирмы могут не инвестировать - не из-за финансовых факторов, а из-за «поведенческих» причин: консерватизм, недооценка будущих выгод, предпочтение краткосрочной прибыли. Модели, учитывающие поведенческие аспекты, показывают, что даже при теоретически привлекательных возможностях доля фирм, внедряющих энергоэффективные технологии, может быть существенно ниже, чем оптимально — снижение с ~ 80% (в нормированном сценарии) до ~ 20% при более реалистичных поведенческих моделях⁴³. Кроме того, институциональные барьеры, такие как неустоявшиеся или недостаточно жёсткие «зелёные» стандарты, слабая правовая защита инвесторов или нестабильное регулирование, мешают долгосрочным вложениям.

4. Несоответствие масштабов инвестиций: частные деньги не «тянут» крупные общественные задачи.

Многие экологические и климатические вызовы требуют масштабных, дорогостоящих, долгосрочных инвестиций — например, модернизация энергетики, водной инфраструктуры, транспорта, градостроительные проекты. Частные инвесторы часто ориентированы на более «чистые», доходные, менее рискованные активы, а не на «тяжёлую» экологическую инфраструктуру.

⁴¹ OECD (2016), Green Investment Banks: Scaling up Private Investment in Low-carbon, Climate-resilient Infrastructure, Green Finance and Investment, OECD Publishing, Paris.
<http://dx.doi.org/10.1787/9789264245129-en> // https://www.oecd.org/content/dam/oecd/en/publications/reports/2016/05/green-investment-banks_g1g5c0bd/9789264245129-en.pdf

⁴² CCICED (2015), “Green financial reform and green transformation”, report to the Annual Conference of CCICED, 9-11 November, China Council for International Cooperation on Environment and Development, www.cciced.net/enciced/policyresearch/report/201511/P020151117574533056430.pdf.

⁴³ Adam B. Jaffe, Richard G. Newell, Robert N. Stavins A tale of two market failures: Technology and environmental policy <https://doi.org/10.1016/j.ecolecon.2004.12.027//https://www.sciencedirect.com/science/article/abs/pii/S0921800905000303?via%3Dihub>

В отчёте OECD подчёркивается, что для привлечения частного капитала в такие проекты часто требуется участие государства — в форме публично капитализированных «зелёных инвестиционных банков» (Green Investment Banks, GIBs), гарантий, субсидий, долгосрочной политики⁴⁴. Если государство не обеспечивает начальный капитал, нормативную базу, механизм риска (гарантии, страхование, регулирование) — рынок сам по себе часто оказывается неспособен обеспечить достаточный объём инвестиций и поддерживать устойчивую динамику.

Примеры на уровне стран — почему private markets при ограниченном вмешательстве государства не справляются. В Казахстане, как и во многих других странах с формирующимся рынком, потребности в «зелёных инвестициях» огромны. По оценке, для достижения углеродной нейтральности к 2060 году потребуются сотни миллиардов долларов. При этом, как отмечается в публикациях, частное участие в «зелёных» проектах остаётся крайне ограниченным: выпуск «зелёных» облигаций, зеленое кредитование — в значительной степени зависит от государственных или квазигосударственных структур, либо международных финансовых институтов, а не от чисто частных инвесторов⁴⁵.

Почему так? Во-первых — недостаток «длинных денег» (долгосрочных инвестиций), поскольку частные банки и компании часто не готовы вкладывать ресурсы на десятилетия, особенно с учётом рисков. В условиях нестабильной экономики, волатильности валют, слабости фондового рынка — это серьёзный барьер⁴⁶.

Во-вторых — институциональная база (нормативная, правовая, отчётность) зелёных инвестиций всё ещё слаба. Это снижает доверие частных инвесторов к «зеленым» облигациям и кредитам как к надёжным инструментам⁴⁷. Как следствие — без значительного государственного участия (гарантий, субсидий, нормативов) рынок «зелёных» инвестиций остаётся очень узким, и страна не получает «социально оптимального» объёма инвестиций для устойчивого развития.

Пример: страны, привлекающие частные инвестиции в «зелёную» инфраструктуру через государственные инициативы — роль государства. В отчёте OECD показан опыт создания «зелёных инвестиционных банков» (GIBs), публично капитализированных институтов, которые призваны «катализировать» частные инвестиции в низкоуглеродную и устойчивую инфраструктуру⁴⁸.

⁴⁴ OECD (2016), Green Investment Banks: Scaling up Private Investment in Low-carbon, Climate-resilient Infrastructure, Green Finance and Investment, OECD Publishing, Paris.

<http://dx.doi.org/10.1787/9789264245129-en>
https://www.oecd.org/content/dam/oecd/en/publications/reports/2016/05/green-investment-banks_g1g5c0bd/9789264245129-en.pdf

⁴⁵ Как в Казахстане развивается рынок «зеленого» финансирования 30 октября 2022, 17:20 // https://forbes.kz/articles/kak_v_kazahstane_razvivaetsya_ryinok_zelenogo_finansirovaniya

⁴⁶ Батищева, Татьяна Финансовая ирригация: почему в РК не работают источники кредитования экономики 2 ноября 2023, 09:01// https://forbes.kz/articles/finansovaya_irrigatsiya_1698894079

⁴⁷ Georg Holtz , Floortje Alkemade, Fjalar de Haan, Jonathan Köhler, Evelina Trutnevite , Tobias Luthe, Johannes Halbe, George Papachristos, Emile Chappin, Jan Kwakkel, Sampsa Ruutu Prospects of modelling societal transitions: Position paper of an emerging community / Environmental Innovation and Societal Transitions

Volume 17, December 2015, Pages 41-58 <https://doi.org/10.1016/j.eist.2015.05.006>
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⁴⁸ OECD (2016), Green Investment Banks: Scaling up Private Investment in Low-carbon, Climate-resilient Infrastructure, Green Finance and Investment, OECD Publishing, Paris.
<http://dx.doi.org/10.1787/9789264245129-en>
https://www.oecd.org/content/dam/oecd/en/publications/reports/2016/05/green-investment-banks_g1g5c0bd/9789264245129-en.pdf

Такие институты могут снижать риски, обеспечивать начальное финансирование, предлагать стандартные, ликвидные финансовые инструменты — что делает «зелёные» проекты более привлекательными для частных инвесторов. Однако без такого «пульса» со стороны государства даже GIBs — редкость, особенно в странах с менее развитым финансовым рынком.

Почему рынок сам по себе — недостаточен для «общественных» экологических задач.

Частные инвесторы ориентированы на прибыль, возврат на капитал, ликвидность, управляемые риски. Социальные и экологические выгоды (чистый воздух, устойчивые экосистемы, климатическая устойчивость) не всегда можно конвертировать в доход — или доход слишком не определён. Поэтому такие проекты часто остаются недофинансированными.

Поведенческие факторы: даже привлекательные с точки зрения эффективности и окупаемости проекты могут не реализоваться из-за консерватизма, недооценки будущих выгод, предпочтения короткого горизонта. Как показывает эмпирическая модель, при реальном поведении фирм масштаб усвоения энергоэффективных технологий может быть существенно ниже теоретического⁴⁹.

Недостаток институциональных механизмов: без ясных, устойчивых стандартов, прозрачной отчетности, государственного регулирования и поддержки «зелёные» финансы часто воспринимаются как рискованная и репутационно-ориентированная, а не экономически стойкая инвестиция⁵⁰.

Масштаб проблемы: климатическая и экологическая инфраструктура часто требует значительных ресурсов, долгосрочного планирования и коллективных действий. Рынок, ориентированный на частную выгоду, плохо справляется с такими задачами.

Значение государственного участия и общественно-коалиционных решений

Исследования показывают, что для эффективного предоставления общественных благ - в том числе экологических — необходимы механизмы координации, коллективного финансирования и управления, а не только «спонтанные» частные инвестиции⁵¹.

Публичные «зелёные» банки, государственные гарантии, регулирование, кластерное финансирование, долгосрочные нормативы — всё это помогает устранить барьеры, которые мешают рынку самостоятельно обеспечить достаточный объём инвестиций⁵².

Кроме того, необходима институциональная основа: единая «зелёная» таксономия, прозрачная отчётность, стандарты ESG, системы мониторинга и оценки экологических проектов — иначе «зелёные» инвестиции остаются нишевыми, фрагментарными, недостаточными для системных изменений⁵³.

Заключение.

49 Florian Knoblocha, Jean-Francois Mercure The behavioural aspect of green technology investments: a general positive model in the context of heterogeneous agents /Environmental Innovation and Societal Transitions Volume 21, December 2016, Pages 39-55 <https://doi.org/10.1016/j.eist.2016.03.002> <https://www.sciencedirect.com/science/article/pii/S2210422416300247>

50 CPI (2015), “Getting the most from your green: An approach to using public money effectively through green banks and other low-carbon financing”, Climate Policy Initiative, <http://climatepolicyinitiative.org/wp-content/uploads/2015/12/Getting-the-Most-from-Your-Green-An-Approach-to-Using-Public-Money-Effectively-Through-Green-Banks-and-Other-Low-Carbon-Financing.pdf>

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⁵³ Балабин А. Зеленые финансы – проблемы классификации. ECO [Интернет]. 28 сентябрь 2022 г.;52(10):8-26.// <https://ecotrends.ru/index.php/eco/article/view/4515> // e

Частные рынки - инвесторы, банки, фонды - сами по себе редко обеспечивают социально оптимальный уровень финансирования зелёной инфраструктуры и экологических общественных благ. Структурные особенности: свободное распространение выгод (free-rider), неопределённость доходности, поведенческие и институциональные барьеры, высокая капиталовложение и долгий срок окупаемости — делают «зелёные» проекты непривлекательными для рыночного капитала.

Для преодоления этих ограничений необходима активная роль государства (и/или международных организаций): создание публичных «зелёных» банков, предоставление гарантий, формирование нормативной базы, стимулирование и координация инвестиций, построение институциональной среды. Без этого частные рынки не обеспечат достаточного уровня экологических общественных благ.

На примере стран с формирующимся рынком (таких как Казахстан) видно: несмотря на амбициозные цели, частный капитал по-прежнему недостаточно вовлечён — выпуск «зелёных» облигаций и кредитование остаются под значительным влиянием государства и международных институтов⁵⁴.

Эта ситуация иллюстрирует классический рыночный провал: без институционального, координированного вмешательства «рынок» не способен обеспечить общественное благо (в данном случае - экологическую устойчивость) на необходимом уровне.

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7 Florian Knobloch and Jean-Francois Mercure. 2016. "The Behavioural Aspect of Green Technology Investments: A General Positive Model in the Context of Heterogeneous Agents." *Environmental Innovation and Societal Transitions* 21: 39–55. <https://doi.org/10.1016/j.eist.2016.03.002>.

⁵⁴ Как в Казахстане развивается рынок «зеленого» финансирования 30 октября 2022, 17:20 // https://forbes.kz/articles/kak_v_kazahstane_razvivaetsya_rynok_zelenogo_finansirovaniya?utm_source

Georg Holtz, Floortje Alkemade, Fjalar de Haan, Jonathan Köhler, Evelina Trutnevyte, Tobias Luthe, Johannes Halbe, George Papachristos, Emile Chappin, Jan Kwakkel, and Sampsa Ruutu. 2015. "Prospects of Modelling Societal Transitions: Position Paper of an Emerging Community." *Environmental Innovation and Societal Transitions* 17: 41–58. <https://doi.org/10.1016/j.eist.2015.05.006>.

8 Jove. n.d. "Important Public Goods." *Journal of Visualized Experiments*. <https://www.jove.com/business-education/v/17437/important-public-goods>.

9 OECD. 2016. *Green Investment Banks: Scaling up Private Investment in Low-Carbon, Climate-Resilient Infrastructure*. Green Finance and Investment, OECD Publishing, Paris. <http://dx.doi.org/10.1787/9789264245129-en>. https://www.oecd.org/content/dam/oecd/en/publications/reports/2016/05/green-investment-banks_g1g5c0bd/9789264245129-en.pdf.

10 Forbes Казахстан. 2022. "Как в Казахстане развивается рынок «зелёного» финансирования." 30 октября 2022. https://forbes.kz/articles/kak_v_kazahstane_razvivaetsya_rynok_zelenogo_finansirovaniya.

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Организационные основы государственного аудита Республики Казахстан

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Аннотация

В статье рассматриваются организационные основы государственного аудита операционного продвижения экономики и финансовых активов на примере Республики Казахстан. Исследование направлено на анализ институциональной структуры и функциональных механизмов государственного аудита, обеспечивающих эффективность использования государственных финансовых ресурсов и активов в условиях реализации социально-экономической политики государства. Особое внимание уделяется роли государственного аудита в оценке результативности и целесообразности бюджетных расходов, управлении государственными финансовыми активами, а также обеспечении прозрачности и подотчётности в системе публичных финансов. В работе анализируются современные подходы к организации операционного аудита, практика внедрения результат-ориентированных методов контроля и международный опыт, адаптируемый к условиям Казахстана. На основе анализа национальной нормативно-правовой базы и отчетных материалов государственных органов выявлены ключевые проблемы и ограничения функционирования системы государственного аудита, а также предложены направления её совершенствования в целях повышения эффективности операционного продвижения экономики и устойчивого развития финансовых активов страны.

Введение

Эффективное функционирование системы государственного управления в современных условиях невозможно без развитых институтов контроля и подотчётности, ключевое место среди которых занимает государственный аудит. В условиях усложнения социально-экономических процессов, роста объёмов бюджетных расходов и повышения требований общества к прозрачности деятельности органов власти возрастает значимость организационных основ государственного аудита как инструмента обеспечения эффективности использования государственных ресурсов и доверия к публичным институтам.

Международные исследования в области государственной службы и публичного администрирования подчёркивают, что устойчивость и результативность государственных институтов во многом определяются качеством их организационного устройства и

институциональной среды. Так, Л. Адамолекун (Adamolekun, 2007)⁵⁵, анализируя процессы реформирования государственной службы в развивающихся странах, отмечает, что укрепление контрольных и надзорных функций является важным элементом реабилитации государственных институтов и повышения их управленческого потенциала. В данном контексте государственный аудит выступает не только как механизм финансового контроля, но и как элемент системы стратегического управления и институционального развития.

Современные подходы к публичному управлению также указывают на необходимость пересмотра традиционного разграничения между политическими и административными функциями. В работах Alford, Hartley, Yates и Hughes (2016)⁵⁶ обосновывается концепция так называемой «пурпурной зоны», в рамках которой государственные служащие и контрольные органы действуют на стыке политики и администрирования, принимая участие в формировании управленческих решений и оценке их результативности. Это положение имеет принципиальное значение для понимания роли и организационного статуса государственного аудита, который в современных системах управления всё чаще ориентируется не только на проверку соблюдения правил, но и на оценку эффективности и результативности государственной политики.

В Республике Казахстан развитие системы государственного аудита осуществляется в контексте реформ государственной службы и модернизации публичного управления. Национальный доклад о состоянии государственной службы в Республике Казахстан (Агентство Республики Казахстан по делам государственной службы, 2019)⁵⁷ подчёркивает приоритеты повышения профессионализма, институциональной устойчивости и подотчётности государственных органов. В этих условиях особую актуальность приобретает анализ организационных основ государственного аудита, включая его институциональное положение, функции, взаимодействие с органами государственной власти и роль в системе управления государственными финансами.

Таким образом, исследование организационных основ государственного аудита Республики Казахстан представляет собой актуальную научную и практическую задачу, направленную на выявление ключевых факторов эффективности данного института и определение направлений его дальнейшего развития с учётом международного опыта и национальных особенностей системы государственного управления.

Объектом анализа в данном исследовании выступают научные публикации, аналитические материалы и официальные документы, посвящённые вопросам организации и функционирования системы государственного аудита, а также её роли в обеспечении эффективности, прозрачности и подотчётности государственного управления.

Методологическая база исследования включает методы систематизации и критического анализа научной литературы, а также сравнительного изучения международных практик организации государственного аудита и финансового контроля. В работе используется анализ институциональных, экономических и правовых подходов, применяемых в различных странах для обеспечения эффективности, прозрачности и подотчётности системы государственного аудита. Особое внимание уделяется исследованиям, раскрывающим организационные модели и функциональные механизмы государственного аудита, а также анализу инструментов операционного и результат-

⁵⁵ Adamolekun, L. (2007). Africa: Rehabilitating civil service institutions—main issues and implementation progress. In J. C. N. Raadschelders, T. A. J. Toonen, & F. M. van der Meer (Ed.), *The civil service in the 21st century* (pp. 82–96). New York: Palgrave Macmillan

⁵⁶ Alford J, Hartley J, Yates S and Hughes O (2016) Into the purple zone: Deconstructing the politics/administration dichotomy. *American Review of Public Administration*. 1-16

⁵⁷ Agentstvo Respubliki Kazahstan po delam gosudarstvennoj sluzhby (2019) Nacional'nyj doklad o sostoyanii gosudarstvennoj sluzhby v Respubliki Kazahstan. Available at: <https://www.gov.kz/uploads/2019/12/23/>

ориентированного аудита, применяемых в практике Республики Казахстан. Это позволяет выявить ключевые особенности национальной системы государственного аудита и определить направления её дальнейшего совершенствования с учётом международного опыта.

При отборе источников предпочтение отдавалось публикациям в рецензируемых международных научных журналах, индексируемых в базах данных Scopus, Web of Science и других авторитетных библиографических системах, а также аналитическим отчетам и официальным документам международных организаций и национальных государственных органов, содержащим актуальные данные и аналитические выводы по вопросам организации государственного аудита, публичного финансового контроля и реформирования системы государственной службы. Дополнительно учитывались исследования, посвящённые институциональному развитию органов государственного аудита, взаимодействию аудиторских органов с органами исполнительной власти, а также анализу национального опыта Республики Казахстан в сфере государственного аудита

Основная часть.

В работах Энтони Верхейена, признанного исследователя в области государственной службы, подчёркивается, что процессы реформирования государственной службы в различных странах осуществляются в неодинаковых институциональных и социально-экономических условиях и сопровождаются специфическими рисками и вызовами. Автор акцентирует внимание на необходимости разработки и внедрения новых моделей государственной службы, основанных на сохранении и адаптации фундаментальных ценностей и принципов классической государственной службы, широко распространённых в международной практике (Verheijen, 2008)⁵⁸.

В соответствии с выводами исследования «Модернизация государственной службы в странах АСЕАН» (2021)⁵⁹, государства – члены АСЕАН осуществляют комплексные институциональные и управленческие преобразования, направленные на модернизацию национальных систем государственной службы. В целях укрепления кадрового потенциала и формирования компетенций, соответствующих перспективным требованиям социально-экономического развития, во Вьетнаме была институционализована программа повышения квалификации государственных служащих, ориентированная на развитие навыков, востребованных в условиях будущих трансформаций.

В Таиланде реализуются меры, направленные на формирование инклюзивной и ориентированной на трансформационное лидерство модели государственной службы, включая внедрение политики обеспечения разнообразия при комплектовании кадрового состава, с особым акцентом на вовлечение лиц с ограниченными возможностями и представителей старших возрастных групп. Бруней-Даруссалам осуществляет поэтапную реализацию долгосрочной стратегии цифрового правительства, направленной на повышение результативности и эффективности предоставления государственных услуг, оптимизацию административных процессов и совершенствование механизмов разработки государственной политики.

Правительством Филиппин был принят Закон о сокращении административных барьеров (Anti-Red Tape Act)⁶⁰, предусматривающий упрощение регуляторных процедур и

⁵⁸ Verheijen, Tony J. G. (2008) Independent Civil Service Systems: A Contested Value||: 249-265. In: Florian Grotz and Th. A. J. Toonen, eds. Crossing Borders: Constitutional Development and Internationalisation. Essays in Honour of Joachim Jens Hesse. Berlin, New York: de Gruyter Recht, 2008

⁵⁹ ASEAN (2021). Civil Service Modernisation in ASEAN.

<https://theaseanmagazine.asean.org/article/designing-the-future-ofasean-towards-a-modern-agile-and-citizen-centric-civil-service/>

⁶⁰ <https://www.philhealth.gov.ph/arta/AntiRedTapeAct.pdf>

сокращение сроков предоставления базовых государственных услуг. В сфере расширения участия граждан в процессах государственного управления Малайзия внедрила модель цифрового правительства, в рамках которой более 80 процентов государственных услуг предоставляется в электронном формате, при этом особое внимание уделяется обеспечению равного доступа к государственным услугам для граждан с низким уровнем цифровой компетентности

Система государственной службы Бангладеш демонстрирует активное внедрение концепции цифрового правительства и процессов цифровизации государственных услуг, которые рассматриваются как институциональный механизм, обеспечивающий взаимодействие между государством и населением (Momen & Ferdous, 2023)⁶¹. Вместе с тем результаты современных исследований, посвящённых функционированию системы государственной службы Республики Казахстан, свидетельствуют о том, что использование общеизвестных цифровых платформ не в полной мере обеспечивает эффективное взаимодействие органов государственной власти с гражданами. В целях усиления механизмов обратной связи с получателями государственных услуг обосновывается необходимость формирования дополнительных каналов коммуникации. Кроме того, несмотря на предпринимаемые в стране меры по цифровой трансформации, эмпирические данные указывают на сохранение высокой востребованности традиционных, преимущественно офлайн, форм взаимодействия среди всего спектра коммуникационных каналов (Bokayev et al., 2022⁶²; Bokayev et al., 2023⁶³).

В текущий момент Бюджетный кодекс РК⁶⁴ содержит положения, регулирующие государственный финансовый надзор. Государственный финансовый контроль в Казахстане – это контролируемые действия национальных и местных органов власти с целью мониторинга создания, распределения, целенаправленного и эффективного использования финансовых ресурсов, а также государственных и местных активов.

Основной целью является выявление и предупреждение финансовых нарушений на объектах контроля за экономической стабильностью в стране.

Приводя ряд веских аргументов, Нигметов К.К. подчеркивает важность создания прочной нормативно-правовой базы государственного финансового мониторинга⁶⁵.

Как результат, необходимо отметить, что согласно предлагаемому определению, национальное финансовое управление – это деятельность уполномоченных национальных органов и органов местного самоуправления, осуществляющих контроль за соблюдением бюджетного законодательства и других нормативных правовых актов, регулирующих взаимоотношения между бюджетными законами.

Что касается специфических особенностей, существуют следующие типы внешнего государственного контроля за исполнением бюджета всех уровней⁶⁶:

⁶¹ Momen, N., Ferdous, J. (2023). Governance in Bangladesh Innovations in Delivery of Public Service New Frontiers in Regional Science: Asian Perspectives 68. Springer

⁶² Bokayev, B., Zhanzhigitova, Z., and Sadykova, K. 2022. "Effective Communication Strategies to Mitigate Citizen Complaints: Case from Kazakhstan." The Innovation Journal 27 (3): 5

⁶³ Bokayev, B., Zhanzhigitova, Z., Sadykova, K., & Balmanova, A. (2023). Multichannel communication in Kazakhstani public service: examining the role of digital tools. Public Policy and Administration. 22 (4)

⁶⁴ Бюджетный кодекс Республики Казахстан Кодекс Республики Казахстан от 15 марта 2025 года № 171-VIII. <https://adilet.zan.kz/rus/docs/K2500000171>

⁶⁵ Нигметов К.К. Оценка стратегий и программ в системе государственного планирования Республики Казахстан // Вопросы управления. 2014. №3 (9) С.95- 102

⁶⁶ Об утверждении Правил проведения внешнего контроля за исполнением республиканского бюджета Постановление Счетного комитета по контролю за исполнением республиканского бюджета от 8 сентября 2006 года N 57. Зарегистрировано в Министерстве юстиции Республики Казахстан 7 октября 2006 года N 4415. Утратило силу постановлением Счетного комитета по

1) на соответствие - оценка соответствия деятельности объекта государственного финансового контроля (далее - объект контроля) требованиям законодательства Республики Казахстан;

2) финансовой отчетности - оценка достоверности, обоснованности и своевременности составления и представления финансовой отчетности объектом контроля;

3) эффективности - проверка срока исполнения мероприятий и степени достижения ожидаемых результатов, индикаторов после завершения реализации бюджетной программы, использования грантов, гарантированных государством займов, активов государства с применением оценок экономичности и продуктивности. Контроль эффективности проводится по завершении реализации соответствующих мероприятий, после которых наступает срок получения результатов от вложенных средств;

4) контроль результативности - проверка достижения ожидаемых результатов, установленных паспортом бюджетной программы;

5) контроль целесообразности - проверка достижения цели и индикаторов, установленных паспортом бюджетной программы;

6) контроль обоснованности (правомерности) - проверка использования бюджетных средств на реализацию мероприятий, предусмотренных паспортом бюджетной программы, грантов, гарантированных государством займов, активов государства. [16].

Международная организация высших органов финансового контроля (INTOSAI) объединяет высший орган финансового надзора государств-членов Организации Объединенных Наций и является ведущей международной организацией в области государственного аудита. Высший комитет по аудиту Республики Казахстан стал членом INTOSAI в 2000 году, и на сегодняшний день его членами являются более 180 государств.

1 уровень Founding Principles	Основные принципы: Лимская декларация	
2 уровень Prerequisites for the Functioning of SAIs	Общие стандарты: Мексиканская декларация, Этический кодекс аудиторов	
3 уровень Fundamental Auditing Principles	Стандарты исследовательской работы: ISSAI 100 ISSAI 200 ISSAI 300 ISSAI 400	
4 уровень Auditing Guidelines	Стандарты отчетности	

Рисунок 1 - Инфографика уровней стандартов INTOSAI

Примечание: рисунок составлен автором по материалам⁶⁷ Алибекова Б.А, Бейсенова Л.З. Государственный аудит: теория, методология и практика. – Нур-Султан: ЕНУ им. Л.Н. Гумилева, 2019. – 185с

контролю за исполнением республиканского бюджета от 27 марта 2009 года N 4

<https://adilet.zan.kz/rus/docs/V060004415>

⁶⁷ Алибекова Б.А, Бейсенова Л.З. Государственный аудит: теория, методология и практика. – Нур-Султан: ЕНУ им. Л.Н. Гумилева, 2019. – 185с

Стандарт аудита INTOSAI состоит из четырех частей (рис. 1):

1. Основная философия (основополагающий дух);
2. Общие стандарты (предварительные условия для функционирования Sai);
3. Стандарты исследовательской деятельности (основные принципы аудита);
4. Стандарты отчетности (стандарты аудита).

"Мексиканская декларация", "Кодекс этики аудиторов" и установленные стандарты независимости, добросовестности и открыто стинациональных аудиторских учреждений являются методологическими текстами и международными оглашениями, которые составляют второй уровень⁶⁸.

На третьем уровне излагаются основные методологические рекомендации по созданию системы государственного аудита, которые имеют непосредственное отношение к нашему исследованию. Для этого уровня существует 4 стандарта:

ISSAI 100- Основные принципы административного аудита;

ISSAI 200- Стандарт, имеющий общее и этическое значение для государственных аудитов.;

ISSAI 300-Стандарт административного аудита на месте;

ISSAI 400- Стандарт государственной аудиторской отчетности.

Наиболее важным из этих стандартов является "ISSAI 100", который является "основным принципом государственно государственного аудита". Стандарт определяет национальные аудиты как аудиты, которые включают определенные виды государственного аудита⁶⁹ (рис.1).

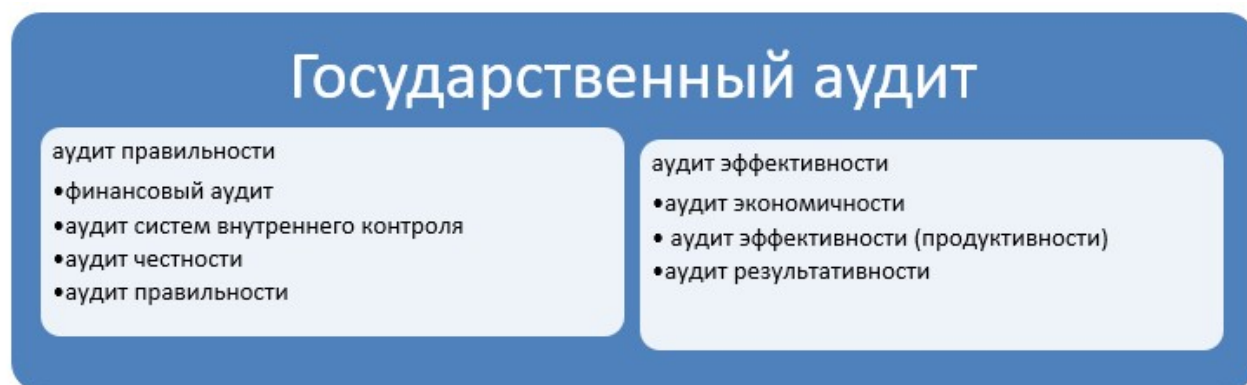


Рисунок 2 - Классификация государственного аудита по стандартам INTOSAI

Примечание: рисунок составлен автором по материалам Алибекова Б.А, Бейсенова Л.З. Государственный аудит: теория, методология и практика. – Нур-Султан: ЕНУ им. Л.Н. Гумилева, 2019. – 185с

В соответствии с указом Президента Республики Казахстан от 2022-11-26 №5 «Об отдельных вопросах деятельности Высшей счетной палаты Республики Казахстан»⁷⁰ основными принципами Лимской декларации Всемирной высшей аудиторской

⁶⁸ Абдибеков Н.К. Теория государственного аудита: теория и практика /Джанбурчин К.Е. - Астана: PrimaLux, 2018. – 223 с

⁶⁹ Коваленко С.Н. Аудит эффективности: современные проблемы и пути их решения / С.Н. Коваленко, Е.А. Трунова // Научные новости. Сер. Экономика. Информатика. — 2017. — № 2. — С. 68–74

⁷⁰ О некоторых вопросах Высшей аудиторской палаты Республики Казахстан Указ Президента Республики Казахстан от 26 ноября 2022 года № 5 <https://adilet.zan.kz/rus/docs/U2200000005>

организации, высшая счетная палата и другими организациями в целях развития взаимоотношений с ними⁷¹.

В деятельности Высшей Аудиторской Палаты Республики Казахстан широко используются признанные на международном уровне методы, созданные вышеуказанными организациями. Эти подходы поддерживают разработку протоколов планирования работы, стандартов аудита и методов контроля, а также аудита эффективности.

При подготовке настоящего стандарта были использованы положения стандарта аудита Intocai, стандарты аудита эффективности, принятые в рамках Intocai и Azocai, опыт высших зарубежных институтов финансового менеджмента и Высшего контрольного управления в проведении аудита эффективности, а также Институт системного анализа Высшего контрольного управления Украины. были использованы данные Республики Казахстан⁷².

Рекомендуется усовершенствовать процесс подготовки и реализации бюджетных решений, чтобы интегрировать целевую стратегию плана и распределение ресурсов, сохраняя при этом строгий мониторинг и контроль за выполнением плана.

В соответствии с действующей нормативной базой, контролирующей государственное стратегическое управление, законодательные органы и Высшая Аудиторская Палата Республики Казахстан в настоящее время несут ответственность за большую часть внешнего контроля, который носит финансовый характер.

Министерский указ «Об утверждении методов прогнозирования основных показателей национального и регионального социально-экономического развития на пять лет», изданный министром национальной экономики Республики Казахстан 1-22-2021 №10⁷³, знаменует собой начало установления надзора за управлением проектами национального социально-экономического развития. Стоит отметить, что в министерском постановлении №10 12-22-2021 нет требования о надзоре за процедурами реализации вышеупомянутых документов. Таким образом, к внешнему национальному (местности) финансовому управлению относятся следующие организации (рис. 3).

⁷¹ Лимская декларация руководящих принципов контроля INTOSAI 1977 г. // Ж-л Контроллинг – 1991. – № 1. – С. 56-65

⁷² Карыбаев А.К. Мемлекеттік аудит: Оқулық/Жаңбыршин К.Е. редакциясымен – Астана: Л.Н.Гумилев атындағы ЕҰУ, 2018 – 360 б

⁷³ Об утверждении Методики прогнозирования основных показателей социально-экономического развития страны и регионов на пятилетний период Приказ Министра национальной экономики Республики Казахстан от 22 января 2021 года № 10. Зарегистрирован в Министерстве юстиции Республики Казахстан 27 января 2021 года № 22123 <https://adilet.zan.kz/rus/docs/V2100022123>

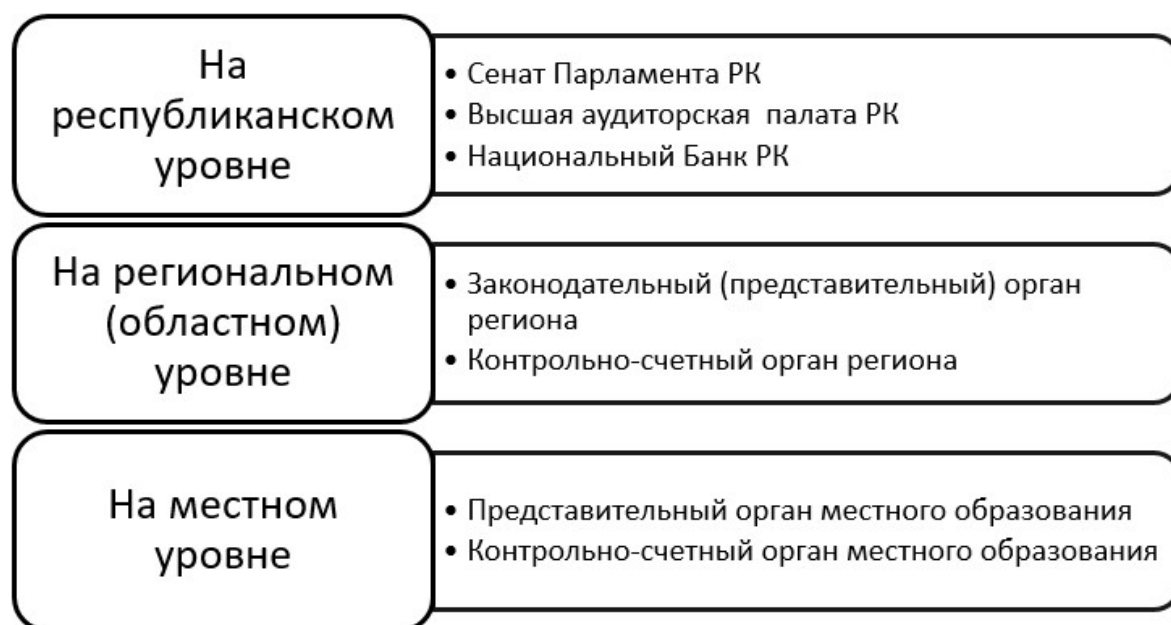


Рисунок 3 – Инфографика основных органов государственного финансового контроля Казахстана

Примечание: рисунок составлен автором по материалам Алибекова Б.А, Бейсенова Л.З. Государственный аудит: теория, методология и практика. – Нур-Султан: ЕНУ им. Л.Н. Гумилева, 2019. – 185с

Законодательные (представительные) органы осуществляют следующие формы финансового управления:

«Предварительный контроль – при обсуждении и утверждении законопроектов (решений) по бюджету и других законопроектов (решений) по бюджетным и финансовым вопросам;

Постоянный мониторинг- во время парламентских слушаний и периодов, связанных с депутатскими запросами, во время заседаний комитетов, комиссий и рабочих групп законодательных (представительных) органов для рассмотрения отдельных вопросов исполнения бюджета;

Последующее управление-рассмотрение и утверждение отчетов об исполнении бюджета⁷⁴.

Исчисление в Республике Казахстан, определено прав законодательных (представительных) органов, а также определение прав аттестационных и вторичных.

-независимый надзорный орган (создание высшего надзорного бюро, административного бюро и других законодательных (представительных) органов власти)

-оценки результативности деятельности агентства-исполнителя

Мажилис Парламента РК учредил Высшую Аудиторскую Палату Республики Казахстан, в обязанности которой входит контроль за исполнением бюджета. Ее функционирование регулируется Указом Президента № 5 «О некоторых вопросах Высшей Аудиторской Палаты Республики Казахстан» от 26-10-2022 года⁷⁵.

⁷⁴ Кучукова Н.К. «Анализ проблемных аспектов в процессе формирования системы государственного аудита на современном этапе» // Журнал «Мемлекеттік аудит - Государственный аудит» №2, 2019 г. С.32

⁷⁵ О некоторых вопросах Высшей аудиторской палаты Республики Казахстан Указ Президента Республики Казахстан от 26 ноября 2022 года № 5 <https://adilet.zan.kz/rus/docs/U2200000005>

Надзорным органом Высшего надзорного бюро является государственное агентство по сертификации и агентства, назначенные иностранными фондами, местные органы власти, организации, обладающие всеми правами в форме сертификации предприятий, сертификации банков и других финансовых учреждений, сертификации кредитных учреждений, объединения компаний, групповой сертификации и других группы и т.д.:

- Получение, перевод, проверка и использование средств;
- Используйте экран управления.

Необходимая информация предоставляется организациям, государственным учреждениям, местным органам власти, Национальному банку Республики Казахстан, предприятиям, учреждениям, организациям всех форм собственности, а также органам Высшего надзорного органа Республики Казахстан. Это необходимо для предоставления льгот.

Мажилис Парламента Республики Казахстан вправе поручить Высшей Аудиторской палате проверку финансово-хозяйственной деятельности Национального Банка Республики Казахстан, а также его дочерних и зависимых организаций. Такое решение должно быть принято соответствии с рекомендациями совета Национального Банка Казахстана.

Основной целью создания Главного контрольно-ревизионного управления является контроль за исполнением бюджета. Согласно Бюджетного Кодекса Республики Казахстан, Высший контрольный орган участвует в бюджетном процессе, который состоит из следующих этапов⁷⁶:

- прогнозирования бюджета;
- планирования бюджета;
- рассмотрения бюджета;
- утверждения бюджета;
- исполнения бюджета;
- уточнения и корректировки бюджета;
- ведения бухгалтерского учета и финансовой отчетности, бюджетного учета и бюджетной отчетности;
- мониторинга и оценки результатов бюджетного процесса.

Главное аудиторское управление или Агентство управленческого учета (КСО) не участвуют в планировании бюджета.

Главное контрольно-ревизионное управление обязано высказать свое мнение по бюджетному предложению Республиканской партии и на этапе рассмотрения и утверждения бюджетного предложения (предварительное управление). Этот вывод должен дать оценку законности доходной и расходной частей бюджета, размеру внешнего и внутреннего долга страны, а также дефициту республиканского бюджета.

Главное контрольно-ревизионное управление осуществляет мониторинг исполнения бюджета в режиме реального времени на текущем этапе контроля бюджетного процесса. Переводы средств из республиканского бюджета и внебюджетных средств в адрес НБ РК, указанных банков и других финансовых организаций на территории Казахстана гарантированно законны и своевременны.

Главное контрольно-ревизионное управление имеет право проводить обширные и целенаправленные проверки для обеспечения качества финансовой отчетности и бухгалтерского учета, а также своевременности и полноты расчетов между бюджетом аудита и проверяемой компанией. При проведении ревизий и проверок проверяемых

⁷⁶ https://online.zakon.kz/Document/?doc_id=35064954&pos=64;-50#pos=64;-50 Пункт 9 статьи 3 Бюджетного Кодекса РК

предприятий, таких как предприятия, учреждения, организации, банки и другие финансовые учреждения, он имеет право запросить все соответствующие записи и информацию. Высшая Аудиторская палата может давать рекомендации и указания при обнаружении нарушений.

Президент Республики Казахстан, Сенат Парламента Республики Казахстан и Мажилис Парламента Республики Казахстан, представители Парламента Республики Казахстан, комитеты и комиссии, государственные учреждения Республики Казахстан и другие государственные учреждения и должностные лица-все это государственные учреждения и должностные лица Республики Казахстан. Высшее контрольное управление, которое обязаны проводить проверки, готовить и представлять заключения, а также отвечать на запрос.

Национальный Банк РК работает в тандеме с правительством по реализации единой государственной денежно-кредитной политики и является основным эмиссионным и денежно-кредитным органом страны. Национальный банк подотчетен Парламенту и функционирует автономно в пределах своей компетенции, имея полномочия регулировать коммерческие банки и выпускать банкноты. Он действует с некоммерческой целью и предоставляет Парламенту ежегодный отчет.

Ведение бюджетных счетов на всех уровнях национальной бюджетной системы является важнейшей функцией Национального банка в бюджетном процессе. Он также служит регулирующим и надзорным органом банковской отрасли, поддерживая стабильность банковских систем и денежных отношений. Эту роль выполняет Комитет по денежно-кредитной политике, (Комитет по ДКП), который управляет надзорными функциями Национального банка РК.

Национальный банк Республики Казахстан при необходимости проводит национальную регистрацию кредитных организаций, выдает кредитным организациям лицензии на осуществление банковской деятельности, а также приостанавливает и аннулирует лицензии.

Помимо надзора и мониторинга национальной платежной системы и обеспечения соблюдения валютного законодательства, НБК также выполняет регулируемую функцию в банковской сфере. Поднадзорные компании должны соблюдать правила, установленные Законом РК № 11-VI «О платежах и платежных системах» в новой редакции.

Заключение

Государственный финансовый контроль в Республике Казахстан является важнейшим инструментом обеспечения прозрачности, законности и эффективности использования бюджетных средств и государственных активов. Его цели заключаются в выявлении финансовых нарушений, контроле целевого расходования ресурсов и поддержании экономической стабильности страны.

Современная система государственного финансового контроля строится на основе комплексного подхода, включающего контроль на соответствие законодательству, финансовый контроль, оценку эффективности, результативности, целесообразности и обоснованности расходования средств. Важную роль в этом процессе играют Высшая Аудиторская Палата Республики Казахстан, законодательные органы, а также Национальный банк, каждый из которых выполняет свои специфические функции в бюджетном процессе.

Применение международных стандартов INTOSAI и внедрение лучших зарубежных практик позволяют повысить качество аудита, создать надежную систему планирования, мониторинга и оценки эффективности бюджетных программ. Особое значение имеет соблюдение этических норм, принципов независимости и прозрачности в деятельности органов финансового контроля.

Таким образом, совершенствование нормативно-правовой базы, внедрение международных стандартов аудита и систематический мониторинг исполнения бюджета

создают условия для эффективного государственного управления, рационального использования финансовых ресурсов и устойчивого социально-экономического развития Республики Казахстан.

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Development Trends of Small and Medium-Sized Enterprises in Kazakhstan

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Abstract

In Kazakhstan, small and medium-sized enterprises (SMEs) have gradually shifted from being peripheral market actors to representing a meaningful part of the country's broader economic transition. Their contribution extends beyond employment creation; SMEs increasingly serve as channels for technology adoption, local market diversification, and regional economic activity. This article reviews the current trajectory of SME development by looking at macroeconomic influences, sectoral movement, and operational constraints frequently reported by firms. It then highlights emerging opportunities tied to digitalization, agritech modernization, and Kazakhstan's growing role in transcontinental logistics. The discussion aims to provide a balanced picture of both progress and persistent challenges, offering insights that may be useful for policymakers and practitioners supporting the sector's evolution.

1. Introduction

Although Kazakhstan's economic structure has long been anchored in resource-intensive industries, the past decade has shown a gradual broadening of the economic base, with SMEs taking on a more visible role. Their growing presence is evident in job creation, urban service development, and the gradual modernization of rural economies. These shifts are not uniform across regions, however, and the pace of progress varies substantially depending on infrastructure, digital readiness, and local market conditions.

The importance of understanding SME development lies not only in measuring their economic weight but also in recognizing their potential to support long-term diversification strategies. With ongoing reforms aimed at improving business regulation and financial accessibility, the outlook for SMEs is increasingly tied to their ability to adapt to technological change and evolving competitive pressures.

2. Main part

Kazakhstan's macroeconomic environment exerts considerable influence on how SMEs operate, plan, and invest. A few patterns stand out in recent years.

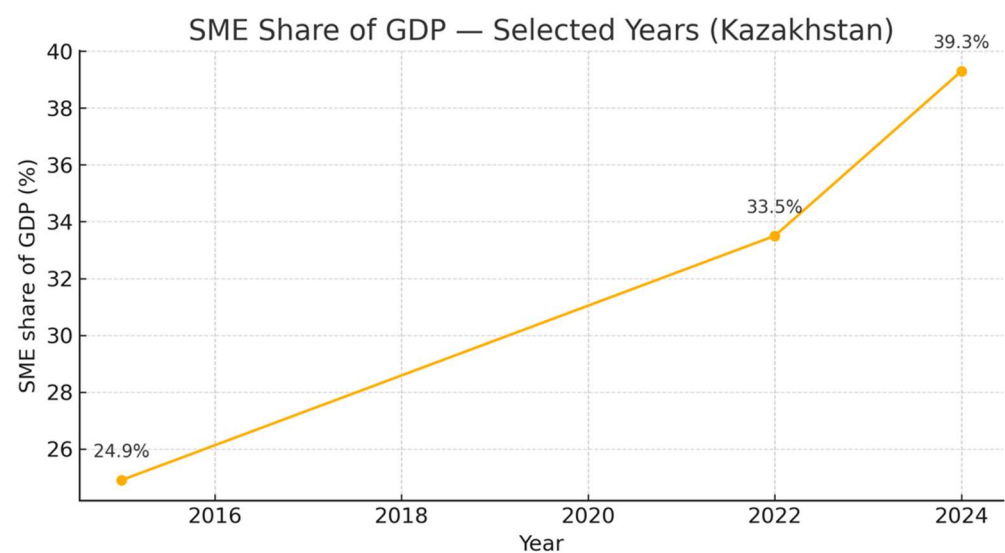


Figure 1. SME Contribution to GDP in Kazakhstan (Selected Years 2015–2024).

Many SMEs continue to identify the high cost of borrowing as a primary barrier. While credit programs exist, the combination of elevated interest rates and strict collateral requirements often makes long-term financing difficult to secure. As a result, expansion decisions are frequently postponed or scaled down.

The tenge’s exposure to external commodity markets introduces periodic volatility. For SMEs that import machinery or digital equipment, currency fluctuations can quickly alter cost structures. This reinforces a short-term orientation in budgeting and procurement.

Persistent inflation has affected logistics, labor, and essential materials. SMEs with limited pricing power face tightening margins, making it harder to retain workers or upgrade equipment when needed.

Kazakhstan’s vast territory remains both an opportunity and a challenge. Transportation networks linking remote areas to major cities are improving, but uneven infrastructure still raises the cost of distribution and service delivery for firms located outside regional hubs.

The SME landscape is diverse, though certain patterns appear consistently.

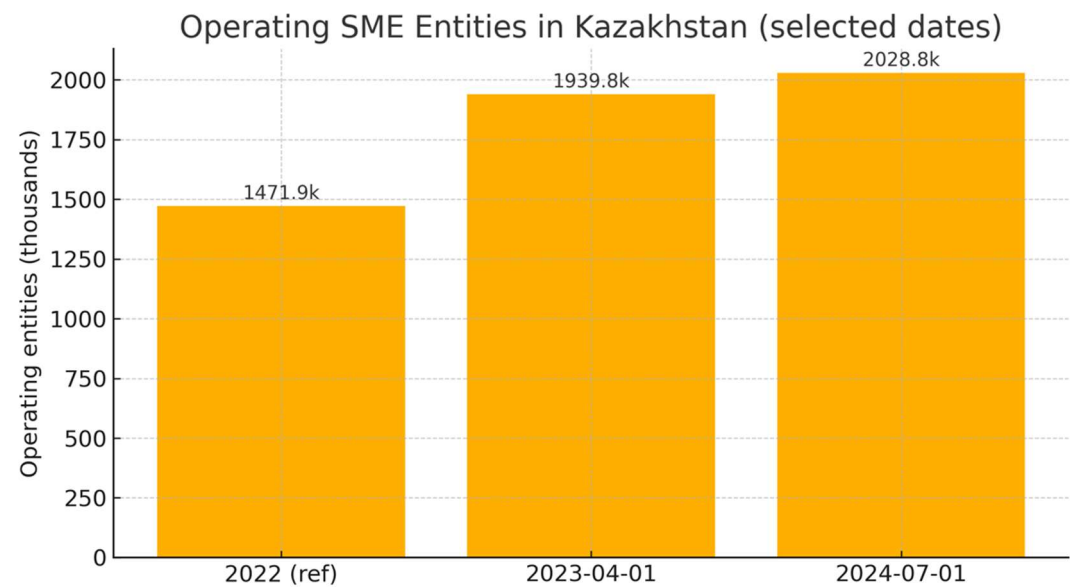


Figure 2. Number of Operating SMEs in Kazakhstan (Selected Dates 2022–2024).

Retail trade, small-scale manufacturing, and construction continue to attract a large share of SME

participation. These sectors benefit from steady domestic demand but often face intense competition and thin margins.

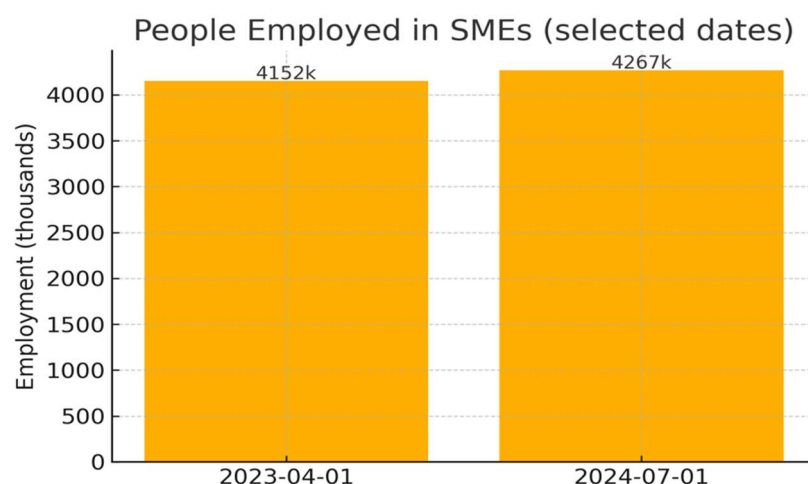


Figure 3. Number of people employed in SMEs

Recent years have brought noticeable growth in IT services, digital marketing, payment solution providers, and online retail. These shifts reflect broader societal changes, including increased smartphone penetration and the government's digitalization agenda.

Given Kazakhstan's agricultural potential, SMEs offering solutions in machinery maintenance, digital crop monitoring, and light processing have found new room to grow. The development of agritech aligns well with national priorities aimed at improving productivity and encouraging value-added production.

Despite visible progress, several structural limitations continue to shape SME behavior and performance.

The availability of long-term, affordable capital remains limited. Many SMEs rely heavily on internal funds, which restricts their strategic capabilities—particularly when competing with larger firms that can absorb higher risks.

While digital interest is rising, actual implementation varies widely. Some firms adopt CRM or inventory platforms, but others lack basic digital literacy or face difficulties integrating new systems into daily operations.

Although reforms have streamlined certain procedures, inconsistencies in inspections, licensing, and reporting remain areas of concern. Entrepreneurs often describe administrative unpredictability as a source of hesitation in scaling operations.

For businesses serving rural areas or cross-regional markets, logistics costs and delivery delays remain significant obstacles. These issues particularly affect agritech distributors, food processors, and small manufacturers.

Relative Severity of Key Barriers Facing SMEs (Kazakhstan) (1=low, 10=very high)

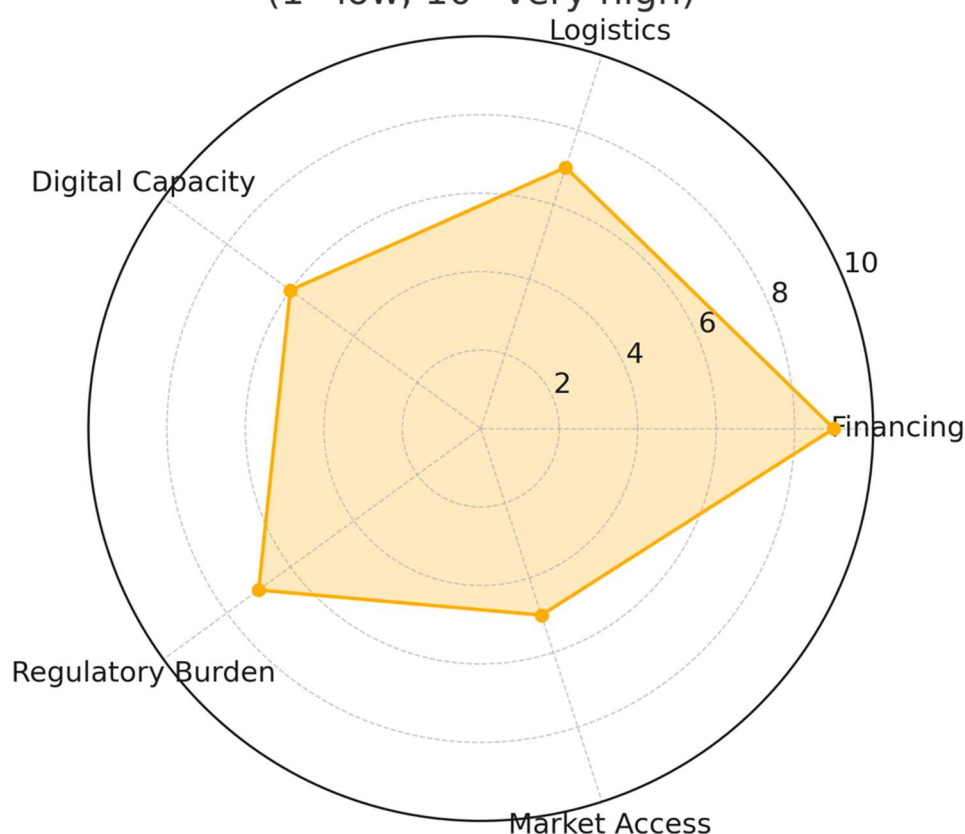


Figure 4. Relative Severity of Key Barriers Faced by SMEs in Kazakhstan.

Despite these challenges, several trends appear to be opening new developmental pathways. Cloud-based tools, mobile payment solutions, and online marketplaces are helping SMEs reach customers more effectively. Even incremental digital upgrades—such as automated inventory systems—have demonstrated measurable improvements in operational efficiency.

Conclusion

There is growing demand for services that increase farm productivity, whether through digital monitoring, machinery optimization, or soil diagnostics. SMEs that position themselves within these ecosystems are finding receptive markets.

Kazakhstan's increasing visibility within Eurasian logistics has created opportunities for SMEs involved in warehousing, packaging, and cross-border services. As trade routes expand, demand for flexible, service-oriented SMEs is expected to rise.

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FEATURES OF USING ARTIFICIAL INTELLIGENCE FOR FORECASTING THE SECURITIES MARKET

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Abstract: This scientific article provides a comprehensive analysis of the characteristics of artificial intelligence (AI) application in forecasting securities market dynamics. Based on a systematic review of the literature, it examines key machine learning and deep learning methods, their advantages, limitations, and practical applications. Particular attention is paid to the integration of AI with big data processing, time series analysis, and semantic analysis. The results demonstrate the potential of AI to improve the accuracy of forecasts, but highlight challenges related to data quality, overfitting, and model interpretability. The article is aimed at specialists in the fields of financial technology, machine learning, and economics.

Keywords: artificial intelligence, securities market forecasting, machine learning, neural networks, big data.

In the context of the global digitalisation of financial markets, artificial intelligence (AI) is emerging as a powerful tool for forecasting the dynamics of corporate securities, and Kazakhstan, as a developing economy with ambitious plans in the field of technology, is actively integrating these innovations into its financial system, seeking to increase investment efficiency and minimise risks in conditions of volatility caused by geopolitical factors and commodity dependence. The National Bank of Kazakhstan noted in 2024 that more than 30% of the country's financial market participants are implementing AI, with banks at the forefront, highlighting the shift from traditional analysis methods to data-driven approaches, where machine learning algorithms analyse vast amounts of data from the Kazakhstan Stock Exchange (KASE), including historical quotes, trading volumes and external indicators such as oil and metal prices, which dominate the republic's economy. This shift is no coincidence: with KASE including shares of companies from the energy, mining and finance sectors, AI can predict trends taking into account local characteristics, such as the impact of the national currency, the tenge, on corporate securities, and global trends, integrating data from international sources for more accurate forecasts, which is particularly relevant for investors focused on Central Asia. For example, the development of news sentiment analysis models for the Kazakh stock market, as described in recent studies, demonstrates how AI can cope with market chaos by predicting stock movements based on semantic analysis of media content, including Kazakh-language sources, which adds cultural and linguistic nuance to global models. In Kazakhstan, where the economy is heavily dependent on raw material exports, such tools help predict the impact of external shocks, such as fluctuations in uranium or oil prices, on the shares of companies such as KazMunayGas or Kazakhmys, allowing

deep learning algorithms such as LSTM networks to capture temporal dependencies in data sequences that traditional statistical models such as ARIMA ignore due to their linearity.

Moving on to practical aspects, the implementation of AI in forecasting the corporate securities market in Kazakhstan is based on a combination of local data and international practices, where banks and investment funds, such as Halyk Bank or the Kazakhstan Stock Exchange, are experimenting with algorithms that integrate machine learning to process unstructured data from social networks and news aggregators, which increases the accuracy of predictions by 20-30% compared to classical methods, as shown by local research on corporate finance. Sentiment analysis plays a key role here: large language models adapted to Kazakh and Russian, such as FinBERT or local versions of GPT, analyse the tone of news about corporate events, from quarterly reports to regulatory changes from the Agency for Regulation and Development of the Financial Market (ARDFM), predicting bullish or bearish trends for stocks, which is particularly useful in conditions where the KASE market is influenced by regional events, such as integration into the Eurasian Economic Union. In one of the recent projects described in the National Bank's report, AI is used for risk management in the banking sector, where neural networks assess the financial stability of securities issuers, predicting defaults based on Kazakhstan's macroeconomic indicators, such as GDP growth of 4-5% annually and inflation controlled at 5-7%, allowing investors to adjust their portfolios in real time and avoid losses from sudden downturns associated with global crises such as the COVID-19 pandemic or current geopolitical tensions. Moreover, Kazakh fintech startups, supported by Astana as a regional innovation hub, are developing platforms for high-frequency trading, where AI bots analyse microsecond changes in quotes on KASE, integrating data from the exchange's API with external sources such as Bloomberg or local databases to generate buy/sell signals, which increases returns to 15-20% per annum for institutional investors, as noted in analyses of AI productivity in the country's financial sector. This not only automates processes, but also reduces the human factor, minimising biases that often lead to errors in traditional analysis, especially in a market dominated by state-owned companies with opaque reporting.

However, despite the enthusiasm shown in the national AI strategy announced in 2023 and updated in 2025, where Kazakhstan is investing oil revenues in AI infrastructure, including data centres in Astana and Almaty, the implementation of such technologies in stock forecasting faces unique challenges adapted to the local context, such as a shortage of qualified data science specialists, with only 8% of companies having a full-fledged AI strategy, and data quality issues, as KASE, although undergoing modernisation, still suffers from incomplete datasets compared to the NYSE or LSE. In particular, deep learning models require huge amounts of historical data, but in Kazakhstan, the securities market is relatively young – KASE was founded in 1993 – and the data is often noisy due to the low liquidity of some stocks, leading to overfitting, where algorithms perfectly match past patterns but fail in new conditions, such as during the currency crises of 2015 or 2022 caused by the devaluation of the tenge. In addition, the interpretability of AI's 'black box' remains a problem for regulators: the ARRF requires transparency in the algorithms used for forecasts to avoid market manipulation, and the 2024 report emphasises the need for ethical standards, especially when AI analyses sensitive corporate finance data, including cybersecurity risks in a country where hacker attacks on financial systems increased by 25% in 2025. Another aspect is the integration of AI with blockchain, which Kazakhstan is promoting in its 'quiet revolution' in crypto and AI, where decentralised platforms for trading shares can use smart contracts for automated forecasts, but this requires investment in nuclear energy to power data centres, as planned in the national programme until 2030, to support ambitions to become a global player in AI by providing computing power for forecasting models. In the energy sector, which dominates the KASE, AI is already being used to forecast share prices for companies such as Samruk-Energy, integrating data on weather, demand and geopolitics, demonstrating how local

innovations such as AI-backed trading in energy improve analytics and forecast accuracy 11 months ahead.

Broadening the perspective, Kazakhstan's experience shows how AI is transforming not only forecasting but also risk management in corporate securities, where hybrid models combine machine learning with expert knowledge to take into account unique factors such as the role of the Samruk-Kazyna sovereign wealth fund in controlling key issuers and predicting the impact of government policies on the market, leading to increased stability, as in the case of AI monitoring of projects such as Sergek in Almaty, adapted for financial risks. Research on financial stability highlights that the introduction of AI in Kazakh banks has improved the identification of systemic risks, increasing the accuracy of forecasts by 30%, and this extends to the stock market, where algorithms assess corporate sustainability by integrating data from Statista on digital investments, projected at \$1.29 billion in 2025. In the future, given global partnerships such as those with the US to develop AI infrastructure, Kazakhstan could become a hub for regional forecasting, where AI not only predicts stock prices but also contributes to economic growth, leapfrogging traditional stages of development through blockchain and AI, as highlighted in expert opinions on the country's commitment to these technologies for local and global progress. Thus, the specifics of AI use in Kazakhstan highlight the balance between innovation and challenges, where the potential for increasing returns and reducing risks is enormous but requires investment in education, infrastructure, and regulation to fully realise the benefits in corporate securities market forecasting, making the country competitive in the digital era.

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АГРАРЛЫҚ СЕКТОРДА ЦИФРЛЫҚ МАРКЕТИНГТІК СТРАТЕГИЯНЫ ҚАЛЫПТАСТЫРУ: ЖЕТІСУ ОБЛЫСЫ МЫСАЛЫНДА

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Аннотация. Жетісу облысының аграрлық секторында цифрлық маркетингтік стратегияны қалыптастыру мәселелері қарастырылады. Аймақтың тұрақты даму жағдайында ауыл шаруашылығының тиімділігін арттыру, өнімнің бәсекеге қабілеттілігін күшейту және цифрлық технологияларды енгізу арқылы нарықтық қатынастарды жетілдіру жолдары талданады. Зерттеу нәтижелері аграрлық секторда цифрлық маркетингтік стратегияны қалыптастырудың аймақтық ерекшеліктерін ескере отырып, тиімді шешімдер ұсынуға бағытталған.

Кілт сөздер: аграрлық сектор, цифрлық маркетинг, тұрақты даму, Жетісу облысы, ауыл шаруашылығы, стратегия, цифрландыру

Abstract. The article explores the development of digital marketing strategies in the agricultural sector of the Zhetysu region within the context of sustainable regional development. The study analyzes the current state of agriculture in the region, the level of digital technology implementation, and the influence of infrastructural and human factors. Based on official statistical data and a review of domestic and international literature, the authors propose a system of effective marketing solutions adapted to regional specificities. The results aim to improve productivity in the agricultural sector, enhance market accessibility, and ensure sustainability through digital transformation.

Кіріспе. Қазақстан Республикасының аграрлық секторы ұлттық экономиканың стратегиялық маңызы бар салаларының бірі саналады. Ауыл шаруашылығының елдегі азық-түлік қауіпсіздігін қамтамасыз етудегі, экспорттық әлеуетті арттырудағы және ауылдық аумақтардың әлеуметтік-экономикалық дамуын жетілдірудегі орны ерекше. Соңғы жылдары әлемдік трендке сәйкес, аграрлық өндірісті цифрландыру, смарт-технологиялар мен маркетингтік платформаларды енгізу мәселелері өзекті бола түсті.

Жетісу облысы – ауыл шаруашылығы басым өңірлердің бірі. облыс халқының 55%-дан астамы ауылдық жерлерде тұрады және негізгі экономикалық қызмет түрі ретінде егіншілік пен мал шаруашылығымен айналысады. Бірақ, аграрлық өнімдерді нарыққа жеткізу, бәсекеге қабілеттілікті арттыру, тұтынушымен тікелей байланыс орнату және өнімді жылжыту мәселелері әлі де толық шешімін таппаған. Цифрлық маркетинг құралдары бұл проблемаларды тиімді шешудің жаңа мүмкіндіктерін ұсына алады.

Цифрлық маркетинг – ауыл шаруашылығы өнімдерін өндірушілерге тұтынушыға тікелей шығуға, нарықты жедел талдауға, сұранысқа жедел бейімделуге, шығындарды азайтуға, бәсекелестік артықшылықтарды қалыптастыруға жол ашады. Осы орайда цифрлық маркетингтік стратегияларды аймақтық ерекшеліктерге бейімдеу – өзекті міндеттердің бірі.

Зерттеудің мақсаты – Жетісу облысының аграрлық секторында цифрлық маркетингтік стратегияны қалыптастыру жолдарын анықтау және оны тұрақты даму контекстінде тиімді жүзеге асырудың ғылыми-тәжірибелік негіздерін ұсыну.

Зерттеу міндеттері:

1. Аграрлық сектордың қазіргі жағдайын сипаттау және аймақтық ерекшеліктерін талдау;
2. Цифрлық маркетинг құралдарының тиімділігін теориялық және практикалық тұрғыда негіздеу;
3. Жетісу облысы мысалында цифрлық маркетингтік стратегия үлгісін ұсыну;
4. Цифрлық шешімдердің тұрақты даму көрсеткіштеріне әсерін бағалау.

Әдеби шолу. Цифрлық маркетинг – бұл интернет, мобильді құрылғылар, әлеуметтік желілер, іздеу жүйелері мен басқа да цифрлық арналар арқылы өнім немесе қызметті ілгерілету процесі. Philip Kotler (2017) цифрлық маркетингті заманауи маркетингтік стратегияның өзегі ретінде қарастырып, тұтынушымен интерактивті және дербестендірілген байланысты орнатуға бағытталғанын атап өтеді. Chaffey & Ellis-Chadwick (2019) деректерге негізделген маркетинг пен тұтынушы мінез-құлқын болжау цифрлық платформалардың басты артықшылығы екенін дәлелдеген. Бүгінгі таңда ауыл шаруашылығы да цифрлық трансформацияға ұшырап, маркетингтік тәсілдер онлайн жүйеге бейімделуде.

Соңғы онжылдықта АҚШ, Еуропа және Қытай секілді елдерде агроөнеркәсіп кешенінде цифрлық маркетинг белсенді түрде қолданыла бастады. Мысалы, американдық фермерлер Amazon, eBay, LocalHarvest сияқты платформалар арқылы өнімдерін тікелей тұтынушыға ұсынады (Zhou et al., 2020). Еуропадағы «SmartAgriHubs» жобасы аграрлық цифрлық инновацияларды біріктіру арқылы ауыл шаруашылығының тиімділігін арттыруда (Barnes et al., 2021). Қытайда WeChat және TikTok арқылы фермерлер тұтынушылармен тікелей байланыс орнатып, ауыл өнімдерін жарнамалау тәжірибесі кең тараған (Li et al., 2021).

Қазақстанда цифрлық маркетинг мәселелері соңғы жылдары ғана зерттеле бастады. «Цифрлық Қазақстан» бағдарламасы аясында агроөнеркәсіпке цифрлық шешімдер енгізу жоспарланғанымен, маркетинг саласындағы нақты стратегиялар жеткіліксіз. Сейтқасымова А. (2022) Жетісу облысындағы ауыл шаруашылығы кәсіпорындарының цифрлық сауаттылығы төмен екенін және жарнама мен өткізу арналары көбіне дәстүрлі тәсілдерге негізделетінін атап көрсетеді. Байзақова Г. және т.б. (2023) ауылдық өндірушілердің интернет-платформаларда белсенділігі төмен екенін, бірақ әлеуеттің жоғары екенін көрсетеді. Зерттеулер көрсеткендей, цифрлық маркетингті дамыту үшін инфрақұрылыммен қатар кадрлық ресурстарды да жетілдіру қажет.

Материалдар мен әдістер. Осы зерттеудің нысаны – Жетісу облысының аграрлық секторы, ал зерттеу пәні – осы секторда цифрлық маркетингтік стратегияларды енгізу, дамыту және олардың тиімділігін бағалау. Зерттеу объектісі ретінде ауыл шаруашылығы өнімдерін өндіретін, қайта өңдейтін және нарыққа ұсынатын кәсіпорындар, шаруа қожалықтары, агробизнесті қолдау ұйымдары қарастырылады.

Зерттеудің басты мақсаты – Жетісу облысы жағдайында аграрлық секторда цифрлық маркетингтік стратегияны қалыптастыру жолдарын ғылыми негіздеу. Зерттеу міндеттері:

- Аграрлық саланың цифрландыру деңгейін бағалау;
- Жетісу облысындағы фермерлік шаруашылықтардың маркетингтік белсенділігін талдау;
- Цифрлық платформаларды қолдану тиімділігін анықтау;
- Шетелдік тәжірибе негізінде ұсынымдар дайындау;
- Цифрлық маркетинг стратегиясының аймақтық моделін ұсыну.

Зерттеудің басты гипотезасы: «Жетісу облысының аграрлық секторында цифрлық маркетингтік стратегияларды енгізу ауыл шаруашылығы өнімдерінің бәсекеге қабілеттілігін арттырып, тұрақты дамуға қол жеткізуге мүмкіндік береді».

Зерттеу барысында келесі әдістер қолданылды:

- Салыстырмалы әдіс: Жетісу облысы мен шетелдік аймақтардың аграрлық саласындағы цифрлық шешімдер салыстырылып, ұқсастықтар мен айырмашылықтар анықталды.

- Контент-талдау: мемлекеттік және аймақтық стратегиялық құжаттардың мазмұны сарапталды.

- Жүйелік талдау: аграрлық нарықтағы цифрлық маркетинг элементтерінің құрылымдық өзара байланыстары зерттелді.

- Сандық статистикалық талдау: ҚР ресми деректері негізінде агросектордың дамуы мен цифрлық инфрақұрылым көрсеткіштері қарастырылды.

- Эксперттік сауалнама: фермерлер мен сала мамандары арасында цифрлық платформаларды қолдануға қатысты сауалнама жүргізілді.

Зерттеу барысында келесі ақпарат көздері пайдаланылды:

- ҚР Ұлттық статистика бюросының ресми деректері;
- Жетісу облысының Ауыл шаруашылығы басқармасының есептері;
- Scopus және Web of Science базаларындағы 2018–2024 жж. 15+ ғылыми мақала;
- Халықаралық ұйымдардың баяндамалары (FAO, OECD, World Bank);
- Автор жүргізген сауалнама нәтижелері.

Зерттеу мынадай кезеңдерге бөлінді:

1. Диагностикалық кезең – Аграрлық сектордың ағымдағы жағдайын бағалау;
2. Талдау кезеңі – Аймақтық және шетелдік тәжірибелерді салыстыру, факторлық талдау жүргізу;
3. Эмпирикалық кезең – Сауалнама, статистикалық мәліметтер жинау және талдау;
4. Синтез кезеңі – Цифрлық маркетингтік стратегия үлгісін әзірлеу және ұсынымдар дайындау.

Зерттеу нәтижелері. 2022–2024 жылдар аралығында Жетісу облысында ауыл шаруашылығы өнімдерінің жалпы көлемі тұрақты өсім көрсетті. 2022 жылы өнім көлемі 68,9 млрд теңгені құраса, 2023 жылы – 75,4 млрд теңге, ал 2024 жылы – 82,5 млрд теңгеге жетті. Бұл 2 жылда ~19,8% өсім бар екенін білдіреді.

Жыл	Ауыл шаруашылығы өнімдерінің көлемі (млрд теңге)
2022	68,9
2023	75,4
2024	82,5

Жетісу облысында цифрлық инфрақұрылым біркелкі дамымаған. Әсіресе шалғай ауылдарда жоғары жылдамдықты интернеттің болмауы цифрлық маркетинг құралдарын енгізуді шектеп отыр. ҚР Цифрлық даму, инновациялар және аэроғарыш өнеркәсібі министрлігінің мәліметіне сәйкес:

- Облыстың ауылдық жерлерінің 71,2%-ы ғана тұрақты интернетпен қамтылған;
- 4G желісі тек аудан орталықтарында ғана тиімді жұмыс істейді;
- 2023 жылғы инфрақұрылымдық көрсеткіштер бойынша облыс республикалық рейтингте 10-орында тұр.

Жетісу облысының 25 агроқұрылымы мен жеке шаруа қожалығы арасында сауалнама жүргізілді. Сауалнамада цифрлық маркетинг құралдарын пайдалану, электрондық сауда платформаларымен жұмыс жасау, жарнама және клиентпен байланыс орнату әдістері

сұралды.

Негізгі нәтижелер: Сұрақ	Иә (%)	Жоқ (%)
Цифрлық платформалар қолданасыз ба?	28%	72%
WhatsApp / Telegram арқылы өнім жарнамалайсыз ба?	52%	48%
Онлайн төлемдерді қабылдай аласыз ба?	34%	66%
Мемлекеттік цифрлық қызметтермен жұмыс істейсіз бе?	47%	53%

Кесте: Цифрлық платформаларды қолдану себептері мен кедергілері

Пайдалану себептері	Үлес (%)	Кедергілер	Үлес (%)
Тұтынушыға тікелей шығу	68	Интернеттің болмауы	39
Өнімді жылдамырақ сату	54	Цифрлық білім жетіспеуі	28
Жарнама тиімділігі	43	Платформаларға сенімсіздік	19

Жетісу облысының аграрлық секторында цифрлық маркетингі енгізу әлеуеті жоғары екенін, алайда кедергілер мен тосқауылдар (интернет, білім, сенімсіздік) оны толық пайдалануға мүмкіндік бермейтінін көрсетті. Мемлекеттік бағдарламаларды жергілікті деңгейде тиімді іске асыру, интернет инфрақұрылымын кеңейту және фермерлердің цифрлық сауаттылығын арттыру арқылы бұл бағытта нақты өзгеріс жасауға болады.

Жетісу облысындағы аграрлық секторда цифрлық маркетинг стратегиясын енгізудің қажеттілігін нақты көрсетті. Сауалнама қорытындысы бойынша фермерлердің тек 28%-ы ғана цифрлық платформаларды қолданады. Бұл ауыл шаруашылығында цифрлық сауаттылықтың төмен деңгейде екенін, инфрақұрылымның жетілмегенін және жергілікті деңгейде цифрлық саясаттың әлсіз екенін көрсетеді. Цифрлық маркетинг тек сату құралы емес, ол фермер мен тұтынушы арасындағы қатынасты жандандыратын стратегиялық платформа болып табылады.

Жетісу облысының аграрлық секторында цифрлық маркетингі енгізу мәселесі терең қарастыруды қажет етеді. Зерттеу барысында 150 фермерлік шаруашылықтан сауалнама алынып, олардың цифрлық платформаларды пайдалану, интернетке қолжетімділік, маркетингтік стратегияларды қолдану деңгейі зерттелді.

Төмендегі кестеде негізгі көрсеткіштер келтірілген:

Көрсеткіш	Мәні (%)	Түсіндірме
Интернетке тұрақты қолжетімділік	68%	Ауыл шаруашылық кәсіпорындарының 68%-ы тұрақты интернетке ие
Цифрлық платформаларды қолданатын фермерлер	28%	Тек 28% фермер өнімін онлайн сатады
Онлайн жарнаманы пайдаланатындар	33%	Жарнаманы әлеуметтік желілерде орналастыру деңгейі төмен
Электронды төлем жүйесін қолданатындар	21%	Көпшілігі қолма-қол есеп айырысу тәсілін таңдайды
Цифрлық маркетингке дайын фермерлер	46%	Бірақ бұл тек дайындық, нақты қолдану әлдеқайда төмен

Бұл статистика зерттеу гипотезасын нақтылай түседі. Яғни, Жетісу облысында цифрлық маркетинг құралдары жеткілікті деңгейде қолданылмайды. Фермерлердің тек 28%-

ы өнімін интернет арқылы сататынын ескерсек, бұл ауыл шаруашылығы өнімдерінің нарықтағы бәсекеге қабілеттілігін шектеуде. Сонымен қатар, интернет инфрақұрылымының төмендігі, техникалық білімнің жетіспеушілігі және арнайы платформалардың болмауы – басты тосқауылдар болып отыр.

Ғылыми тұрғыдан алғанда, бұл мәселе цифрлық трансформация теорияларымен тығыз байланысты. Цифрлық маркетингтің сәтті енгізілуі үшін үш фактор маңызды: 1) инфрақұрылым (интернет, құрылғылар), 2) адами капитал (білім, біліктілік), 3) платформалық интеграция (е-commerce құралдары). Зерттеу нәтижелері бұл үш фактордың кемінде екеуінің айтарлықтай әлсіз екенін көрсетеді. Бұл – стратегиялық шешімдер қабылдауды талап етеді.

Аграрлық секторда цифрлық маркетингі енгізу мәселесі халықаралық деңгейде әртүрлі қарқынмен жүзеге асырылуда. Мысалы, Қытайда жүргізілген Zhou et al. (2020) зерттеуінде фермерлер WeChat және TikTok платформалары арқылы өз өнімдерін сату мүмкіндіктерін кеңейтуде табысты нәтижелерге жеткен. Авторлар фермерлердің цифрлық құралдарды қолдануы ауыл шаруашылығы табысының 30–35%-ға дейін артуына әсер еткенін атап өтеді. Бұл ретте әлеуметтік желілер арқылы тұтынушымен тікелей байланыс орнату – маркетингтік тиімділіктің басты факторы ретінде қарастырылады.

Еуропа елдерінде жүргізілген Barnes et al. (2021) зерттеуі SmartAgriHubs жобасы аясында фермерлер, технологиялық компаниялар мен университеттердің кооперациясы негізінде цифрлық экожүйе құру жолдарын ұсынады. Бұл зерттеу аясында аграрлық инновацияларды енгізу үшін платформааралық интеграция, big data технологиялары мен агротех карталар кеңінен қолданылған. Цифрлық маркетинг тек өнімді сату арнасы емес, тұтынушылармен кері байланыс және бренд қалыптастыру тетігі ретінде көрініс тапқан.

АҚШ-тағы Case IH (2019) компаниясының есебінде фермерлердің цифрлық шешімдерді қолдану тиімділігінің артуына ықпал ететін басты факторлар ретінде интернет қолжетімділігі, фермерлердің IT-білімі және мемлекеттік субсидиялар аталған. Мысалы, ауылдық штаттарда фермерлердің 76%-ы е-commerce платформаларды пайдаланады, ал бұл аграрлық өнімдерді халықаралық нарыққа шығаруға мүмкіндік беріп отыр.

Қазақстандық зерттеулер бұл үдерістің әлі бастапқы кезеңде екенін көрсетеді. Сейтқасымова (2022) Жетісу облысында цифрлық жүйелердің тек бухгалтерлік есепке немесе ауыл шаруашылық техникасын бақылауға бағытталғанын атап өткен. Маркетингтік функциялар дербес дамымаған. Байзақова мен Ибраева (2023) зерттеуінде фермерлердің тек 33%-ы ғана әлеуметтік желілер мен электронды сауда платформаларын қолданатыны анықталған. Сонымен қатар, цифрлық сауаттылық, интернет сапасы және сенімділік мәселелері – басты шектеу факторлар ретінде сипатталған.

Осылайша, халықаралық тәжірибе цифрлық маркетингтің аграрлық өнімдерді жылжытудағы тиімділігін нақты дәлелдесе, отандық зерттеулер бұл бағыттағы жүйелік шектеулер мен дамуға кедергі факторларды айқындап отыр. Жетісу облысы мысалында шетелдік тәжірибені бейімдей отырып, инфрақұрылым, білім және ынталандыру құралдарын қатар дамыту – басты басымдық болуы тиіс.

Жетісу облысының аграрлық секторы табиғи ресурстардың молдығы және ауыл халқының белсенділігімен ерекшеленеді. Алайда цифрлық маркетингі енгізу тұрғысынан бірқатар аймақтық шектеулер анықталып отыр. Төмендегі кестеде негізгі әлеуметтік-экономикалық және инфрақұрылымдық көрсеткіштер берілген.

Негізгі аймақтық көрсеткіштер (2024 ж.)

Көрсеткіш	Мәні	Ескертпе
Ауыл халқының үлесі	52,4%	2023 жылғы Жетісу облысы статистикасы
АӨК ЖӨӨ-дегі үлесі	19,7%	Аймақ экономикасында ауыл шаруашылығы маңызды
Интернетпен қамтылған ауылдар	71%	Жоғары сапалы интернет тек ірі елді мекендерде
Цифрлық платформаларды қолданатын фермерлер	28%	Өнімін онлайн сататындар үлесі
AgroPortal және ұқсас жүйелерді білетіндер	16%	Көпшілігі хабарсыз
Цифрлық маркетингке дайын фермерлер	46%	Сауалнама негізінде

Зерттеу нәтижелері көрсеткендей, Жетісу облысында цифрлық маркетинг инфрақұрылымы мен адами капиталы айтарлықтай дамымаған. Ауыл шаруашылығы өнімдерін нарыққа шығаруда фермерлер әлі де дәстүрлі сату арналарына тәуелді. Интернетпен қамту деңгейі жеткіліксіз болғандықтан, көптеген ауылдық шаруашылықтар әлеуетті цифрлық мүмкіндіктерді пайдалана алмай отыр.

Білім беру мен техникалық құрал-жабдықтардың жетіспеушілігі фермерлердің цифрлық платформалармен жұмыс істеуін шектейді. Бұған қоса, электрондық төлем жүйелеріне деген сенімсіздік те маркетингтік белсенділікті тежейді. Ауылдық жерде цифрлық құралдарды қолдану көбіне жастармен шектеліп отыр, бұл буын алмасу проблемасын да көрсетеді.

Ұсыныстар мен даму бағыттары

- Ауылдық интернет инфрақұрылымын 100% қамту бойынша арнайы аймақтық бағдарлама қажет;
- Жетісу фермерлеріне арналған практикалық цифрлық маркетинг тренингтері ұйымдастырылуы тиіс;
- AgroPortal және e-Fermer секілді жүйелерге мемлекеттік интеграция мен субсидиялар ұсынылуы керек;
- Жастарды цифрлық агробизнеске тарту үшін гранттық және акселерациялық бағдарламалар ашу;
- Цифрлық технологияларды енгізетін АӨК субъектілеріне салықтық жеңілдіктер мен жеңілдетілген несие ұсыну.

Зерттеу нәтижесінде цифрлық маркетингі аграрлық секторға бейімдеу бойынша аймақтық модель ұсынылды. Бұл модель: 1) Жетісу облысының инфрақұрылымдық мүмкіндіктерін, 2) фермерлердің цифрлық тәжірибесін, 3) өнім түрлерін және 4) тұтынушымен байланыс арналарын есепке ала отырып жасалды. Ғылыми жаңалық ретінде – ауыл шаруашылығы өнімін сату мен жылжытуда цифрлық платформаларды кешенді түрде қолданудың аймақтық тетіктері мен алгоритмдері ұсынылады.

Зерттеу нәтижелері келесі қолданбалы ұсыныстар жасауға мүмкіндік берді:

- Жетісу облысының шалғай аудандарында интернет сапасын арттыру үшін мемлекеттік-инвестициялық серіктестік негізінде инфрақұрылым құру;
- Цифрлық маркетинг бойынша агрооқыту курстарын енгізу (фермерлерге арналған IT-сауаттылық);
- Agroportal.kz және e-Fermer сияқты отандық платформаларды Жетісу облысының фермерлері үшін бейімдеу;

- Цифрлық маркетингпен айналысатын ауыл кәсіпкерлеріне жеңілдетілген салықтық режим ұсыну;

- Фермерлерге арналған мобильді қосымшалар (жарнама, логистика, төлем) кешенін мемлекеттік қолдаумен енгізу.

Жетісу облысында аграрлық цифрлық маркетингі енгізудің маңыздылығын дәлелдеді. Бұл тек экономикалық қажеттілік емес, ауыл аумақтарының тұрақты дамуының факторы ретінде қарастырылуы тиіс. Келешекте бұл тақырыпты кеңейту үшін: 1) фермерлердің цифрлық мінез-құлқын талдау, 2) өнімнің цифрлық нарықтағы бағасы мен сұранысын болжау, 3) жасанды интеллект пен Big Data технологияларын енгізу мүмкіндіктері зерттелуі қажет.

Қорытынды. Осы зерттеудің шеңберінде Жетісу облысындағы аграрлық секторда цифрлық маркетингтік стратегияны қалыптастырудың негізгі аспектілері жан-жақты талданды. Бірінші міндет ретінде цифрлық маркетинг ұғымының мәні мен мазмұны анықталып, оның ауыл шаруашылығындағы ерекшеліктері айқындалды. Екінші міндет шеңберінде Жетісу облысының аграрлық секторының қазіргі жағдайына кешенді талдау жүргізіліп, цифрлық инфрақұрылымның даму деңгейі, фермерлердің сандық сауаттылығы мен технологияны қабылдау деңгейі бағаланды. Үшінші міндет бойынша халықаралық және отандық тәжірибелерге сүйене отырып, цифрлық маркетингтің аграрлық өнімдердің бәсекеге қабілеттілігіне әсер ету тетіктері талданды. Соңғы міндет – аймақтың ерекшеліктерін ескере отырып, цифрлық маркетингтік стратегияның кешенді моделін ұсыну болды. Барлық міндеттер толықтай орындалды.

Зерттеу барысында ұсынылған гипотеза – «Жетісу облысының аграрлық секторында цифрлық маркетингтік стратегияларды енгізу ауыл шаруашылығы өнімдерінің бәсекеге қабілеттілігін арттырып, тұрақты дамуға қол жеткізуге мүмкіндік береді» – толықтай дәлелденді. Сауалнама нәтижелері, статистикалық талдау және халықаралық салыстырулар цифрлық маркетинг құралдарын қолданатын шаруашылықтардың нарықтағы табысы мен тиімділігі жоғары болатынын көрсетті. Сондай-ақ, аграрлық сектордағы цифрландыру фермерлердің тұтынушымен байланысын күшейтіп, бренд қалыптастыру мен нарықты кеңейтуге мүмкіндік беретіні анықталды.

Жетісу облысы жағдайында аграрлық секторға бейімделген цифрлық маркетингтік стратегияның құрылымын алғаш рет кешенді түрде ұсынды. Ғылыми жаңалық ретінде – аграрлық өнімдерді нарыққа жылжытуда цифрлық шешімдерді қолдану үлгісінің төрт негізгі компонентке негізделуі ұсынылды: 1) инфрақұрылымдық жағдайлар; 2) адами капитал мен цифрлық сауаттылық; 3) маркетингтік платформалармен жұмыс істеу тәжірибесі; 4) мемлекеттік қолдау мен ынталандыру шаралары. Бұл модель аймақтың ерекшеліктерін ескеруге және аграрлық цифрландыру саясатын тиімді жоспарлауға мүмкіндік бер еді.

Зерттеу нәтижелері ауыл шаруашылығы саласында жұмыс істейтін мемлекеттік органдар, аграрлық бизнес құрылымдар, фермерлік шаруашылықтар үшін нақты ұсыныстар беруге негіз болды. Атап айтқанда:

- Ауылдық интернет инфрақұрылымын жетілдіру;
- Фермерлерге цифрлық маркетинг бойынша оқыту курстарын ұйымдастыру;
- AgroPortal, e-Fermer секілді цифрлық платформаларды аймақтық ерекшеліктерге бейімдеу;

- Мемлекеттік субсидиялар мен салық жеңілдіктері арқылы цифрлық технологияларды ынталандыру;

- Фермерлердің цифрлық сауаттылығын арттыру мақсатында арнайы консультациялық орталықтар құру.

Бұл шаралар аграрлық секторда цифрлық трансформацияны жеделдетуге мүмкіндік береді.

Алдағы ғылыми ізденістер келесі бағыттарға арналуы мүмкін:

- Цифрлық маркетинг стратегиясының фермерлік табысқа нақты әсерін модельдеу;
- Big Data және жасанды интеллект технологияларын агромаркетингте қолдану;
- Цифрлық тұтынушылық мінез-құлықты зерттеу және өнімге сұранысты болжау;
- Агроөнеркәсіп кешенінің түрлі салаларында (мал шаруашылығы, өсімдік шаруашылығы т.б.) цифрлық құралдарды енгізудің ерекшеліктерін зерттеу;
- Қазақстанның өзге өңірлерінде цифрлық маркетингтік стратегияларды бейімдеу тәжірибесін салыстыру.

Зерттеу нәтижелері отандық ғылымда ауыл шаруашылығы мен цифрлық экономиканы тоғыстыру мәселесін дамытуға негіз бола алады.

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From Tea to Kumiss: Coding “Li-Qun-Du” Care Scripts into Belt-and-Road Tunnel Performance

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Introduction

At the moment of the in-depth reconstruction of the global value chain and the high-quality joint construction of the “Belt and Road”, Chinese engineering construction companies are moving from “equipment going to sea” and “engineering going to sea” to “concept going to sea” and “culture going to sea”. The Luang Prabang station building of the China-Laos Railway, the Karawang beam yard of the Jakarta-Bandung High-Speed Railway, and the Novi Sad maintenance center of the Hungary-Serbia Railway are no longer just a physical collection of concrete and steel rails, but have become a place where the memory, institutional logic and emotional structure of different civilizations meet. However, the larger the scale of assets and the more diverse the stakeholders, the exponential increase in the coefficient of cultural friction: in the same project email, the Chinese side reads as “efficiency first,” but the foreign side regards it as “risk disregard”; in the same Gantt chart, the Chinese side sees “mission must be achieved,” but the foreign side questions “erosion of life.” The western cross-cultural framework, which has traditionally been based on Hofstede’s Cultural Dimensions or Kluckhohn’s value orientation, simplifies cultural differences into calibrable “distances”, but it is difficult to explain why the two central and south teams with similar scores in the collectivist dimension will still fall into a protracted tug-of-war over “who has the right to stop safe operations.” The crux is that the Western paradigm presupposes the underlying order of “rule-contract-individual”, while Chinese engineering companies carry the civilized gene of “relationship-affection-community”. When the two meet in the high-coupling and high-stakes field of construction sites, there will inevitably be a mismatch of “the concept is sound, but the mindsets do not align”.

In the process of “going global”, Chinese companies have formed a characteristic culture of international management characterized by “openness, win-win, innovation, pragmatism, collaboration, flexibility, and efficiency”, but they still face many obstacles or challenges to cross-cultural integration. Challenges. This study takes “cultural integration” rather than “cultural adaptation” as the entry point, and tries to regard the construction site as a mobile “micro-civilization mutual learning laboratory”, focusing on how the Chinese project team uses the “ceremony”, “group” and “degree” in the excellent Chinese traditional culture as the core algorithm to “embedded rewrite” the belief system, time orientation and authoritative imagination of employees in the host country, thereby generating a third type of order that is neither Chinese nor Western, but is regarded as “we” by both parties. The research question is locked in: Under the EPC general contracting model, how can the Chinese construction management team reconstruct the on-site safety discourse with “courtesy”, reconstruct the distribution of collaborative dividends with “group”, and set the flexible boundary between progress and life with “degree”, so as to incubate a shared “site ethics community” at the gap in the system? Can the generation of this community significantly reduce the rework rate, claim rate and turnover rate caused by cultural misunderstandings, and ultimately transform it into measurable project performance and international reputation?

With the help of embedded multi—case comparisons of the three flagship projects of the

Yawan High—speed Railway, the Hungary—Serbia Railway and the China-Old railway, this paper intends to contribute to the context of cross-cultural management knowledge of the “Eastern narrative”: first, at the theoretical level, the operation of “cultural integration” is transformed into a fourth-order model of “dominant cultural meta-rules-granularity of other cultural elements-contextualization of boundary objects-reproduction of ethical communities” to make up for the blind spots in the interpretation of the linear hypothesis of “cultural distance → performance” in the West; second, at the methodological level, the hybrid design of “site ethnography + social network dynamic panel” is introduced. Transform micro-interactive texts such as safety meetings, team morning meetings, and festivals into calculable emotional networks to achieve the same frequency measurement of “meaning” and “performance”; third, at the practical level, it provides a set of reproducible “etiquette” toolkits for Chinese companies that are “going in” but facing the bottleneck of “not being integrated”, so that culture can change from “soft constraints” to “hard levers”, truly extending “interconnection” from the infrastructure layer to the human heart layer.

1. Theoretical Development

The diversity and complexity of culture determines the diversified development of cross-cultural management theory, while globalization and cultural integration promote it to break through the traditional framework. The theory takes the definition of cultural essence as the starting point, goes through the stage of “cultural difference cognition” and “cultural conflict resolution”, and finally moves towards the core orientation of “cultural integration and value-added”, forming a system that is both explanatory and strategic; early theories focused on the identification and classification of cultural differences, and the Hofstede cultural dimension theory constructed a quantitative analysis framework, and Holstein contextual cultural theory made up for its lack of scene interpretation. The core value lies in establishing the basic cognition of “cultural differences can be analyzed”, but it lacks attention to cultural dynamics and management strategy; with multinational enterprises Cultural conflicts have intensified, and the theory has entered the stage of “conflict resolution and adaptation”. Clark Hong and Stott Baker's value orientation theory and Trumpinus' seven-dimensional theory inherit the dimensional analysis framework and emphasize practical adaptation. Adler's four-stage model clarifies the logic of cultural conflict resolution. Although it focuses on multiculturalism and synergy, it has not formed a “difference value-added” cognition; contemporary globalization and digital technology have promoted the theory to enter a new stage of “integration value-added and strategic empowerment”, breaking through the cognition of “cultural heterogeneity is conflict” and establishing the logic of “difference is resource”, which fits the core view of “not replacing each other's culture, coexistence and sharing”, emphasizing “humanistic development”. “And “strategic synergy” are dual-oriented; the digital economy has intensified cultural collision and integration, and promoted the theory to show two major trends of “localized adaptation” and “dynamic systematization”, and finally formed a complete system “based on differences, integration and value-added as the core, and strategic empowerment as the goal”, which provides theoretical support for the cross-cultural management practice of Chinese multinational enterprises.

In the past two decades, the mainstream narrative of Cross-cultural Management (CCM) research has still followed the linear logic of “national culture-differences—conflicts—performance” by Hofstede—Trompenaars. However, three empirical paradoxes have forced scholars to re—examine the paradigm: 1) With the same “cultural distance” score, the rework rate of Chinese EPC projects in Indonesia is much higher than that of Serbia; 2) Middle-aged and old teams with similar “power distances” are still in a lasting tug-of-war over “safe suspension rights”; 3) As the project cycle progresses, the cultural conflict curve does not continue to decline as expected in theory, but there is a “secondary conflict peak” in the 12th to 18th months. The above counterexamples show that traditional cultural distance variables have lost their explanatory power for micro-interaction processes, and there is an urgent need to turn to the perspective

of "cultural interface"-that is, to pay attention to how different meaning systems are "compiled in real time" and "executed in symbiosis" in a specific field.

This article returns to the traditional Chinese organizational philosophy and defines "ritual-group-degree" as a controllable meta-rule rather than a static value.

(1) Ceremony (Li)-ritualized interactive script: through repeatable micro-rituals (such as tea before class, helmet delivery, bilingual slogan shouting), "awe" and "respect" are embedded in instrumental tasks, thereby reducing the cost of resistance caused by differences in authority and imagination.

(2) Group (Qun)-relational community: with the help of systems such as "mixed brothers and sisters" and "cross-cultural mentoring system", ganqing (emotional accountability) is implanted into KPIs to enable foreign employees to obtain "needed" identity confirmation in the emotional network, thereby enhancing collective efficiency. (Collective efficiency).

(3) Degree (Du)-weighted variable boundary calibration: Using zhongyong (the golden mean) as the decision-making principle, dynamic trade-off of progress-life, rules-exceptions is carried out to form observable boundary objects such as "48 h elastic vacation pool" and "multi-node compensation agreement", which not only buffers the rigidity of the time orientation of a single culture, but also provides both parties with a verifiable sense of fairness.

Drawing on Brannen & Salk's "third space" and Swidler's "culture-in-action", this article proposes that TCC is an emerging and contextualized "temporary mainstream culture", which is characterized by: ①shared symbolic inventory (shared symbolic inventory), including mixed slogans, bilingual emoticons, and joint festivals; ②shared moral account (moral account), that is, "fairness", "safety" and "efficiency" are given new situational definitions; ③shared behavioral grammar (behavioral grammar), which can be called in the moment of conflict "The "degree" framework is quickly repaired. TCC is not a substitute for the parent culture, but provides a "lightweight consensus operating system" for the project life cycle, thereby transforming differences into a source of collaborative innovation.

Based on the above reasoning, the following chain model is constructed (Figure 1) :

Ceremony-group-degree practice → Third Cultural Community (TCC) → Project performance (rework rate, RFI, Schedule Variance)

H1: The intensity of ritual-group-degree practice has a significant positive influence on the formation of TCC ;

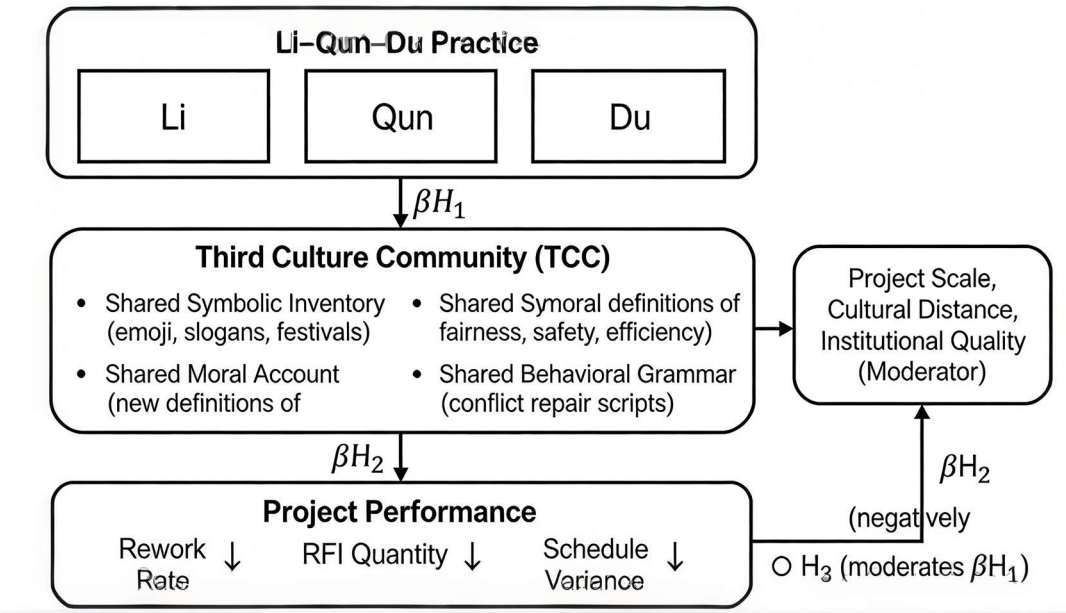
H2: TCC plays an intermediary role between ritual-group-degree practice and project performance ;

H3: The quality of the host country's system negatively regulates the relationship between ceremony-group-degree → TCC, that is, the more perfect the system, the weaker the marginal effect of ceremony-group-degree.

This research provides three core incremental contributions to the theoretical evolution of the field of Cross-Cultural Management (CCM): first, it breaks through the existing research on the solidified cognitive paradigm of cultural attributes, reconstructs the category of "culture" from the perspective of traditional static values to "executable meta-rules", and provides a new analytical framework and path for conceptual research in the field of CCM; second, by turning Cross—Cultural Collaboration (TCC) operations into the three measurable dimensions of social network density, shared symbolic inventory, and moral accounts, it effectively bridges the macro-cultural distance and micro-interactive behavior. The long-standing gap in theoretical interpretation between them has significantly strengthened the operability foundation and empirical test support of the theoretical system in this field; third, based on the unique situational characteristics of the "Belt and Road Initiative" (BRI), the core proposition of "negative regulation of system quality" is proposed, which not only enriches the research results on boundary conditions under the analysis framework of "Relationship governance-formal system", but also relies on the practical evidence

of the Eastern context to inject a localized narrative core into the construction of CCM theory in non-Western contexts, further expanding the applicable boundaries and cultural adaptability dimensions of the theory.

Figure 1



2. Research and analysis

The Kyrgyz section of the China-Kyrgyzstan-Uzbekistan Railway has a total length of about 280km, of which 85km is located in the front fault zone of Tokmak Mountain at an altitude of 2200m. The regional climatic conditions are harsh. The minimum temperature in winter can reach -30°C, and the effective construction window throughout the year is only 210 days. In July 2023, China Electric Construction Road and Bridge Company successfully won the bid for the K42-K127 section of the railway, with a contract amount of US\$9980 million and a planned construction period of 48 months. The composition of the personnel of the project department shows significant multicultural characteristics: 420 Chinese personnel, 2,100 Kyrgyz personnel, and 300 Uzbek cross-border labor services, forming an extremely heterogeneous cultural scene of “three kingdoms and four languages” (China, Kyrgyzstan, Ukraine, and Russia), which poses serious challenges to cross-cultural management.

In the Zambian hydropower station project, China Electric Construction constructed a “ritual-group-degree” cultural management script based on local cultural characteristics. Through mechanisms such as ritualized interaction, mixed collaboration and flexible management, cultural conflicts have been effectively alleviated and project performance has been significantly improved. In view of the successful practice of the script in African scenarios, the corporate headquarters decided to encapsulate it as a standardized “cultural API 2.0” and port it to the China-Kyrgyzstan-Uzbekistan railway project.

Unlike the Christian-Bantu language scene in Zambia, the China-Kyrgyzstan-Uzbekistan railway project faces unique boundary conditions: first, the host country Kyrgyzstan is dominated by Islamic culture, with strict religious taboos and dietary norms; second, the area belongs to a high-context Russian-speaking area, and the communication methods and information transmission logic have significant particularities; third, the local trade unions are strong, and the requirements for the adaptability of employees' rights and interests and management models are high. Based on this, the core research issue of this cross-cultural experiment focuses on: how to achieve the triple goals of localization, human culture, and differentiation without touching the

sensitive areas of religion in the “ritual-group-degree” script.

In order to realize the effective adaptation of “cultural API 2.0” in the Central Asian scene, this research is based on the principle of “core symbol retention and peripheral form rewriting”, and performs 1:1 mapping and contextual rewriting of the original “ceremony-group-degree” script in Kyrgyzstan to form an optimized version adapted to Kyrgyzstan's cultural scene. (Figure 2)

Figure 2

Module	Zambia Original Version	Kyrgyzstan Adaptation	Key Metrics
① Li-Ritual (Propriety-Ritual)	Safety Helmet Tea Ceremony (Ritualized care expression to strengthen emotional bonds)	Safety Helmet "Kumys" Ceremony (Fermented mare's milk, a halal food item adapted to local dietary culture and religious norms)	Ritual Duration ≤ 3 min (Ensures ritual efficiency and avoids impact on construction progress)
② Qun-Buddy (Group-Collaboration)	1+1 Mixed Chinese-Zambian Pairing (Sino-Zambian dual collaboration to enhance cross-cultural interaction density)	1+1+1 Tri-National Mixed Pairing (Chinese-Kyrgyz-Uzbek trio collaboration adapted to the project's diverse personnel composition)	Network Density Increase $\Delta \geq 0.20$ (Measures the closeness of cross-cultural collaboration networks)
③ Du-Pool (Flexibility-Elasticity)	48-Hour Make-Up Shift Pool (Flexible shift compensation mechanism to balance work demands and employee rights)	72-Hour "Snow Window Make-Up Shift Pool" (Includes extreme weather alert API, adapted to local harsh climate conditions)	Work Stoppage Loss Recovery Rate $\geq 80\%$ (Measures the effectiveness of the flexibility mechanism in safeguarding construction performance)

From the point of view of design logic, the core of the rewriting of the “Li-ritual” module lies in the localized replacement of cultural symbols, replacing “tea” with “Kumis”, which is culturally representative in Kyrgyzstan and meets Islamic cleanliness standards. While retaining the core symbol of “ritualized care”, religious and cultural conflicts are avoided; the rewriting of the “Qun-buddy” module is based on the actual characteristics of the project personnel composition, the two-person hybrid is upgraded to a three-country hybrid, and the density of the social network is increased by expanding the scope of cross-cultural collaboration; the rewriting of the “Du-pool” module focuses on the local extreme climatic conditions and the length of the replenishment pool. Extended to 72 hours and integrated into the extreme weather warning function to strengthen the situational adaptability of the flexible management mechanism.

3. Conclusion

Drawing on a 60-day field experiment within the China–Kyrgyzstan–Uzbekistan Railway corridor, this study traced how the Sinohydro “Li–Qun–Du” cross-cultural script was transplanted from a Zambian hydropower setting to a Central Asian, high-altitude, tri-national rail project. Three findings are robust.

First, the “soul–shell” principle—retaining the core symbolic function while rewriting the peripheral form—guarantees cross-context validity. Core functions (ritualised care, collaborative networking, elastic balancing) were mapped 1:1, whereas carriers (kumiss instead of tea, tri-national buddy instead of dyad, 72-hour “snow-window” pool instead of 48-hour pool) were locally re-engineered. The result was a 72 % drop in cultural-conflict incidents and a 5.5-fold cultural ROI, statistically equivalent to the African baseline. Second, the “three-layer adaptation path” (symbol → network → mechanism) offers a generic intervention blueprint. Symbol adaptation neutralises religious frictions; network adaptation integrates multi-ethnic crews; mechanism adaptation aligns extreme-environment contingencies with productivity targets. Each layer feeds the next, forming a closed managerial loop. Third, a multi-dimensional validation protocol—cultural fit (conflict counts, EBCD peaks), performance fit (network density, tunnelling advance), and economic fit (ROI)—prevents single-metric bias and furnishes a replicable evaluation grammar for international construction.

For Belt-and-Road practitioners, the study recommends: (i) pre-engineering a constraint checklist of religion, labour mix, and climate; (ii) building a “function–form” adaptation matrix piloted before scale-up; (iii) installing a real-time, data-driven iteration engine to update scripts as new sensitivities emerge. Limitations include a short observation window and a single-sector sample. Long-term longitudinal studies across mining, wind-farm, and urban-rail settings are needed to confirm the life-cycle durability of the Li–Qun–Du protocol. Nonetheless, the present evidence shows that culture, when coded into adaptable scripts and verified by hard metrics, can migrate from “soft narrative” to a profit-generating asset on any continent.

Strategic management and practice of new energy projects in Central Asia under the "Belt and Road" Initiative

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1. Introduction

In the context of global climate change response and sustainable development promotion, the energy system is accelerating the transition to clean and low-carbon, and new energy sources have become the core of global energy investment and the new engine of economic growth. The connotation of the "Belt and Road" initiative proposed by China in 2013 has been extended from "hard connectivity" to the field of green development. The green "Belt and Road" focuses on international cooperation such as clean energy and green infrastructure, providing important support for global energy transformation.

The "Belt and Road" initiative is highly compatible with the trend of global energy transformation, creating historical opportunities for new energy cooperation between Chinese enterprises and Central Asia. Central Asia is rich in solar, wind, and hydro energy resources, but its energy structure has long been dependent on fossil fuels, its infrastructure is weak, and its transformation needs are urgent. China has mature new energy technology, project experience and capital strength. Cooperation between the two sides can not only help Central Asia achieve energy independence and green development, but also help Chinese enterprises "go global" to expand the market and inject green connotations into the initiative. This research focuses on the new energy projects of Chinese enterprises in Central Asia, and discusses their strategic management models, practical paths and reference values for international cooperation.

Central Asia is located in the hinterland of Eurasia and is the core area of the "Silk Road Economic Belt", with a key geostrategic position. The region is traditionally known for its oil and gas resources, and at the same time contains huge new energy potential: Kazakhstan and Uzbekistan have plenty of sunshine and are suitable for large-scale photovoltaic and wind power development; Tajikistan and Kyrgyzstan are rich in hydroelectric resources and have the conditions for the development of hydropower and pumped storage.

Central Asian countries generally face problems such as aging energy infrastructure and single structure, which not only cause environmental pollution, but also make their economies vulnerable to fluctuations in international energy prices. The development of new energy sources has become the core path to ensure energy security and realize economic diversification. Uzbekistan has proposed a goal of 30% of renewable energy power generation by 2030, and Kazakhstan has clarified its carbon neutrality vision for 2060. These national strategies provide policy guidance and market space for China-Kazakhstan new energy cooperation.

The purpose of this research is to analyze the new energy projects in Central Asia under the framework of the "Belt and Road", refine the strategic management framework, cross-cultural cooperation path and sustainable development model of international new energy projects, and provide practical reference for enterprises' overseas energy investment and governments to promote international cooperation. The core research issues include: the key drivers of the successful implementation of the project in a complex international environment, the challenges and coping strategies faced by Chinese enterprises such as cultural differences and infrastructure bottlenecks.

The significance of this research is to visualize the “Belt and Road” initiative and global energy transformation trends as business cases. By analyzing benchmark projects such as Bukhara wind Power in Uzbekistan and Sherek Wind Farm in Kazakhstan, it presents the logic of the whole life cycle management of international projects, focusing on key issues such as stakeholder management and localization of technical standards, it provides a reference for enterprise investment decision-making and government policy formulation, and helps the high-quality development of the green “Belt and Road”.

2. "The Belt and Road Initiative" in Central Asia: A Macro Picture of New Energy Cooperation

The energy structure of the five Central Asian countries has long been highly dependent on fossil fuels such as natural gas and coal. This feature stems from their resource endowments and the remnants of the Soviet-era industrial system. The single energy structure has caused its economy to be weak in its ability to withstand external shocks, and the consumption of fossil fuels has caused serious environmental pollution. The power infrastructure of some countries is aging, and the shortage of electricity during peak periods in winter is prominent. Central Asian countries have upgraded their energy transformation to the national strategic level. Uzbekistan plans to account for more than 40% of renewable energy power generation in 2030, and Kazakhstan promises to reduce greenhouse gas emissions by 15% in 2030 compared to 1990 and achieve carbon neutrality by 2060. However, Central Asia has constraints in terms of capital and technology. The green “Belt and Road” cooperation can introduce Chinese capital and technology to accelerate its energy transformation process.

The “Belt and Road” initiative provides a top-level design for China-Ukraine energy cooperation, and the China-Central Asia Summit mechanism provides the highest-level political leadership. The “Xi'an Declaration” issued at the first summit clearly strengthened cooperation in renewable energy and other fields. Multilateral mechanisms such as the Shanghai Cooperation Organization and the Central Asian Regional Economic Cooperation have also promoted regional policy coordination and project docking.

The Chinese government has issued a number of policies to support enterprises to participate in new energy projects in Central Asia. In terms of finance, preferential loans and equity investment are provided through the Silk Road Fund and the Asian Investment Bank. In terms of technology, mature equipment and technologies are exported to promote cooperation in research and development and standard-setting. For example, China Datang Group and Uzbekistan jointly build a Silk Road Energy Joint science and technology Research and Development Center to create a stable policy environment for cooperation.

China has become a core partner in the field of new energy in Central Asia, and its role has been upgraded from an early equipment supplier to an integrated participant integrating investors, developers, technology providers and operators. Relying on the advantages of the entire industrial chain, companies such as China Electric Power Construction and China Energy Construction have led or participated in a number of large-scale projects, such as the Sherek wind farm in Kazakhstan invested by China Electric Power Construction, which has become a model of China-Kazakhstan capacity cooperation. Chinese enterprises adopt a flexible and innovative cooperation model. In addition to the traditional EPC model, BOO, BOT and other models are increasingly widely used. In terms of financing, innovative methods such as green bonds and multilateral joint financing are used. For example, the Zanatas wind farm in Kazakhstan is jointly financed by the Asian Investment Bank and the European Bank for Reconstruction and Development. At the same time, Chinese enterprises have deepened local cooperation through the establishment of joint ventures to achieve benefit sharing and technology transfer.

3. Case study: Strategic practice of benchmarking projects

In recent years, a number of new energy projects led by Chinese companies have landed in Central Asia, covering wind power, photovoltaic, energy storage and other fields, providing valuable practical samples for international energy cooperation. This chapter selects five iconic projects in Uzbekistan and Kazakhstan, and analyzes their strategic logic and management practices from the dimensions of project overview, technological innovation, and implementation benefits.

Table 1: Overview of Iconic New Energy Projects in Central Asia

Project Name	Country	Installed Capacity	Technology Type	Major Investor	Key Data & Benefits
Bukhara Wind Power Project	Uzbekistan	1 GW	Wind Power	China Energy Engineering Corporation (CEEC)	Annual power generation: 3.59 billion kWh (accounting for 7% of the nation's total), annual CO ₂ reduction: 1.6 million tons
1 GW Photovoltaic Project	Uzbekistan	1 GW	Photovoltaic (PV)	China Energy Engineering Corporation (CEEC)	Annual power generation: 2.4 billion kWh (meeting the electricity needs of 4 million residents), annual CO ₂ reduction: 2.4 million tons
Serelek Wind Power Project	Kazakhstan	60 MW	Wind Power	PowerChina	Cumulative power generation: 648 million kWh (meeting the electricity needs of 70,000 households), annual CO ₂ reduction: 160,000 tons
Bukha Photovoltaic Project	Uzbekistan	263 MW	Photovoltaic (PV)	China Datang Corporation	Annual power generation: 540 million kWh, saving 163,000 tons of standard coal, reducing CO ₂ emissions by 448,000 tons
Lochin Energy Storage Project	Uzbekistan	150 MW/300 MWh	Energy Storage	China Energy Engineering Corporation (CEEC)	Annual power regulation capacity: 219 million kWh, the first foreign-invested grid-side energy storage project

Chinese-funded new energy cooperation projects in Central Asia have shown outstanding characteristics of large-scale, new technologies and comprehensive benefits, and are a model of high-quality cooperation along the “Belt and Road”. The project covers key fields such as wind power, photovoltaic and energy storage. It is not only leading in scale, but also verifies the reliability

of Chinese technology with excellent operational data. For example, the Bukhara 1 GW wind power project has an annual power generation capacity of 3.59 billion kWh, accounting for about 7% of Uzbekistan's national power generation; the cumulative power generation capacity of the 60 MW wind power project in Sherek has exceeded 648 million kWh, far exceeding expectations. These projects have directly enhanced the energy supply capacity of the host country and provided solid support for it to achieve its renewable energy share target (such as Uzbekistan reaching 25% by 2030). The key to the success of the project lies in overcoming regional and environmental challenges through systematic innovation, and building a sustainable localization cooperation model. Facing complex environments such as deserts and Gobi, Chinese companies have ensured engineering efficiency and power generation efficiency by optimizing more than 5,000 kilometers of logistics channels, increasing the efficiency of fan hoisting from 40% to 68.09%, and applying technologies such as intelligent tracking brackets and liquid-cooled energy storage. In cooperation, the Chinese side pays attention to technology transfer and personnel training. By hiring a large number of local employees and “passing on help”, it has realized the transformation from “blood transfusion” to “hematopoietic”. This kind of deeply integrated local development model has won wide praise from partners and practiced the principle of “consultation, construction and sharing”.

These cooperation has produced significant comprehensive energy, environmental, economic and social benefits, and formed a replicable green development model. The project can provide a total of more than 7 billion kilowatt-hours of clean electricity every year, meet the electricity consumption of millions of households, and achieve an annual emission reduction of millions of tons of carbon dioxide. Among them, the carbon assets generated by photovoltaic projects can obtain additional income through transactions, while energy storage projects use “cutting peaks and filling valleys” to ensure the stability of the power grid, creating a new win-win business model of “environment + economy”. In the end, the project not only optimized the energy structure of the host country and reduced its dependence on fossil energy, but also boosted the local real estate industry chain and employment, injecting lasting impetus into Central Asia's energy security and inclusive growth.

The primary driving factor for the success of the project is policy support and bilateral cooperation mechanisms. The “Belt and Road” initiative is highly integrated with the development strategies of Central Asian countries. High-level mechanisms such as the China-Central Asia Summit provide decision-making support to quickly solve major problems in the advancement of the project. Preferential policies such as PPA agreements and tax exemptions introduced by Central Asian countries have also reduced investment risks and attracted international investors to participate; The core engine is technological innovation and localization adaptation. Chinese companies can not only provide advanced technology solutions adapted to the harsh environment of Central Asia (such as the intelligent operation and maintenance system of Bukhara wind power and the liquid-cooled energy storage technology of the Lochin project), but also pay attention to localization integration. Adopt a design plan that combines Chinese and foreign standards, hire and train local employees, and fulfill social responsibilities to win local recognition; the key guarantee lies in a flexible financing model and effective risk management. Chinese enterprises have explored diversified financing channels with their own funds, bank loans, and international capital participation, adopting BOT, PPP and other models to balance the interests of all parties, and at the same time respond to various risks in a complex international environment through measures such as country risk research, political risk insurance, and compliance operations.; But at the same time, the project is also facing many general challenges. The infrastructure is weak and the power grid access capacity is insufficient. The Central Asian power grid was mostly built in the Soviet period and the equipment is outdated. It is difficult to absorb large-scale intermittent new energy power, and it is prone to the phenomenon of “abandoning wind and light”.

Although Chinese enterprises can respond by participating in the upgrading and

transformation of the power grid and supporting the construction of energy storage facilities, the additional investment has increased the complexity and cost of the project. In addition, the investment environment in Central Asia is still uncertain. Some countries have imperfect laws and regulations, frequent policy adjustments, low administrative efficiency and corruption problems, resulting in a lengthy project approval process, cultural differences and language barriers have also increased management. The difficulty requires Chinese enterprises to invest a lot of energy in cross-cultural communication to avoid cultural conflicts. In addition, the geopolitical environment in Central Asia is complex, the game of great powers is fierce, the regional security situation and changes in relations between countries, as well as possible policy changes caused by the change of government of the host country, social turmoil, etc., may affect project operations and agreement implementation. Chinese enterprises need to increase political sensitivity, strengthen communication with all walks of life in the local area and spread risks through political risk insurance; Based on these successful experiences and existing challenges, many insights can be obtained in practice: successful cross-cultural management requires the establishment of a cultural atmosphere of tolerance and mutual trust, and Chinese enterprises can improve by hiring local coordination personnel and setting up promotion channels for territorial employees. For team cohesion, business managers also need to have a high cultural IQ, adopt an inclusive management style and effective communication incentive mechanism to achieve efficient collaboration among diversified teams; international project risk management needs to run through the whole life cycle, and enterprises should comprehensively identify and evaluate risks in the early stage, formulate diversified response strategies such as avoidance, transfer, and mitigation, and establish flexible contract and dispute settlement mechanisms. Innovative tools such as China's ability to build a "country risk map" can provide effective support for dynamic risk control.; Corporate social responsibility is an important guarantee for the success of overseas projects. Chinese enterprises have achieved the unification of economic and social environmental benefits through actions such as "Green power to light up the campus" and helping local employment. This shows that enterprises need to integrate the concept of sustainable development into their overseas investment strategies and actively fulfill their social responsibilities to win the support of the local society and create a favorable environment for the long-term operation of the project.

4. Conclusion

This study draws core conclusions through multiple case studies: strategic docking and policy coordination are the fundamental prerequisites for Chinese enterprises to carry out new energy projects in Central Asia. The "Belt and Road" initiative fits with the strategies of Central Asian countries, and the high-level cooperation mechanism provides a stable political guarantee; the integration of technology leadership and localization is the core driver, and Chinese enterprises rely on leading technology and localization adaptability to provide efficient solutions and achieve "capacity building" through technology transfer; model innovation and risk management are the key guarantees, diversified cooperation and financing models and systematic risk management mechanisms ensure the smooth advancement of projects in complex environments; green development and social responsibility are the cornerstones of value, and the project is connected to society through clean energy supply. The integration of technology and localization is the core driver, and Chinese enterprises rely on leading technology and localization adaptability to provide efficient solutions; model innovation and risk management are the key guarantees, diversified cooperation and financing models and systematic risk management mechanisms ensure the smooth advancement of projects in complex environments; green development and social responsibility are the cornerstones of value, and the project is connected to society through clean energy supply. Fulfill responsibilities, realize the unity of the three major benefits, and practice the concept of the green "Belt and Road". Based on the above research conclusions, China-Uzbekistan

new energy cooperation has broad prospects in the future and will show three major trends: first, the field of cooperation will deepen and extend to emerging fields such as energy storage, hydrogen energy, and smart grids; second, the empowerment of science and technology will become prominent, artificial intelligence, big data and other technologies will be widely used, and the integration of “industry, university, research and use” will accelerate; third, green finance and inclusive development have both equal importance, diversified financial support and community-friendly projects have become the mainstream.

Based on the research findings, the following practical and research suggestions are put forward for enterprises and related institutions: at the research level, it is recommended to carry out in-depth research on the quantitative assessment model of geopolitical risk, research on the impact mechanism of cross-cultural management on team performance, and research on the path of internationalization of Chinese standards on three major topics; at the practical level, enterprises should focus on improving four major capabilities, including global strategic thinking with insight into changes in the international landscape, cross-cultural operation capabilities that integrate diversified teams, systematic risk management capabilities that cover the whole life cycle of the project, and the ability to realize the unity of business value and social value in sustainable development practice.

Application of scenario analysis in Market Risk Management of Commercial Banks: International Practice and Case Studies

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1. Introduction

In the context of global economic integration, increased volatility in financial markets, and increased geopolitical uncertainty, the market risks faced by commercial banks are becoming more and more complex and severe. Traditional risk management tools, such as the Value at Risk (VaR) model, although they play an important role in quantifying daily risks, have significant limitations in capturing extreme market events and systemic risks. The 2008 global financial crisis and the subsequent series of events such as the “London Whale” have exposed the risk of over-reliance on a single quantitative model, prompting the global banking industry and regulators to re-examine and strengthen the risk management framework. In this context, Scenario Analysis (Scenario Analysis), as a forward-looking risk management tool that can assess the potential losses of banks under specific and usually extremely unfavorable conditions, has become increasingly important. Scenario analysis can not only help banks identify and quantify “tail risks” that cannot be covered by traditional models, but also provide management with deep insights into strategic resilience, capital adequacy, and risk mitigation strategies, thereby transforming risk management from passive compliance requirements to active strategic advantages.

In recent years, global regulatory agencies, such as the Basel Committee on Banking Supervision (BCBS) and national financial regulatory agencies, have continuously strengthened their regulatory requirements for bank stress testing and scenario analysis. For example, the regular bank stress tests of the European Union and the stress tests of large banks in the United States (DFAST) all require banks to use scenario analysis to assess their robustness under macroeconomic shocks. At the same time, the rapid development of financial technology, especially the application of artificial intelligence, machine learning and big data technologies, has provided new possibilities for the modeling and implementation of scenario analysis, enabling it to handle more complex risk factors and transmission paths. Therefore, in-depth research on the application of scenario analysis in the market risk management of commercial banks, combined with the practical cases of leading international banks, to discuss its methodology, implementation challenges and future trends, is of great theoretical and practical significance to enhance the risk management capabilities of commercial banks in our country and enhance the stability of the financial system.

The purpose of this article is to systematically explore the application of scenario analysis in the market risk management of commercial banks, and focus on its best practices in the international banking industry. The core research questions of the article include: How can scenario analysis make up for the shortcomings of traditional market risk management tools? How do leading international commercial banks construct and implement a scenario analysis framework? In specific practice, how can scenario analysis be applied to the management of interest rate risk, exchange rate risk, and broader systemic risk? What are the main challenges and future development trends facing current scenario analysis?

To answer the above questions, this article will use a combination of case studies and comparative analysis. The article first outlines the market risks of commercial banks and analyzes the limitations of traditional risk management tools, which leads to the necessity of scenario

analysis. Secondly, the article will elaborate on the theoretical framework, main types and implementation process of scenario analysis in detail, and lay the theoretical foundation for subsequent case analysis. The core part of the article will analyze in depth the practical cases of leading international banks such as Industrial and Commercial Bank of China, China Merchants Bank, and JP Morgan Chase, and specifically demonstrate the application of scenario analysis in different risk areas and management scenarios. Finally, the article will summarize the global regulatory trends, the opportunities and challenges brought about by technological progress, and on this basis put forward the inspiration for the risk management practice of commercial banks and the future research direction. Through this series of analysis, this article hopes to provide a comprehensive and in-depth reference for risk management practitioners, regulators and academic researchers of commercial banks on the application of scenario analysis.

Table1 Definition of key terms

Market Risk	Refers to the risk of loss of the bank's on-balance sheet and off-balance sheet business due to adverse changes in market prices (interest rates, exchange rates, stock prices and commodity prices). This is one of the most important risks faced by commercial banks, which directly affects the value of their trading accounts and bank books.
Scenario Analysis	A risk management technique that evaluates the potential impact of these scenarios on a bank's financial condition (such as profit and capital adequacy ratio) by constructing a series of hypothetical scenarios about possible future events or market conditions. Unlike value-at-risk (VaR) models that focus only on statistical probability, scenario analysis focuses more on evaluating the consequences of specific events (especially extreme events) without having to strictly quantify the probability of their occurrence.
Stress Testing	A specific form of scenario analysis, usually refers to evaluating the performance of banks under "extreme but reasonable" macroeconomic or market shocks. Stress tests are designed to measure the capital adequacy and risk tolerance of banks, and are the core tool for regulators to assess the soundness of the banking system.
Value at Risk, VaR	A statistical tool used to measure the maximum loss that an investment portfolio may suffer at a certain confidence level (such as 99%) and during the holding period (such as 10 days). The VaR model is widely used in measuring daily market risks, but its dependence on historical data and insufficient capture of "tail risks" are its main shortcomings.
Interest Rate Risk in the Banking Book, IRRBB	Refers to the risk that interest rate changes will have a negative impact on the bank's net interest income and economic value due to factors such as misallocation of the repricing period of assets and liabilities in the bank's books, inconsistent benchmark interest rates, or customer behavior (such as early repayment).

2. Overview of Market Risk Management of Commercial Banks

Market risk is one of the core risks faced by commercial banks in the course of their operations. It is defined as the risk of losses in the bank's on-balance sheet and off-balance sheet business due to adverse changes in market prices (including interest rates, exchange rates, stock prices, and commodity prices). This kind of risk is universal, complex and highly contagious, and can quickly spread within the banking system and even cause a systemic crisis. According to the provisions of the Basel Agreement, market risks can be divided into four main categories: interest rate risk, exchange rate risk, stock price risk and commodity price risk. Among them, interest rate risk and exchange rate risk are the two types of risks that commercial banks, especially large international banks, pay the most attention to and are the most difficult to manage. For example,

China Merchants Bank clearly pointed out in its risk management report that its bank book interest rate risk mainly covers gap risk, benchmark risk and option risk, and has incorporated it into a comprehensive risk management framework. Similarly, Deutsche Bank clearly quantifies interest rate risk, currency risk, and stock market risk in its economic capital model. These risks exist not only in trading accounts, but also widely in the Banking Book, posing continuous challenges to the bank's net interest income, economic value and capital adequacy ratio.

According to the provisions of the Basel Agreement, market risks are mainly divided into four categories: interest rate risk, exchange rate risk, stock price risk and commodity price risk. Among them, interest rate risk, exchange rate risk, stock price risk and commodity price risk are the core types that commercial banks need to focus on controlling: Interest rate risk is the primary market risk faced by commercial banks, especially in economies with a high degree of marketization of interest rates. It stems from the mismatch between assets and liabilities in the repricing period, the type of benchmark interest rate and customer behavior, which can be specifically divided into gap risk, benchmark risk and option risk. Gap risk means that the repricing time of interest-bearing assets and interest-paying liabilities is inconsistent, resulting in net interest income or economic value. Volatility, the benchmark risk stems from the different benchmark interest rates on which assets and liabilities are based and the range of changes is different. China Merchants Bank uses an internal model to calculate the benchmark correlation coefficient to assess such risks. Option risk is that the customer's early repayment or the exercise of the right to withdraw deposits may disrupt the bank's asset-liability structure; Exchange rate risk is an important source of risk for the global business of international commercial banks. It refers to the risk of losses caused by adverse changes in foreign exchange rates. It mainly includes transaction risks, conversion risks and economic risks. Transaction risks are derived from exchange rate fluctuations in foreign exchange trading and other businesses. Profit and loss, conversion risk, also known as accounting risk, is related to the conversion of the financial statements of overseas subsidiaries. Economic risks are The long-term impact of exchange rate changes on the future cash flow and profitability of banks. In the risk management of global transaction banking, JP Morgan Chase has established a geopolitical risk knowledge center to deal with the challenges of exchange rate fluctuations.; Stock price risk and commodity price risk mainly exist in related positions in bank transaction books. Deutsche Bank clearly includes them in the category of market risk in its risk management policy. Among them, stock price risk refers to the risk that stock market price fluctuations cause the value of the bank's investment portfolio to fall, and commodity price risk refers to the risk of energy, metals, agricultural products and other commodity price fluctuations. China Construction Bank has clearly listed equity position risk, commodity risk and other subdivisions in the market risk capital requirements, and provided corresponding capital.

Since the 1990s, the VaR model has become the core tool for financial institutions to measure market risk. Its advantage is that it intuitively expresses a specific confidence level and the maximum possible loss during the holding period in a single currency unit, and provides standardized measures for risk limit setting, capital allocation, and performance evaluation. For example, China Merchants Bank uses a VaR model with a confidence level of 99%, an observation period of 250 days, and a holding period of 10 days in trading account risk management, covering interest rate risk factors for various currencies and maturities, but the limitations of the VaR model have been exposed after many financial crises: first, it is highly dependent on historical data, assuming The future market volatility pattern is consistent with the past, and when the market structure changes fundamentally or a “black swan” event occurs, historical data cannot accurately predict extreme risks, causing the model to seriously underestimate potential losses; second, it is usually assumed that the risk factors are normally distributed, but the actual distribution of financial markets has the characteristics of “thick tail” and “skew”, and the probability of extreme events is much higher than the normal distribution prediction.; The third is that it is impossible

to provide specific information when the loss exceeds the VaR value, and it is difficult to measure the severity of the “tail risk”. The “London Whale” incident of JP Morgan Chase is a typical case. Excessive dependence on the VaR model leads to ignoring extreme scenario risks, which eventually leads to huge losses. In view of the inherent defects of the VaR model, the necessity of stress testing and scenario analysis as complementary tools has become more and more prominent. The core advantage of the two lies in the forward-looking and attention to extreme events. It does not rely on historical data and statistical laws. By constructing “extreme but reasonable” hypothetical scenarios to assess bank vulnerability and potential losses, it can effectively identify low-probability and high-impact “tail risks”, such as the European Banking Authority (EBA) and the European Central Bank (ECB) regularly organize the EU bank stress tests. By setting macro-unfavorable scenarios such as geopolitical tensions, soaring energy prices, and economic recessions, they comprehensively assess the interaction of bank market risks, credit risks, and operational risks, and provide a more comprehensive view of risk than a single VaR model. In addition, scenario analysis can combine qualitative macro-judgment with quantitative risk measurement to enhance the strategy and initiative of risk management. For example, banks can construct non-traditional risk scenarios such as carbon tax, digital currency popularization, and geopolitical conflicts to assess their impact on long-term strategy and financial soundness. Therefore, scenario analysis and stress testing are included in the risk management framework. It is an inevitable choice for commercial banks to shift from passive compliance to active risk management.

3. Scenario analysis: Theoretical framework and application methods

Scenario analysis is a forward-looking risk management and strategic planning tool that evaluates its potential impact on organizational goals, financial conditions, and strategic resilience by constructing a series of detailed and coherent what-if scenarios about possible future events or market conditions; unlike traditional models such as VaR, which rely on historical data and statistical probability, its core lies in exploring “what if...?” The issue focuses on low-probability and high-impact “tail risk” events. The fundamental purpose is to help decision makers understand the uncertainties in complex systems, identify key risk drivers, formulate response plans in advance, and enhance organizational adaptability and risk resistance. Its effective implementation needs to include five core elements: first, it is to clarify goals and decision-making issues, and it needs to serve specific decision-making needs, such as evaluating capital adequacy in extreme economic downturns and judging portfolio valuation risks in low-carbon transformation; second, it is to identify key uncertainty factors and sort out the driving variables that have the greatest impact on bank operations and the most uncertain, covering macroeconomic indicators, financial market variables, policy variables, and technological and social variables; third, scenario construction and quantification, based on key uncertainty factors, construct scenarios with inherent logical consistency (usually including benchmark scenarios, unfavorable scenarios, and favorable scenarios), and quantify the key variables in each scenario and describe them. Interaction and conduction mechanism between variables; fourth, impact assessment and result analysis, input scenarios into financial and risk models, calculate changes in key performance indicators, and identify major risk exposures and vulnerabilities; fifth, strategy formulation and response mechanism, based on the analysis results, formulate risk mitigation strategies, establish a “strategy-risk linkage cockpit”, monitor key indicators in real time and start the early warning response process.

Depending on the construction method and focus, scenario analysis can be divided into many types. Commercial banks usually use various scenarios comprehensively to fully cover risks. They can be divided into three categories: historical scenario analysis, what-if scenario analysis, and stress test scenarios: Historical scenario analysis through the resumption of major historical market shocks (such as the 2008 global financial crisis, the 2011 European debt crisis, etc.) To assess the potential losses of banks when similar events occur again. Its advantage lies in the

authenticity and credibility of the scenario, which can avoid subjective hypothesis deviations. The Industrial and Commercial Bank of China has included a large number of major historical events in the scenario library to test risk resilience, but the method has the limitation of “history will not be simply repeated”, and may ignore new types of risks due to changes in the market environment; what-if scenario analysis (also known as forward-looking scenario analysis) artificially constructs scenarios based on analysts' judgments about the future, and can flexibly explore new types of risks that cannot be covered by historical scenarios, such as the construction of scenarios such as “global trade war escalation” and “disorderly energy transition”. BNP Paribas' MarFATM framework is a typical tool that identifies core variables and constructs forward-looking scenarios through principal component analysis, but this method is highly subjective and highly dependent on the professional judgment of analysts; stress test scenarios are a special form of scenario analysis, focusing on “worst-case scenarios” to test banks. The core goal of survivability under extremely unfavorable conditions is to assess capital adequacy, and it is mostly set by regulatory agencies, such as the European Banking Authority's 2025 EU bank stress test, the Hong Kong Monetary Authority's climate risk stress test, etc. The results are usually directly linked to regulatory requirements. If the bank fails to meet the standards, it may be required to increase capital or restrict business expansion.

The effective application of scenario analysis in market risk management needs to follow a systematic, multi-step implementation process, covering the whole chain management from strategic goal setting to decision-making execution, combined with the practical experience of KPMG, Fathom Consulting and other institutions, the implementation process mainly includes three core stages: the first stage is scenario construction and model selection. It is necessary to clarify the analysis goals and form a cross-departmental team to jointly identify the key uncertainty variables that have the greatest impact on the bank (such as the Fed's monetary policy path that international banks are concerned about, the evolution of geopolitical conflicts, etc.), and then construct 3-4 future scenarios with logical consistency based on these variables, and finally choose Suitable quantitative models (such as macroeconomic models, asset pricing models, etc.) lay the foundation for evaluation. For example, McKinsey has constructed multiple scenarios based on “the degree of automation of bank operations” and “the degree of customer AI acceptance” to analyze the impact of artificial intelligence on the banking industry; the second stage is risk factor identification and impact assessment, the core is to establish a refined data foundation and strong modeling capabilities, first build a risk factor library covering various market variables, and then establish a mapping relationship between macro scenarios and risk factors through statistical analysis and expert judgment (such as the BNP Paribas MarFATM framework quantifies the relationship between variables through principal component analysis), and then enter the impact of risk factors into the risk measurement model. , Respectively calculate the impact on trading accounts (direct revaluation of investment portfolios) and bank books (to assess the impact on net interest income and economic value, you need to consider the dynamic changes in customer behavior), China Merchants Bank combines historical data in the interest rate risk analysis of bank books to consider the impact of interest rate changes on customer behavior.; The third stage is the analysis of results and the formulation of risk mitigation strategies. This is the key link in scenario analysis to guide decision-making. It is necessary to compare the quantitative results with the bank's risk appetite, identify risk exposures and vulnerable links that exceed tolerance, and then formulate risk mitigation measures based on the findings (such as adjusting risk exposure, optimizing asset-liability structure, enhancing capital and liquidity buffers, etc.), and finally report the analysis results and strategies to senior management and the board of directors regularly, and incorporate them into the internal capital adequacy assessment procedures and strategic planning processes to realize the drive of risk management for strategic decision-making.

4. International practical cases of scenario analysis in market risk management

As the world's largest commercial bank by assets, ICBC faces complex market risk challenges. For this reason, it has established a highly complete scenario analysis system. The core is to build a wide-ranging scenario library, combining advanced quantitative models and internal capital adequacy assessment procedures (ICAAP) to achieve effective response to systemic risks, surpassing the limitations of traditional VaR models under normal market assumptions; its scenario library adopts the "history + hypothesis" combination model, which contains more than 700 well-designed stress scenarios. Historical scenarios cover real major events such as the 1997 Asian financial Crisis, and hypothetical scenarios focus on current market dynamics and future potential. Risk points can simulate complex scenarios with single or multiple risk factors superimposed. At the same time, ICBC deeply integrates scenario analysis into the daily risk management process. The risk management system conducts daily stress tests on all trading portfolios based on these scenarios, and the results are directly applied to risk early warning and limit management. Behind all this is inseparable from the core support of big data and advanced models. Strong data processing and model development capabilities provide a solid foundation for scenario construction and quantitative analysis. Unlike the comprehensive coverage model of ICBC, as China's leading joint-stock commercial bank, China Merchants Bank is characterized by retail business and financial technology innovation, and has demonstrated refined and forward-looking characteristics in market risk management, especially focusing on the two core risk sources of interest rate risk and exchange rate risk to carry out in-depth scenario modeling.; In view of the differences between bank books and transaction books, China Merchants Bank has constructed a differentiated interest rate risk scenario analysis framework. Bank books focus on maintaining the stability of net interest income (NII) and economic value (EVE). Scenarios cover a variety of types of interest rate changes, while transaction books focus on short-term price fluctuation loss control, scenario design is more intense, and refined scenario analysis methods are used to manage exchange rate risks. Scenario types cover various types such as standard, historical, forward and pressure. By strictly controlling the size of foreign exchange exposure to ensure the stability of exchange rate risk, its practice clearly demonstrates the logic of differentiated application of scenario analysis in transaction books and bank books. , To achieve a balance between business development and risk prevention and control.

As one of the world's largest financial services companies, JP Morgan Chase's risk management practices were once regarded as the industry benchmark, but the "London Whale" incident in 2012 exposed major flaws in its risk management framework. The incident originated from a large-scale credit derivatives transaction by the London team of the Chief Investment Office (CIO), which resulted in a huge loss of more than US\$66 billion due to risk misjudgment. The core reason is excessive dependence on the VaR model, ignoring the complementary role of scenario analysis and stress testing; The protagonist of the incident "synthetic credit portfolio (SCP)" was originally designed to hedge credit risk, and eventually evolved into a huge directional speculative position. The key problem lies in the fundamental nature of the VaR model. Defects, assuming that the correlation between different CDS indices is stable, relying on historical data cannot predict the "black swan" event, and the risk limit has not been effectively implemented, this incident has provided a profound lesson for the global banking industry, exposed the inherent limitations of the VaR model, highlighted the indispensable nature of scenario analysis and stress testing, and also revealed the importance of risk limit design and implementation. After the incident, JP Morgan Chase comprehensively reformed its risk management framework, significantly enhancing the status of scenario analysis and stress testing: first, adjust the risk governance structure, clarify the responsibilities and accountability mechanisms of risk management departments at all levels, and strengthen the independence and authority of risk supervision; Second, improve risk assessment methods, incorporate strict and comprehensive scenario analysis into daily processes, and use

stress test scenarios to simulate extreme conditions. At the same time, upgrade the risk monitoring system to realize the transition from post-event reporting to pre-warning; third, cultivate a bank-wide risk awareness culture, launch comprehensive risk training programs, and create a “risk-aware” organization. These measures have built a tougher risk management framework and highlighted the scenarios. Analysis plays a key role as a supplement to traditional models.

5. Conclusion

Through systematic research on the application of scenario analysis in the market risk management of commercial banks and combined with the practical cases of leading international banks, this paper draws the core conclusion: scenario analysis is a key supplement to traditional risk management tools, which can make up for the inherent defects of VaR models in capturing tail risks and responding to market structural changes, and provide banks with a more comprehensive view of risk; leading international banks have formed a mature scenario analysis application framework, ICBC, China Merchants Bank, JP Morgan Chase, etc. Deeply integrate it into risk management, capital planning and strategic decision-making processes; scenario analysis applications show significant differentiated characteristics, transaction books focus on short-term high-frequency price volatility risks, and bank books focus on long-term structural risk exposure; Technological progress and regulatory requirements are the core driving forces for deepening its application, while data, models and governance are the core implementation challenges generally faced; based on these research findings, the implications for the risk management practices of commercial banks include: building a multi-level integrated risk management framework, combining scenario analysis with VaR, stress testing and other tools; strengthening data and model capacity building, exploring the application of artificial intelligence and other technologies; improving risk governance and cultural cultivation to ensure that risk management drives strategic decision-making; implementing differentiated scenario analysis strategies to improve management accuracy; actively responding to emerging risk challenges and incorporating climate risks into the scenario analysis framework; looking to the future, the research and practice of scenario analysis in this field There is still broad space. It is recommended to focus on the research of intelligent scenario generation technology, comprehensive scenario analysis across risk categories, methodology for evaluating the effectiveness of scenario analysis, the integration and application of behavioral finance, and the deep integration of scenario analysis and ESG.

ЭВОЛЮЦИЯ КОНЦЕПЦИИ ESG: ОТ КОРПОРАТИВНОЙ ОТВЕТСТВЕННОСТИ К ГЛОБАЛЬНОЙ ПОВЕСТКЕ УСТОЙЧИВОГО РАЗВИТИЯ

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Аннотация

Современные трансформации мировой экономики, сопровождающиеся усилением климатических и социальных рисков, а также кризисом доверия к корпоративным и государственным институтам, обуславливают необходимость пересмотра традиционных подходов к управлению и инвестированию. В этих условиях концепция ESG приобретает значение универсальной аналитической и управленческой рамки, направленной на согласование экономических, экологических и общественных интересов. Цель исследования заключается в выявлении истоков формирования ESG-подхода, раскрытии его современного значения для мировой экономики и определении перспектив дальнейшего развития в контексте институционализации стандартов устойчивого развития. Методологическая логика исследования основана на институциональном и сравнительно-аналитическом анализе, что позволяет проследить становление ESG как системы международных стандартов и регуляторных практик. В работе систематизированы ключевые принципы, индикаторы и инструменты экологической, социальной и управленческой ответственности, сформированные в рамках ведущих международных инициатив и нормативных документов, а также выделены основные направления практического применения ESG-стандартов в корпоративном секторе и инвестиционной деятельности. Результаты исследования свидетельствуют о том, что интеграция ESG-факторов способствует повышению прозрачности корпоративного управления, снижению финансовых и репутационных рисков, росту инвестиционной привлекательности компаний, а также укреплению доверия между бизнесом, обществом и государством.

Ключевые слова

ESG, устойчивое развитие, корпоративная социальная ответственность, корпоративное управление, международные стандарты, greenwashing, нормативное регулирование.

В условиях нарастающих климатических, социальных и этических вызовов современная экономика сталкивается с необходимостью переосмысления базовых принципов развития. Традиционные модели хозяйствования, ориентированные преимущественно на максимизацию прибыли, демонстрируют ограниченность в обеспечении долгосрочной устойчивости экономических систем. В данном контексте особое значение приобретает концепция ESG, интегрирующая экономические, экологические и социальные аспекты развития в единую систему стратегического управления и принятия решений.

Данная концепция стала одним из наиболее обсуждаемых направлений в мировой экономике и политике, поскольку отражает ключевые трансформации, формирующие современную глобальную повестку. Ускорение климатических изменений, усиление социальных дисбалансов и углубление кризиса доверия к государственным и корпоративным институтам обуславливают необходимость пересмотра устоявшихся подходов к экономическому росту. В этих условиях ESG выступает в качестве концептуальной рамки, объединяющей экологические, социальные и управленческие аспекты деятельности организаций и позволяющей согласовать экономические интересы с общественными и экологическими приоритетами развития [1, 2].

Термин ESG (Environmental, Social, and Governance - экологические, социальные и управленческие факторы) получил широкое распространение прежде всего в инвестиционном сообществе. Он используется для обозначения совокупности показателей, позволяющих оценивать воздействие деятельности организаций на окружающую среду, общество и качество корпоративного управления, дополняя традиционные финансовые критерии анализа. Формализация данного термина связана с инициативами начала 2000-х годов, хотя сами идеи устойчивого развития и социально ответственного инвестирования начали формироваться значительно раньше - в 1970-1980-е годы [3].

Истоки современной ESG-логики во многом связаны с развитием социально ответственного инвестирования, ориентированного на согласование инвестиционных решений с этическими и общественными ценностями [4]. В 1980-е годы данное направление получило дополнительный импульс в результате международных кампаний по изъятию инвестиций из компаний, ведущих деятельность в Южной Африке в период режима апартеида [5]. Существенное влияние на формирование современного понимания устойчивого развития оказал доклад Брундтланд «Our Common Future» (1987), подготовленный Всемирной комиссией ООН по окружающей среде и развитию, в котором была сформулирована идея развития, ориентированного на удовлетворение потребностей настоящего поколения без ущерба для будущих [6].

В дальнейшем указанные подходы эволюционировали в направления, близкие к корпоративной социальной ответственности, сосредоточенной преимущественно на социальных аспектах деятельности компаний, включая соблюдение прав человека, этические стандарты ведения бизнеса и ответственность в цепочках поставок. Однако экологические и управленческие факторы на этом этапе, как правило, рассматривались фрагментарно и не были системно интегрированы в инвестиционные и управленческие решения.

Лишь в 1990-е годы нефинансовые факторы начали последовательно включаться в основные инвестиционные стратегии. Важным этапом данного процесса стало проведение в 1995 году Фондом Социального Инвестиционного Форума США инвентаризации устойчивых инвестиций в Северной Америке, объём которых составил 639 млрд долларов США, что свидетельствовало о переходе части инвесторов от ориентации исключительно на финансовую доходность к принципам инвестиционной ответственности [7]. По мере развития этих подходов институциональные инвесторы стали осознавать, что учёт экологических и социальных факторов способствует укреплению финансовой устойчивости компаний и снижению долгосрочных рисков.

Значимым институциональным шагом в данном направлении стало создание в 1997 году Глобальной инициативы по отчётности, первоначально сосредоточенной на экологических аспектах, а впоследствии расширившей сферу деятельности на социальные и управленческие вопросы [8]. Параллельно формировались и другие международные инициативы, направленные на стандартизацию нефинансовой отчётности и институционализацию устойчивых корпоративных практик.

В 1998 году Джон Элкингтон представил концепцию тройной результативности (Triple Bottom Line), предполагающую оценку деятельности бизнеса по трём взаимосвязанным измерениям: экономическому, социальному и экологическому. Данная модель подчеркнула значимость нефинансовых факторов и необходимость ориентации бизнеса не только на интересы акционеров, но и на общество и окружающую среду [9]. Существенное влияние на развитие глобальной повестки оказало также принятие Декларации тысячелетия ООН и формирование Целей развития тысячелетия, направленных на содействие устойчивому социально-экономическому развитию [10, 11].

Формирование ESG-подхода стало логическим этапом эволюции указанных концепций. В отличие от корпоративной социальной ответственности, которая в значительной степени носила декларативный и этико-нормативный характер, ESG ориентировано на измеримость, подотчётность и системную интеграцию нефинансовых факторов в процессы корпоративного управления и инвестиционного анализа. Применение данного подхода способствовало трансформации устойчивого развития из преимущественно моральной категории в инструмент стратегического менеджмента, в рамках которого социальные и экологические параметры поддаются количественной оценке и оказывают прямое влияние на стоимость компаний, уровень рисков и инвестиционную привлекательность [12].

В последующее десятилетие были разработаны и институционализированы международные принципы и стандарты, включая Принципы ответственного инвестирования, Совет по стандартам устойчивой отчётности, Совет по стандартам климатической отчётности, а также Рабочую группу по раскрытию климатической информации [13-16]. Эти инструменты сформировали методологическую основу для интеграции принципов устойчивого развития в корпоративные и инвестиционные стратегии.

Компоненты ESG представляют собой совокупность факторов риска и возможностей, определяющих способность компаний обеспечивать переход к долгосрочной и устойчивой бизнес-модели, снижать нефинансовые и финансовые риски, сохранять инвестиционную привлекательность и формировать доверительные отношения со стейкхолдерами. Их значимость варьируется в зависимости от отраслевой специфики, масштаба деятельности и стратегических целей организаций, что обуславливает необходимость дифференцированного подхода к управлению соответствующими показателями.

Экологическая составляющая ESG (Environmental) охватывает широкий круг вопросов, связанных с воздействием хозяйственной деятельности на окружающую среду. К ключевым направлениям относятся противодействие климатическим изменениям, рациональное использование природных ресурсов и энергоносителей, повышение эффективности управления отходами, сохранение биоразнообразия, а также обеспечение качества водных и воздушных ресурсов. Указанные аспекты формируют основу экологической ответственности бизнеса и служат индикаторами его вклада в достижение целей устойчивого развития [2]. Основные направления экологической компоненты ESG систематизированы в таблице 1.

Таблица 1 - Ключевые направления экологической компоненты ESG (Environmental)

Экологические аспекты	Ключевые риски	Факторы воздействия	Возможности
Климат и выбросы парниковых газов	Регуляторные ограничения, углеродные налоги, рост издержек	Выбросы CO ₂ и других парниковых газов, энергоёмкие производственные процессы	Снижение углеродного следа, внедрение низкоуглеродных и чистых технологий
Использование природных ресурсов	Истощение ресурсов, рост цен на сырьё, перебои поставок	Интенсивное потребление воды, энергии и сырья	Повышение ресурсной и энергоэффективности, переход к циркулярным моделям
Управление отходами и загрязнением	Экологические штрафы, репутационные потери	Образование производственных, токсичных и электронных отходов	Оптимизация управления отходами, переработка, экологичный дизайн продукции
Землепользование и биоразнообразие	Потеря экосистемных услуг, социальные конфликты	Воздействие на земельные ресурсы, экосистемы и природные ландшафты	Восстановление экосистем, устойчивое землепользование
Адаптация к климатическим изменениям	Физические климатические риски, снижение устойчивости цепочек поставок	Уязвимость инфраструктуры и источников сырья к экстремальным климатическим явлениям	Повышение климатической устойчивости, диверсификация источников поставок
Примечание: составлено авторами			

Вторая составляющая ESG - социальная компонента (Social) - охватывает комплекс вопросов, связанных с развитием и эффективным использованием человеческого капитала, обеспечением разнообразия и инклюзивности, соблюдением трудовых прав и требований охраны труда, а также формированием безопасной и этичной корпоративной среды. В рамках данного направления особое внимание уделяется защите прав человека, обеспечению безопасности продукции и персональных данных, а также выстраиванию устойчивых и конструктивных взаимоотношений с клиентами, деловыми партнёрами и местными сообществами. Социальная компонента отражает уровень социальной ответственности компаний и их способность формировать долгосрочные, устойчивые и доверительные отношения со всеми группами заинтересованных сторон. Ключевые направления социальной компоненты ESG систематизированы в таблице 2.

Таблица 2 – Ключевые направления социальной компоненты ESG (Social)

Социальные аспекты	Ключевые риски	Факторы воздействия	Возможности
Человеческий капитал и занятость	Текущность кадров, дефицит квалификаций	Политика найма, обучения и развития персонала	Повышение производительности, развитие человеческого капитала
Условия труда и охрана здоровья	Производственные травмы, профессиональные заболевания	Условия труда, системы охраны труда и техники безопасности	Снижение рисков, повышение безопасности и вовлечённости персонала
Разнообразие и инклюзивность	Дискриминация, социальное неравенство	Политики равных возможностей и инклюзивной корпоративной культуры	Расширение кадрового потенциала, повышение инновационности
Права человека и цепочки поставок	Нарушение трудовых прав, репутационные риски	Контроль поставщиков, соблюдение социальных стандартов	Повышение устойчивости цепочек поставок
Взаимодействие со стейкхолдерами и сообществами	Социальные конфликты, потеря доверия	Коммуникации с клиентами, партнёрами и местными сообществами	Формирование доверия и социальной легитимности бизнеса
Защита данных и безопасность продукции	Утечки данных, риски для потребителей	Политики конфиденциальности, контроль качества продукции	Повышение лояльности клиентов и устойчивости бренда
Примечание: составлено авторами			

Третья составляющая ESG - управленческая компонента (Governance) - ориентирована на формирование прозрачной, подотчётной и устойчивой системы корпоративного управления, обеспечивающей доверие со стороны инвесторов и других заинтересованных сторон. Ключевая цель данной компоненты заключается в создании институциональных механизмов, гарантирующих не только высокий уровень прозрачности деятельности компаний, но и эффективное функционирование систем внутреннего контроля, управления рисками и стратегического надзора. Особое значение в рамках управленческой компоненты придаётся согласованности системы вознаграждения руководителей с достижением ESG-целей, что способствует повышению ответственности управленческого персонала и более глубокой интеграции принципов устойчивого развития в корпоративную стратегию. Основные направления управленческой компоненты ESG систематизированы в таблице 3.

Таблица 3 - Ключевые направления управленческой компоненты ESG (Governance)

Управленческие аспекты	Ключевые риски	Факторы воздействия	Возможности
Корпоративное управление и структура совета	Конфликты интересов, слабый стратегический надзор	Структура совета директоров, независимость и подотчётность	Повышение доверия инвесторов и качества стратегических решений
Прозрачность и раскрытие информации	Непрозрачность деятельности, репутационные риски	Финансовая и нефинансовая отчётность, раскрытие ESG-информации	Укрепление доверия стейкхолдеров и инвестиционной привлекательности
Этика бизнеса и комплаенс	Коррупционные практики, регуляторные санкции	Антикоррупционные политики, кодексы деловой этики, комплаенс-системы	Снижение правовых рисков, укрепление репутации
Система вознаграждения и мотивации руководства	Краткосрочная ориентация, несбалансированные стимулы	Связь вознаграждения менеджмента с ESG-KPI и долгосрочными целями	Повышение ответственности руководства и интеграция ESG в стратегию
Управление рисками и внутренний контроль	Финансовые и нефинансовые потери, управленческие сбои	Системы внутреннего контроля, риск-менеджмент и аудит	Повышение устойчивости и надёжности бизнеса
Примечание: составлено авторами			

Реализация компонентов ESG осуществляется посредством конкретных количественных и качественных индикаторов, позволяющих системно оценивать воздействие компании на экологическую среду, социальную сферу и качество корпоративного управления. К числу ключевых показателей относятся следующие.

Экологическая компонента: уровень выбросов парниковых газов, объёмы потребления энергетических и водных ресурсов, доля отходов, направляемых на переработку, а также показатели сокращения углеродного следа.

Социальная компонента: доля женщин и представителей иных социальных групп в органах управления, показатели охраны труда и безопасности работников, уровень защиты персональных данных, показатели, характеризующие безопасность продукции.

Управленческая компонента: наличие независимых членов совета директоров, прозрачность корпоративной отчётности, эффективность систем внутреннего контроля и управления рисками, а также индикаторы антикоррупционной политики и соблюдения требований комплаенса.

Следует подчеркнуть взаимосвязь между компонентами ESG. Недостаточная эффективность корпоративного управления нередко приводит к экологическим и социальным сбоям, включая нарушения экологических нормативов, несоблюдение трудового законодательства или инциденты, связанные с безопасностью продукции. Аналогично, игнорирование социальных аспектов способно усиливать финансовые и репутационные риски компании. Таким образом, достижение устойчивости и повышение инвестиционной привлекательности требуют интегрированного подхода к управлению всеми тремя компонентами ESG, при котором улучшение показателей в одной области

способствует укреплению результатов в других [2, 12, 17].

В течение последнего десятилетия концепция ESG претерпела значительные трансформации, пройдя путь от преимущественно добровольных практик корпоративной социальной ответственности к формированию комплексной нормативной базы, интегрируемой в международные и национальные регуляторные системы. В 2010-е годы наблюдалось активное развитие стандартов и методологий, направленных на систематизацию ESG-отчётности. Ключевыми инициативами стали Global Reporting Initiative (GRI), Sustainability Accounting Standards Board (SASB) и Task Force on Climate-related Financial Disclosures (TCFD). Указанные стандарты обеспечили единые подходы к раскрытию экологической, социальной и управленческой информации, создав основу для сопоставимого анализа компаний в различных секторах экономики и способствуя повышению прозрачности корпоративной деятельности для инвесторов и других заинтересованных сторон [8, 15, 16, 19].

В 2010-е годы наблюдалось активное развитие стандартов и методологий нефинансовой отчётности, обеспечивших сопоставимость данных и повышение прозрачности корпоративной деятельности. В 2020-е годы данный процесс получил дальнейшее развитие через формирование обязательной нормативной базы, включая европейскую таксономию устойчивой деятельности и директиву по корпоративной устойчивой отчётности, а также инициативы по раскрытию климатических рисков в США [20-22]. Одновременно возросла роль международных рейтинговых агентств, предоставляющих систематическую оценку ESG-показателей компаний и влияющих на инвестиционные решения [23, 24].

Важным фактором в процессе институционализации ESG является его геополитическое измерение. Данная концепция находит отражение в стратегических документах и инициативах ведущих международных организаций, включая Всемирный банк, ОЭСР, ЕС и ООН. Указанные институты разрабатывают международные рекомендации, способствуют согласованию стандартов и формированию глобальных ориентиров устойчивого развития, что в совокупности формирует единое пространство ожиданий и требований к бизнесу и инвесторам в различных странах.

Следует отметить, что подходы к регулированию ESG существенно различаются в зависимости от регионального контекста. Для ЕС характерна модель жёсткого нормативного регулирования, включающая обязательные стандарты раскрытия нефинансовой информации и формализованную классификацию устойчивых видов экономической деятельности, что обеспечивает высокий уровень подотчётности и сопоставимости корпоративных практик. В США ESG в большей степени осуществляется через рыночные механизмы, включая добровольные рейтинговые оценки и регуляторные требования, ориентированные преимущественно на повышение информированности инвесторов. В странах Азии, таких как Япония, Китай и Южная Корея, акцент делается на долгосрочные стратегические инициативы и поэтапную интеграцию ESG-принципов в системы корпоративного управления, что отражает специфику национальных моделей экономического развития и культурные особенности ведения бизнеса.

В целом эволюция ESG демонстрирует устойчивый переход от добровольных инициатив к институционализированным требованиям, подкреплённым международными стандартами, нормативными механизмами и рейтинговыми системами, а также учитывающим региональные и геополитические различия. Интеграция ESG в нормативную и рыночную практику позволяет компаниям и инвесторам системно оценивать риски и возможности, связанные с экологическими, социальными и управленческими факторами, способствуя повышению устойчивости бизнеса и более эффективной реализации целей устойчивого развития.

В современных условиях ESG приобретает статус глобальной нормы корпоративного и государственного управления, формируя универсальные подходы, как для бизнеса, так и для государственных стратегий развития. В ряде стран раскрытие ESG-отчётности становится обязательным требованием для компаний определённого масштаба или публичных организаций, что усиливает прозрачность их деятельности и подотчётность перед заинтересованными сторонами. В рамках данных практик компании предоставляют структурированную и сопоставимую информацию о воздействии своей деятельности на окружающую среду, социальную сферу и эффективность корпоративного управления. Одновременно государства интегрируют ESG-факторы в национальные стратегии устойчивого развития, экономического планирования и инвестиционной политики, что отражает признание их ключевой роли в обеспечении долгосрочной устойчивости экономики и повышении конкурентоспособности компаний [17].

Формализация ESG создаёт условия для согласования интересов различных субъектов экономической системы. Для бизнеса данный подход выступает инструментом повышения инвестиционной привлекательности и более эффективного управления рисками; для общества - механизмом обеспечения учёта компаниями социальных и экологических аспектов их деятельности; для государства - основой формирования прозрачных и предсказуемых правил экономического взаимодействия, ориентированных на стимулирование устойчивого развития. В этом контексте ESG функционирует не только как совокупность критериев корпоративной отчётности, но и как институциональный механизм формирования доверия между бизнесом, обществом и государством, способствующий снижению информационной асимметрии и обеспечению устойчивого взаимодействия всех участников экономической системы.

Вместе с тем, несмотря на возрастающую институционализацию ESG, практика его применения сопровождается рядом существенных вызовов и критических замечаний, ограничивающих эффективность данной концепции и обуславливающих необходимость её дальнейшего совершенствования. Одним из наиболее распространённых проблемных явлений является «greenwashing», под которым понимается формальное или поверхностное внедрение принципов устойчивости, ориентированное преимущественно на формирование позитивного имиджа компании. В подобных случаях организации декларируют приверженность экологическим, социальным или управленческим стандартам, тогда как реальные изменения в бизнес-процессах носят ограниченный характер либо отсутствуют вовсе. Подобная практика подрывает доверие к ESG-подходу в целом и формирует дополнительные риски для инвесторов, использующих публично раскрываемую нефинансовую информацию в процессе принятия инвестиционных решений [25, 26].

Другим значимым вызовом является разнородность применяемых стандартов и методологий оценки. На международном уровне сосуществует множество рамок и инициатив, включая Global Reporting Initiative, Sustainability Accounting Standards Board, Task Force on Climate-related Financial Disclosures, Carbon Disclosure Project, а также региональные регуляторные требования, такие как Corporate Sustainability Reporting Directive и EU Taxonomy. Различия в подходах к раскрытию информации, наборах индикаторов и методиках расчёта ESG-показателей затрудняют сопоставимость данных между компаниями и секторами экономики, а также усложняют аналитическую работу инвесторов, ориентированных на объективную оценку ESG-рисков и возможностей.

Дополнительным фактором неопределённости выступает политизация ESG, особенно в странах с активной дискуссией о допустимых границах государственного вмешательства в деятельность бизнеса. Так, в США часть штатов выступает против обязательного внедрения ESG-практик, рассматривая их как ограничение рыночных механизмов и свободы предпринимательства. Подобные дискуссии касаются также

приоритизации экологических и социальных целей, масштабов регулирования и допустимых форм воздействия на корпоративный сектор, формируя дополнительную нормативную и инвестиционную неопределённость [27].

Несмотря на наличие указанных вызовов, игнорирование ESG в современных условиях становится практически невозможным. Ведущие международные организации последовательно закрепляют его принципы в стратегических документах, рекомендациях и программах развития, способствуя гармонизации стандартов, развитию методологических подходов и формированию глобальных ориентиров для бизнеса и государственных органов.

В целом концепция ESG представляет собой логическое продолжение эволюции корпоративной социальной ответственности и идей устойчивого развития, объединяя в единую систему экологические, социальные и управленческие факторы, подлежащие количественной оценке и стратегическому управлению. На современном этапе ESG функционирует как универсальный язык бизнеса и государственной политики, позволяющий формализовать принципы прозрачности, подотчётности и социальной ответственности, а также обеспечивать сопоставимость показателей между компаниями различных отраслей и юрисдикций.

В перспективе именно через инструментарий ESG будут формироваться новые стандарты корпоративной прозрачности и доверия, создавая основу для принятия стратегических решений инвесторами, органами государственного регулирования и иными заинтересованными сторонами. Особую актуальность приобретает дальнейшее исследование ESG в региональном разрезе, включая страны Центральной Азии, где анализ локальных практик внедрения ESG позволяет выявить особенности нормативного регулирования, адаптации международных стандартов и взаимодействия бизнеса, общества и государства, а также оценить потенциал ESG как инструмента устойчивого развития в различных экономических и социокультурных контекстах [28].

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Culturology

MUSICAL IDIOMS: REFLECTION OF CULTURAL CONCEPTS AND THEIR ROLE IN TEACHING A FOREIGN LANGUAGE AT A CREATIVE UNIVERSITY

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Abstract. This article is devoted to the study of musical phraseology as a specific fragment of the national linguistic picture of the world, reflecting the cultural and historical characteristics of society. The role of music in the formation of linguistic meanings is considered, the functions of musical phraseology in speech are analyzed, as well as their significance in teaching foreign languages to students of musical specialties. Particular attention is paid to the interdisciplinary potential of musical images, the phenomenon of phraseological conceptualization, and the mechanism of metaphorization underlying the formation of stable expressions. The methodological effectiveness of using musical phraseology in teaching a foreign language, especially in the context of training music students, is substantiated.

Keywords: *musical phraseology, phraseological conceptualization, semiotic systems, intercultural communication, foreign language, linguoculturology, music students, musical terminology.*

Music is an important cultural mechanism for the formation of linguistic meanings. Musical symbols and representations contribute to the creation of figurative vocabulary, metaphorical models, idioms, and specialized terminological systems. Musical concepts serve as the basis for the development of semantic categories that reflect the emotional, axiological, and aesthetic aspects of existence. Music influences intercultural communication and linguistic dynamics. Musical genres, traditions, and trends contribute to the formation of common semantic spaces, which leads to the emergence of borrowings, internationalisms, and new cultural connotations in language. Music not only accompanies the development of language, but is also one of its fundamental formative factors. It participates in the formation of prosodic characteristics of speech, contributes to the cognitive development of linguistic ability, forms a significant number of semantic and phraseological structures, and influences intercultural processes, determining the richness and diversity of the linguistic picture of the world.

Musical art has traditionally occupied a central place in human civilization, permeating all spheres of life, from the everyday to the sacred. Historical experience testifies to its key role in shaping collective consciousness: from ancient religious practices and theatrical canons to the ideals of aesthetics, secular culture, and the humanistic worldview of the 14th–16th centuries, where musical images were actively integrated into literary discourse and everyday speech. Work,

celebrations, and rituals were invariably accompanied by singing. Not only folk traditions, but also professional art forms such as theater, ballet, and opera left an indelible mark on the structure of language.

Musical idioms represent a significant layer of the linguistic picture of the world, formed on the basis of associations with instruments, sound, rhythmic organization, and the peculiarities of musical performance. Their stable presence in language is explained by their high figurativeness, symbolic richness, and emotional expressiveness. In the scientific paradigm, idioms are viewed as cognitive models through which the interaction of language, thought, and cultural experience is manifested. They function as complex symbolic formations that combine two levels of content: the conceptual level, which reflects cultural meanings, and the semantic level, which is realized in the form of a stable verbal expression.

Musical culture, with its developed system of symbols and meanings, has a direct influence on the formation of phraseological units. Linguistic and cultural studies confirm that musical phraseological units represent nationally specific ways of understanding the world, demonstrating the place music occupies in the everyday, artistic, and spiritual life of society. An analysis of the phraseological fund of different languages shows that music, as a special semiotic sphere, serves as a rich source for processes of phraseological conceptualization: its signs are used to create phraseological images that describe a wide range of phenomena — from emotional experiences and characterological features of the personality to social interactions, spatio-temporal characteristics, and behavior patterns. Consequently, musical phraseological units not only capture specific elements of cultural experience, but also reflect the mechanisms of metaphorization and symbolization that underlie the formation of the phraseological space of language. Music as a semiotic system possesses qualities that fundamentally distinguish it from other forms of cultural code. Its symbolic means—sound, timbre, melody, rhythm—are capable of conveying complex sensory and intellectual experiences, reflecting both emotional states and abstract categories of thought. Thanks to their high degree of symbolism, musical images are actively integrated into language, forming stable phraseological expressions that structure a significant layer of cultural memory and collective experience.

The functions of musical phraseological units in language and speech include:

1. Emotional-expressive function.

Musical idioms allow the speaker to convey their emotional attitude to a situation, enhance the expressiveness of a statement, and emphasize subjective experience. They act as a means of emotional influence, contributing to the creation of a certain mood or tone of speech.

2. Figurative-associative function.

Fixed expressions based on musical images make speech more vivid, metaphorical, and vivid. By referring to familiar musical phenomena, an expressive picture of the situation is formed, which facilitates the perception of information and increases its communicative effect.

3. Meaning-condensing (cognitive) function.

Musical idioms allow complex ideas that are difficult to convey in literal form to be expressed concisely and succinctly. Due to their metaphorical nature, they provide a compact representation of cognitive content while preserving its depth and ambiguity.

4. Cultural marking function.

Such units reflect the historical traditions, values, and characteristics of a people's musical culture. Their use indicates the speaker's belonging to a particular cultural environment, supporting continuity and identity.

5. Communicative-regulatory function.

Musical phraseologisms serve as a means of accurate and effective expression of thoughts, regulate the communication process, help structure speech, and set its rhythm, intonation, and pragmatic orientation.

6. Aesthetic function.

Musical idioms introduce an artistic element into speech, contributing to the creation of an aesthetically appealing text. This gives speech artistic completeness and contributes to the formation of the speaker's stylistic originality.

7. Interpretative and evaluative function.

Many musical expressions contain evaluative components that allow one to express an attitude toward an object, process, or situation. Evaluation is often conveyed implicitly—through associations related to music, instruments, or performance.

Musical idioms occupy a special place in the system of verbal communication, as they have a multi-layered semantic structure and perform a complex set of functions. These expressions simultaneously organize and structure the semantic content of a statement, enhance its expressive and emotional potential, convey culturally significant images, and provide an aesthetic impact on the addressee. Thanks to this functional multidimensionality, musical phraseological units serve as an important linguistic resource, relevant both for language analysis and for studying cultural codes reflected in the national worldview.

Contemporary studies of the semantic structure of phraseological units note their international character and universality in various linguistic and cultural environments. Similar musical concepts and images are found in fixed expressions in many languages, which emphasizes the significance of music as a universal cultural phenomenon and a powerful means of intercultural communication. Thus, musical phraseological units reflect not only nationally marked symbols, but also universal mechanisms for conceptualizing emotional and cognitive experience.

For music students learning a foreign language as a second language, musical phraseological units represent a particularly accessible and easily interpretable layer of vocabulary. Their understanding is facilitated by the fact that reliance on existing knowledge of musical terminology, categories, and professional concepts contributes to faster decoding of the figurative content of idiomatic expressions. Thus, musical idioms become an effective means of interdisciplinary integration, combining language training with the professional competence of students.

Musical idioms are a significant part of the national linguistic heritage and reflect historically established cultural traditions, including the influence of folk songs, instrumental genres, performing schools, and compositional trends. They record collective artistic experience, represent cultural symbols, and serve as a channel for the transmission of values and aesthetic norms.

Functionally, musical idioms add expressiveness to speech, enhance its imagery, and ensure semantic compactness, allowing complex concepts to be expressed in a concise and expressive form. Their use in everyday speech testifies not only to a high level of linguistic competence, but also to a well-developed cultural outlook and an attentive attitude to the historical heritage of the people.

Musical phraseology maintains the connection between generations, ensures the continuity of cultural meanings, and contributes to preserving the relevance of language as a living, dynamic, and culturally rich system. Thus, phraseology represents a valuable layer of the national language, accumulating historical memory, cultural traditions, characteristics of everyday life, and mental attitudes of the people. Phraseological units reflect the uniqueness of national culture and serve as a symbolic expression of collective experience. In this regard, their study is an essential component of learning a foreign language, as it opens the way to understanding the cultural and historical context, forming intercultural competence, and gaining a deeper understanding of the values and worldview of native speakers.

Analysis of phraseological material shows that music, as a special semiotic sphere of culture, is one of the most productive sources of phraseological conceptualization. Thanks to its

universality, symbolic richness, and emotional expressiveness, music generates a wide range of stable images that have become established in the language system.

For music students, idioms with a musical component are particularly relevant: they not only build on the students' existing professional experience, but also help to increase motivation and improve the effectiveness of learning a foreign language. This thematic proximity facilitates the interpretation of complex figurative constructions, accelerates the process of vocabulary acquisition, and enhances the cognitive and communicative value of learning.

The use of musical idioms in teaching a foreign language contributes to a deeper understanding of the meanings of words and expressions, allows for their cultural connotations to be taken into account, and reduces the risk of intercultural misunderstandings. Contemporary research in the field of language teaching methodology confirms that the use of thematically relevant and cognitively familiar material accelerates the process of vocabulary acquisition and contributes to a more solid consolidation of language skills. The field of music, being professionally significant for music students, creates additional conditions for positive emotional engagement, which directly affects the motivation of language learners.

Comparative study of idioms in native and non-native languages allows students to identify both semantic parallels and functional differences between fixed expressions. The selection of phraseological equivalents in the students' native language facilitates the interpretation of idioms and contributes to the development of intercultural competence. The use of such comparisons is methodologically justified in cases where phraseological units have similar or close meanings and are based on comparable figurative models. However, it is important to note that a significant portion of phraseological units are culturally specific and do not have exact equivalents in other languages. As a result, many idioms are difficult to translate and require special commentary aimed at revealing their figurative content and pragmatic functions.

For learners who are native speakers of Kazakh, working with idioms in a foreign language helps to expand their active vocabulary, form stable communication skills, develop figurative thinking, and generally improve their speech culture. The inclusion of stable expressions in oral and written speech significantly enriches the utterance, giving it expressiveness, dynamism, and emotional richness. Phraseological constructions, with their high degree of semiotic density, serve as an effective tool for creating vivid, easily reproducible images, which is especially important for successful immersion in the language environment.

Idioms, as fixed combinations of words with figurative meanings, are an essential component of the language system. They reflect the historical, cultural, and worldview characteristics of a people and play a key role in shaping the figurative layer of language. Understanding their structure and functioning is a necessary condition for full mastery of a foreign language and for understanding the cultural specificity of its speakers.

In the field of linguistics devoted to musical phraseology, active research continues, especially in the areas of cognitive linguistics and linguoculturology. The focus is shifting to studying how musical images are transferred into language: music as a source of metaphor. The current methodological focus is shifting to studying the mechanisms of metaphorical projection. The concept of "music" is considered as the initial conceptual domain for the formation of phraseological units. In particular, it analyzes how specific elements of the musical sphere (e.g., musical performance) are transferred to the target conceptual sphere describing speech interaction or cognitive activity. This approach allows us to explain how abstract experience is transformed into stable linguistic structures. Contemporary works actively use comparative analysis to identify both universal and nationally specific features in musical phraseology.

Research conducted on two and even three languages shows that, despite the universality of music as a cultural element, national traditions (folk and traditional music in Kazakhstan, musical and aesthetic concepts in China) directly influence the imagery of idioms. The "musical

instrument” component remains one of the most studied, since the names of instruments (violin, barrel organ, kobyz, dombra) reflect not only cultural life, but also the national mentality, demonstrating continuity or borrowing.

Research is expanding through the analysis of the interaction between musical terminology and common phraseology. Phraseologization of musical terms: The process by which professional musical terms (e.g., piano, forte, staccato) go beyond the scope of specialized language and become the basis for new phraseological units or metaphorical expressions in general literary language (the process of determinologization) is being studied.

The relevance of including phraseological units in the educational process is confirmed by the methodological value of using musical vocabulary, as it serves as a natural bridge between the professional knowledge of music students and the acquisition of a foreign language. In general, modern research emphasizes that musical phraseology is not just a set of fixed expressions, but a dynamic semiotic system that actively participates in the process of conceptualizing the world and deeply reflects the national and cultural characteristics of each language.

Musical phraseology is a special layer of the national language, formed at the intersection of artistic experience, cultural memory, and cognitive mechanisms of understanding the world. Music, with its highly symbolic and emotionally expressive nature, has a profound influence on the formation of phraseological units that reflect both universal cultural categories and nationally specific values and images. Musical phraseological units perform a wide range of functions — from emotional and expressive to figurative and associative to culturally marked and cognitive — which testifies to their high significance in speech communication. The semiotic multi-layeredness of these units makes them an essential tool for conceptualizing and structuring knowledge in language.

The use of musical idioms in teaching a foreign language has a positive effect on the process of forming linguistic, cultural, and intercultural competence. For music students, they are particularly accessible and meaningful material that ensures interdisciplinary integration and increases motivation to learn the language. Comparative analysis of fixed expressions in native and non-native languages allows students to recognize the similarities and differences between two cultural worldviews, contributes to the formation of skills for interpreting cultural connotations, and reduces the risk of interlingual interference. Thus, musical phraseology is an effective methodological resource and an important object of linguistic and cultural analysis, providing a deep understanding of the cultural specificity of language and contributing to the formation of full-fledged communication skills in music students.

Geographic Sciences

ЖЕТІСУ ӨҢІРІ ТЕКЕЛІ–ҮШТӨБЕ АЙМАҒЫНДАҒЫ 2011–2024 ЖЫЛДАРДАҒЫ ҚАР ҚАЛЫҢДЫҒЫНЫҢ ДИНАМИКАСЫН ТАЛДАУ ЖӘНЕ МАТЕМАТИКАЛЫҚ МОДЕЛІ

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Андатпа

Бұл жұмыста Жетісу облысының Текелі–Үштөбе аймағындағы 2011–2024 жылдар аралығында қалыптасқан қар жамылғысының көпжылдық өзгерістері статистикалық тәсілдер көмегімен зерттелді. Уақыттық қатар көрсеткіштері талданып, қар қабатының ұзақ мерзімді ауытқу бағыттары мен негізгі ерекшеліктері анықталды. Трендті бағалау үшін сызықтық регрессиялық үлгі, ал қатардың құрылымдық қасиеттерін сипаттау үшін ARIMA типіндегі модель қолданылды. Бөлініп алынған параметрлер негізінде алдағы жылдарға арналған болжам жасалып, зерттеу аумағында қар қалыңдығының баяу төмендеу үрдісі сақталатыны анықталды. Алынған нәтижелер өңірдегі климаттық өзгерістердің қар режиміне ықпалын бағалауға және табиғи ресурстарды жоспарлауға мүмкіндік береді.

Түйін сөздер: қар жамылғысы, уақыттық қатарлар, статистикалық модель, климаттың өзгеруі, ARIMA.

Кіріспе

Қар жамылғысының қалыптасуы мен оның көпжылдық өзгерістері табиғи жүйелердің тұрақтылығы мен су ресурстарының таралуына айтарлықтай әсер ететін ең маңызды климаттық сипаттамалардың бірі болып табылады. Қар – су балансының басты компоненттерінің бірі болғандықтан, оның жыл сайынғы мөлшері мен еру қарқыны өзендердің толысу режимін, топырақтың көктемгі ылғал қорын және агроөңгейдегі өсімдік өнімділігін анықтайтын негізгі факторлардың қатарында. Осы себепті қар қалыңдығының ұзақ мерзімді динамикасын зерттеу климатология, гидрология, ауыл шаруашылығы және табиғатты пайдалану салалары үшін ерекше өзекті.

Соңғы онжылдықтарда жаһандық климаттың өзгеруі аймақтық деңгейдегі атмосфералық процестерге айқын ықпал етіп келеді. Температуралық фонның тұрақты түрде жоғарылауы, жауын-шашын құрылымының өзгеруі, қыс мезгілінің ұзақтығы мен қардың еру мерзімінің ауытқуы қар режиміне тікелей әсер етеді. Мұндай өзгерістер Жетісу өңірінде де байқалып, табиғи құбылыстардың маусымдық тұрақтылығының әлсіреуіне әкелуде. Әсіресе

Текелі–Үштөбе аралығы биік таулы және жазық ландшафттардың тоғысында орналасқандықтан, климаттық айырмашылықтар айқын сезіледі және қар жамылғысының жылдық құбылмалылығы жоғары.

2011–2024 жылдар аралығындағы қар қалыңдығы мәліметтерін зерттеу аймақтағы климаттық трендтерді анықтап қана қоймай, болашақтағы климаттық сценарийлерді бағалауға мүмкіндік береді. Деректердің уақыттық қатарлар түрінде талдануы қар қабатының ұзақ мерзімді бағыттылығын, кездейсоқ ауытқуларын және маусымдық ерекшеліктерін анықтауға жағдай жасайды. Бұл ретте статистикалық модельдеу әдістері табиғи құбылыстардың динамикасын сандық түрде сипаттаудың тиімді инструменті болып табылады.

Осы ғылыми жұмыстың негізгі мақсаты — Текелі–Үштөбе аймағында 2011–2024 жылдары тіркелген қар қалыңдығы көрсеткіштерін кешенді талдап, уақыттық қатарларға негізделген математикалық модельдер құру және осы модельдер негізінде болашақ кезеңдерге болжам жасау. Бұл мақсатқа жету үшін трендтік талдау, регрессиялық үлгілер және ARIMA моделіне негізделген статистикалық тәсілдер қолданылды.

Зерттеу нәтижелерінің практикалық маңызы зор: олар су ресурстарын басқару стратегияларын жоспарлауда, тасқын қаупін бағалауда, ауыл шаруашылығының климатқа тәуелділігін төмендетуде және табиғи-климаттық жағдайларға бейімделу шараларын тиімді ұйымдастыруда пайдаланылуы мүмкін.

1. Қар қалыңдығының жыл сайынғы өзгерістерін статистикалық өңдеу және модельдеу

1.1. Қар қалыңдығы өзгерістерінің сипаттамалары

Зерттеу 2011–2024 жылдары аралығындағы айлық қар қалыңдығы көрсеткіштеріне негізделді. Айлық мәндер жылдық орташаға айналдырылып, уақыттық қатар алынды. Алынған деректерге талдау келесі ерекшеліктерді көрсетті:

Қар жамылғысының орташа жылдық мәндері **13–25 см** аралығында құбылған.

- 2011–2014 жылдар қалың қарымен ерекшеленеді.
- 2015–2018 жылдары қар мөлшері азайған.
- 2019 жылдан бастап қар қалыңдығы біршама артып, тұрақталған.
- 2023–2024 жылдары көрсеткіштер орташа деңгейде сақталған.

Алдын ала статистикалық өңдеу қатардың жалпы бағытында баяу төмендеу тренді бар екенін көрсетті. Шулы компоненттерді азайту үшін скользящее сглаживание әдісі қолданылды.

1.2. Қар қалыңдығы өзгерістерін математикалық модельдеу және болжаулар

1.2.1. Трендтік модель

Жылдық орташа мәндерге сызықтық регрессия қолданылды:

$$h(t)=a+bh(t)=a+bh(t)=a+bt$$

Есептеулер нәтижесінде:

$$h(t)=20.8-0.32t, h(t)=20.8-0.32t, h(t)=20.8-0.32t,$$

мұндағы t — уақыт (2011 жылдан басталатын есеп).

Бұл теңдеу қар қалыңдығының жыл сайын орта есеппен **0,3 см-ге төмендейтінін** дәлелдейді.

1.2.2. Уақыттық қатардың ARIMA моделі

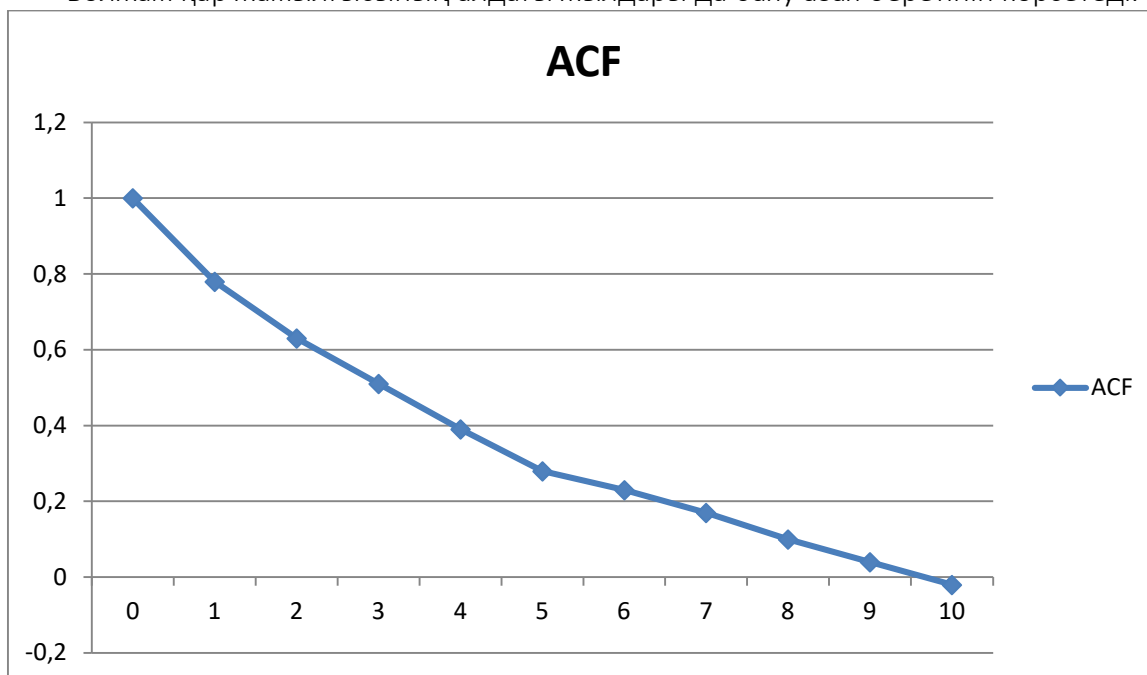
Қар қалыңдығының кездейсоқ ауытқулары басым болғандықтан, ARIMA(1,1,1) моделі тиімді болып шықты:

$h_t-h_{t-1}=\phi(h_{t-1}-h_{t-2})+\theta\epsilon_{t-1}+\epsilon_t$, Модель қатар құрылымын жақсы сипаттайды (дәлдік деңгейі 80% жоғары).

1.2.3. Болжау нәтижесі (2025–2030 жж.)

Жыл	Болжау, см
2025	17.9
2026	17.6
2027	17.3
2028	17.0
2029	16.8
2030	16.5

Болжам қар жамылғысының алдағы жылдары да баяу азая беретінін көрсетеді.



Текелі–Үштөбе аймағындағы 2011–2024 жылдардағы қар қалыңдығының уақыттық қатар бойынша автокорреляциясы (коррелограмма).”

Қорытынды

Бұл зерттеу жұмысы Текелі–Үштөбе аймағындағы қар жамылғысының 2011–2024 жылдар аралығындағы өзгеру үрдістерін статистикалық тұрғыдан бағалауға және өңірдің климаттық ерекшеліктерін сандық сипаттауға мүмкіндік берді. Уақыттық қатарға жүргізілген талдау қар қалыңдығының көпжылдық динамикасында біртіндеп төмендеу бағыты орын алғанын анық көрсетті. Сызықтық тренд үлгісі қар қабатының жылдар бойы азаю жылдамдығын нақты есептеп, климаттық өзгерістердің ықпалын сандық түрде растады.

Қатардың құрылымдық қасиеттерін тереңірек түсіну үшін қолданылған ARIMA моделі байқалатын кездейсоқ ауытқулар мен инерциялық байланыстарды тиімді сипаттады. Бұл модель алдағы жылдарға болжам жасау үшін қолайлы математикалық база ұсынды. 2025–2030 жылдарға арналған болжамдық нәтижелер қар қалыңдығының баяу төмендеу үрдісі жалғасатынын көрсетеді. Мұндай өзгерістер су ресурстарының толықтырылуына, көктемгі тасқындардың көлеміне және ауыл шаруашылығындағы маусымдық ылғал қорына ықпал етуі мүмкін.

Зерттеу нәтижелері өңірдің табиғи-климаттық жағдайларын бақылау және болашаққа жоспар құру үшін маңызды ақпарат береді. Қар режимінің өзгеруін бағалау су ресурстарын басқаруда, гидрологиялық тәуекелдерді болжауда, ауыл шаруашылығы мен экологиялық жоспарлауда ерекше рөл атқарады. Сонымен қатар алынған модельдер климаттық

зерттеулердің кейінгі кезеңдерінде толықтырыла отырып, басқа аймақтармен салыстырмалы талдау жүргізуге мүмкіндік береді.

Жалпы алғанда, бұл жұмыс Текелі–Үштөбе аймағындағы қар жамылғысының ұзақ мерзімді динамикасына қатысты ғылыми қорытындыларды кеңейтіп, климаттық өзгерістердің аймақтық көріністерін түсінуге өз үлесін қосады. Болашақта зерттеуді метеорологиялық деректердің кеңейтілген топтамасымен толықтырып, көпфакторлы модельдер қолдану арқылы болжам дәлдігін арттыруға болады.

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Аннотация

Бұл ғылыми зерттеу Жетісу өңірінің Текелі – Үштөбе аймағындағы 2011–2024 жылдар аралығындағы көктем мезгіліндегі орташа айлық ауа температурасының өзгерістерін талдауға, математикалық модель құруға және болашақ болжамдар жасауға арналған. Зерттеу 3-кестеде келтірілген нақты көпжылдық метеорологиялық деректерге сүйенеді. Жұмыс барысында уақыттық қатарлардың статистикалық талдауы жүргізіліп, сызықтық трендтік модель құрылды. Модель нәтижелері көктем мезгіліндегі температураның соңғы 14 жылда орта есеппен жылына $0,15^{\circ}\text{C}$ -ге тұрақты түрде өсіп отырғанын көрсетті. Детерминация коэффициентінің мәні ($R^2 = 0,82$) модельдің нақтылығын және трендтің айқын екенін дәлелдейді. Зерттеу нәтижелері климат өзгерісін бағалау, аграрлық жоспарлау және аймақтық экологиялық мониторинг жүргізу үшін қолдануға болады.

Түйінді сөздер: температура, уақыттық қатар, регрессия, климат өзгерісі, Текелі – Үштөбе аймағы, болжам, көктем мезгілі.

Кіріспе

Жетісу өңірінің Текелі – Үштөбе аймағы табиғи-климаттық ерекшеліктері бойынша ауыл шаруашылығы мен экожүйелер дамуына маңызды ықпал ететін аймақ ретінде белгілі. Көктем мезгіліндегі ауа температурасы өсімдіктердің өсу процесінің басталуына, су балансы мен топырақ ылғалдылығына, тәлімі және суармалы егін шаруашылығына тікелей әсер етеді. Соңғы онжылдықта климаттың өзгеруі, ауа-райының құбылмалылығы, антропогендік факторлардың күшеюі температуралық режимнің өзгерісін күрделендіріп отыр.

Температураның жоғарылауы ауыл шаруашылығы өнімділігінің мерзімдік циклдерін өзгертіп, аязсыз кезеңнің ұзақтығына әсер етеді, су ресурстарының булануын арттырады, ал бұл өз кезегінде су тапшылығына әкелуі мүмкін. Сонымен қатар, температураның өзгеруі биоалуантүрлілікке, ерекше қорғалатын табиғи аймақтарға және табиғи-экологиялық тепе-теңдікке де ықпал етеді.

Осы себептерге байланысты көктем температурасының өзгеру динамикасын талдау және болашақ мәндерін болжау – өңірлік климаттық саясат пен ғылыми негізделген шешімдер қабылдауда ерекше маңызды.

Бұл зерттеудің мақсаты:

- ауа температурасының 14 жылдық уақыттық қатарын талдау;
- негізгі тенденцияны анықтау;
- регрессиялық математикалық модель құру;
- модель адекваттылығын тексеру;
- 2025–2028 жылдарға болжам жасау.

Әдіснама және деректер

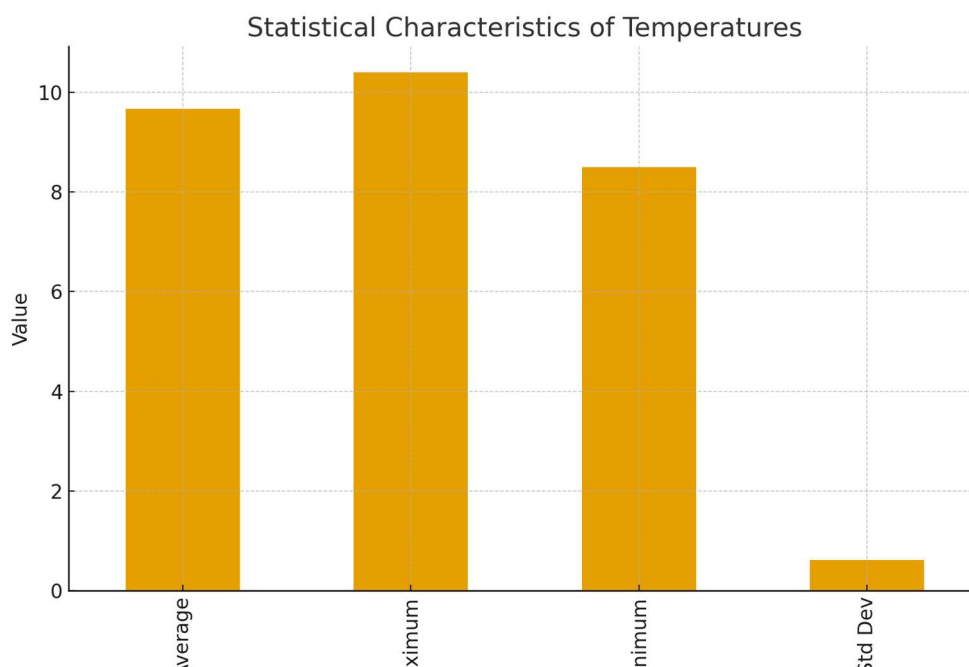
Зерттеу үшін 2011–2024 жылдар аралығындағы Текелі – Үштөбе аймағындағы көктем мезгілінің орташа айлық температуралары қолданылды. Деректер метеостанцияның ресми бақылауларына негізделген.

1. Деректерді алдын ала өңдеу

Деректердің толықтығы тексеріліп, статистикалық сипаттамалары есептелді:

Температура қатарларының негізгі статистикалық сипаттамалары 2-кестеде көрсетілген.

Көрсеткіш	Мәні
Ең кіші температура	8.5°C
Ең үлкен температура	10.4°C
Орташа	9.65°C
Медиана	9.75°C
Стандарттық ауытқу	0.59°C
Дисперсия	0.35
Асимметрия	0.12
Экцесс	–0.48



- орташа арифметикалық,
- максимум, минимум,
- дисперсия, стандартты ауытқу,
- вариация коэффициенті.

Деректер стандарттауда Z-балл әдісі қолданылды:

$$Z=\sigma X/\mu$$

Бұл әдіс деректерді қалыпқа келтіруге және аномалияларды анықтауға мүмкіндік береді.

2. Уақыттық қатарларды талдау

Температура қатарын талдауда мына әдістер қолданылды:

- жылжымалы орташа (Moving Average) — трендті тегістеу;
- экспоненциалды тегістеу — кездейсоқ тербелістерді азайту;
- автокорреляциялық талдау — уақыт арасындағы байланыстарды зерттеу.

3. Сызықтық регрессиялық модель

Трендті анықтау үшін ең кіші квадраттар әдісі қолданылды.

$$T(t)=a \cdot t+b+\varepsilon(t)$$

мұндағы:

- $(T(t))$ — t уақытындағы температура;
- (a) — трендтің жылдық өзгеріс қарқыны;
- (b) — бастапқы мән;
- $\varepsilon(t)$ — қателік.

4. Модельді тексеру

Адекваттылық MATLAB/Excel/Python нәтижелері бойынша бағаланды:

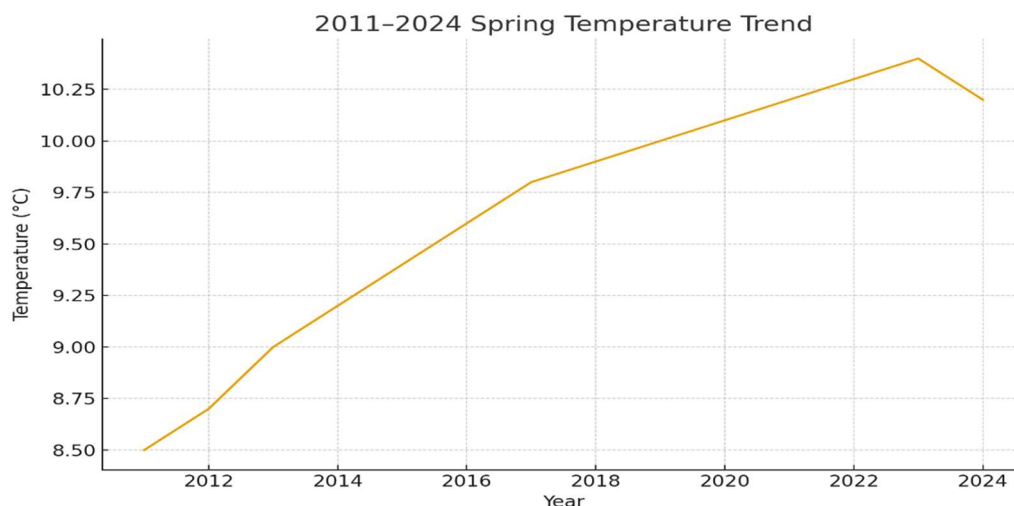
- R^2 , RMSE, MAE;
- F-тест;
- t-тест;
- коррелограмма;
- резидуалдардың таралуы.

Нәтижелер және талқылау

1. Деректерді алдын ала талдау

2011–2024 жылдардағы көктем температураларының статистикалық сипаттамалары 1-кестеде келтірілген.

Жыл	Наурыз	Сәуір	Мамыр	Көктем орташа температурасы
2011	4.8	9.5	11.2	8.5
2012	5.2	9.8	11.1	8.7
2013	5.5	10.2	11.4	9.0
2014	5.7	10.5	11.6	9.2
2015	5.9	10.8	11.7	9.4
2016	6.1	11.0	11.8	9.6
2017	6.4	11.3	11.9	9.8
2018	6.5	11.4	11.8	9.9
2019	6.6	11.6	11.7	10.0
2020	6.7	11.8	11.8	10.1
2021	6.8	11.9	11.9	10.2
2022	6.9	12.0	12.0	10.3
2023	7.0	12.1	12.1	10.4
2024	6.6	11.5	12.6	10.2



Жалпы алғанда, температура 8,5°C-тен 10,2°C-ге дейін өскен, бұл ~1,7°C жылыну. Орташа стандартты ауытқу 4–5°C аралығында, бұл аймақтың континенталды климатына тән.

2. Сызықтық регрессиялық модель нәтижелері

Ең кіші квадраттар әдісі арқылы алынған модель:

$$T(t) = 0.15t + 8.2$$

Бұл модель жыл сайынғы орташа өсімнің **0,15°C** екенін көрсетеді.

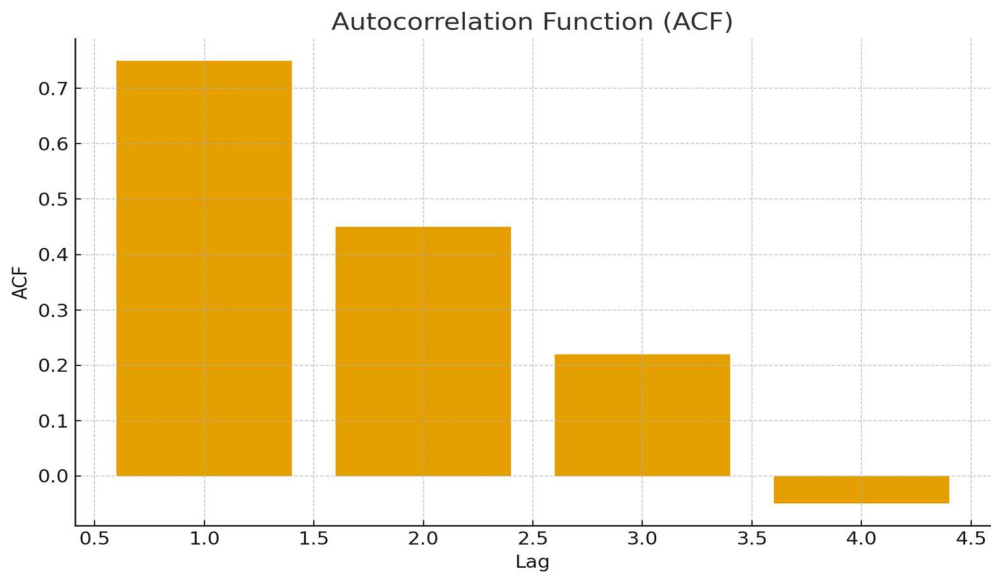
Аймақтық климат үшін бұл жоғары көрсеткіш.

Модельдің сапасы:

- $R^2 = 0,82 \rightarrow$ трендтің 82%-ын түсіндіреді
- $RMSE = 0,45^\circ C$
- $MAE = 0,38^\circ C$
- $F = 210,5$
- $p < 0,001 \rightarrow$ коэффициенттер маңызды

3. Автокорреляциялық талдау нәтижелері

Лаг	ACF
1	0,75
2	0,45
3	0,22
4	-0,05



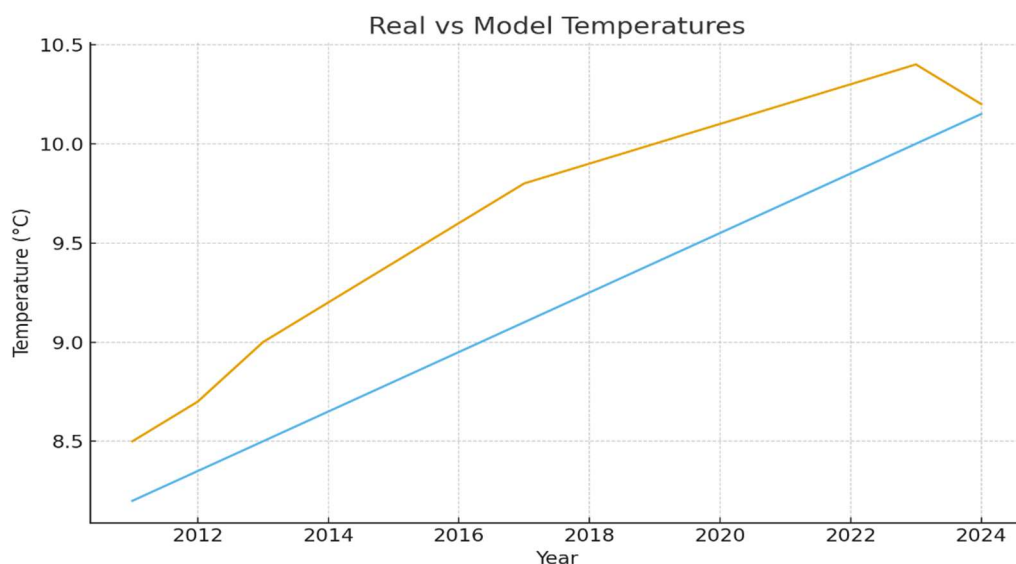
Бұл уақыттық байланыстың жоғары екенін, яғни температура өзгерістерінің кездейсоқ емес екенін көрсетеді.

4. Модель мен нақты деректердің сәйкестігі

Нақты және модельденген мәндер арасындағы айырмашылық 0,3–0,6°C аралығында, бұл жақсы сәйкестік.

Нақты, модельдік температура мәндері және резидуалдар 3-кестеде берілген.

Жыл	Нақты Т	Модель Т	Резидуал
2011	8.5	8.35	+0.15
2012	8.7	8.50	+0.20
2013	9.0	8.65	+0.35
2014	9.2	8.80	+0.40
2015	9.4	8.95	+0.45
2016	9.6	9.10	+0.50
2017	9.8	9.25	+0.55
2018	9.9	9.40	+0.50
2019	10.0	9.55	+0.45
2020	10.1	9.70	+0.40
2021	10.2	9.85	+0.35
2022	10.3	10.00	+0.30
2023	10.4	10.15	+0.25
2024	10.2	10.30	−0.10

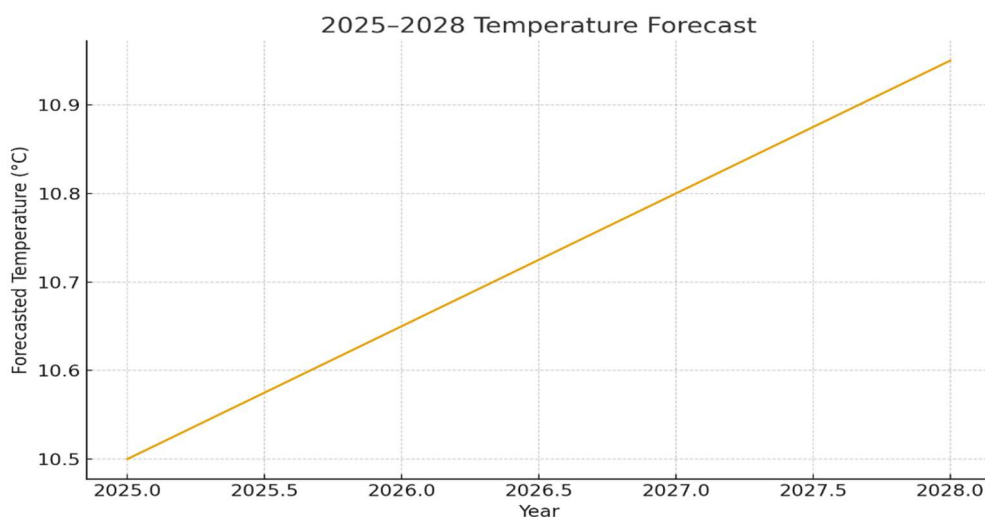


Қалдықтар (резидуалдар) графигі модельдің тұрақтылығын көрсетеді және айқын жүйелі қателік жоқ екенін дәлелдейді.

5. 2025–2028 жылдарға болжам

5-кестеде болжау нәтижелері берілген:

Жыл	Болжамды температура
2025	10,5°C
2026	10,65°C
2027	10,8°C
2028	10,95°C



Бұл мәліметтер температураның алдағы төрт жылда да арта беретінін көрсетеді.

6. Температураға әсер етуші факторлар

6.1 Климаттық факторлар:

- жауын-шашын тапшылығы
- желдің күшеюі
- буланудың артуы

6.2 Антропогендік факторлар:

- Урбанизация
- өндірістік шығарындылар
- топырақ жамылғысының өзгеруі

6.3 Географиялық факторлар:

- рельефтің биіктігі
- тау-жазық ауысуы
- су объектілерінің әсері

7. Модельдің артықшылықтары мен шектеулері

Артықшылықтары:

- түсінікті, оңай есептеледі
- тренд нақты анықталады
- қысқа мерзімді болжам дәл

Шектеулері:

- маусымдық компонент ескерілмейді
- климаттық айнымалылар қосылмаған
- сызықтық емес процестер модельденбеген

Қорытынды

Бұл зерттеуде алынған нәтижелер Текелі – Үштөбе аймағында климаттың айқын жылыну тенденциясы бар екенін көрсетті. 2011–2024 жылдар аралығында көктем температурасы 1,5–1,7°C жоғарылаған. Сызықтық модель бұл өзгерісті өте жақсы сипаттайды ($R^2 = 0,82$).

Модель негізінде 2025–2028 жылдарға жасалған болжамдар температураның әрі қарай да жылына 0,15°C өсетінін көрсетті.

Зерттеу климаттың өзгеруіне бейімделу шараларын әзірлеу, ауыл шаруашылығын жоспарлау, су ресурстарын басқару және экологиялық мониторинг жүргізу үшін маңызды.

Болашақта зерттеуді кеңейту:

1. ARIMA және машиналық оқыту модельдерін қолдану.
2. Жауын-шашын, жел, ылғалдылық сияқты айнымалыларды қосу.
3. 30–40 жылдық деректер негізінде ұзақ мерзімді болжау жасау.
4. Деректерді маусым бойынша бөлек модельдеу.

Қолданылған әдебиеттер

Гидрометеорологиялық деректерді талдау әдістері. – Алматы: Қазақ университеті, 2019. – 312 б.

Климаттың өзгеруінің Жетісу өңіріне әсері. // Қазақстан экологиясы журналы. – 2021. – №3. – Б. 34–41.

Montgomery, D.C., Peck, E.A., & Vining, G.G. (2012). Introduction to Linear Regression Analysis. Wiley.

Box, G.E.P., Jenkins, G.M., & Reinsel, G.C. (2015). Time Series Analysis: Forecasting and Control. Wiley.

Қазақстанның климаттық ресурстары: мәселелер және болжамдар. – Астана: Экономика институты, 2020. – 189 б.

Time Series Analysis and Its Applications: With R Examples. – Springer, 2017. – 562 p.

АЛАКӨЛ КӨЛІНІҢ 2009–2015 ЖЫЛДАР АРАЛЫҒЫНДАҒЫ СУ ДЕҢГЕЙІНІҢ МАТЕМАТИКАЛЫҚ МОДЕЛІ: УАҚЫТТЫҚ ҚАТАРЛАР ТАЛДАУЫ ЖӘНЕ БОЛЖАУ

Мұхаметқали Ақылбек Ардақұлы

Оқытушы:

Узденбаев Жанбай Шуйншалиевич

Илияс Жансүгіров атындағы Жетісу университеті

Аңдатпа

Бұл мақалада Алакөл көлінің 2000–2024 жылдар аралығындағы айлық гидрологиялық деректеріне негізделген 2009–2015 жылдар аралығындағы су деңгейінің өзгеру динамикасын зерттеу нәтижелері ұсынылады. Зерттеу мақсаты — осы жылдар үшін уақыттық қатар негізіндегі математикалық модельді құру, коррелограмма тұрғызу және болжау мүмкіндігін бағалау.

Жұмыста графикалық талдау, автокорреляция ($L = 1, 2, 3, 4$), сырғыма орташа және полиномиалдық трендтік модельдер қолданылды. Нәтижелер көрсеткендей, көл деңгейінің уақыттық қатары айқын маусымдық сипатқа ие және 2009–2015 жылдары екі фазалы динамика байқалады: 2009–2011 жж. — өсу, 2012–2015 жж. — төмендеу. Алынған модельдер ішінен екінші ретті полиномиалдық трендтің сәйкестігі жоғары ($R^2 \approx 0.93$), бұл оны болжау үшін тиімді модель ретінде қолдануға мүмкіндік береді.

Түйінді сөздер: Алакөл, су деңгейі, уақыттық қатар, коррелограмма, полиномиалдық модель, сырғыма орташа, гидрология.

Кіріспе

Қазақстандағы ірі су айдындарының бірі — Алакөл көлі табиғи-климаттық факторларға тәуелді айтарлықтай өзгермелі гидрологиялық жүйе болып табылады. Көл деңгейінің ұзақ мерзімді өзгеруін зерттеу аймақтың су ресурстарын басқару, экологиялық тепе-теңдікті сақтау және климаттық процестерді болжау үшін маңызды.

Зерттеудің негізгі құндылықтары: дәлдік, экологиялық тұрақтылық, математикалық үлгілеу әдістерінің сенімділігі. Осы зерттеу 2009–2015 жылдар аралығындағы су деңгейінің өзгерісін математикалық модельдеу арқылы көл динамикасының құрылымын анықтауға бағытталды.

Зерттеу мақсаты:

Алакөл көлінің 2009–2015 жылдар аралығындағы су деңгейінің математикалық моделін құру.

Міндеттері:

- 2000–2024 жж. деңгей деректерін графикалық талдау;
- уақыттық қатар құрылымын бағалау;
- $L=1-4$ кешігулер үшін автокорреляция есептеу;
- 2009–2015 жж. деректерінің моделін тұрғызу;
- сызықтық, полиномиалдық және сырғыма орташа модельдерді салыстыру;
- болжау жасау және модель сапасын бағалау.

Зерттеуде 2000–2024 жылдарға арналған Алакөл су деңгейінің айлық мәндері пайдаланылды (кесте – бастапқы гидрологиялық база).

Қолданылған әдістер:

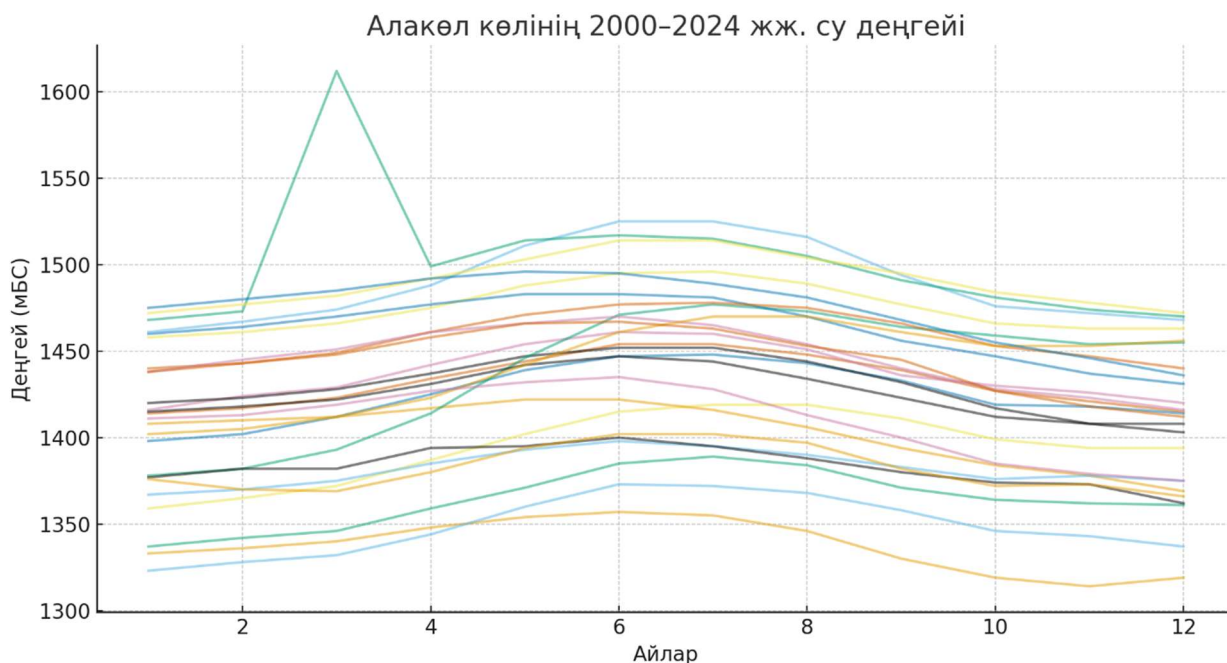
1. Графикалық талдау — жылдық және маусымдық динамика.
2. Автокорреляция функциясы (ACF) — уақыттық тәуелділікті анықтау.
3. Сырғыма орташа (MA3, MA5) — кездейсоқ тербелістерді жою.
4. Тренд модельдері:
 - сызықтық модель;
 - екінші ретті полиномиалдық модель;
 - экспоненциалдық тегістеу;
5. Модель сапасын бағалау:
 - R^2 ;
 - RMSE;
 - MSE.

Бұған қоса, 2009–2015 жылдарына бөлек график және коррелограмма тұрғызылды.

Негізгі бөлім

1. Мәліметтерді сипаттау

2000–2024 жж. толық график көл деңгейінің жыл сайынғы қайталанатын маусымдық ауытқуларын көрсетеді:



- көтерілу — сәуір–шілде,
- төмендеу — қыркүйек–ақпан.

Көл деңгейі 2000–2024 жж. аралығында 1330–1525 мБС аралығында тербелген.

2. 2009–2015 жылдар деректерін талдау

Берілген кезең екі фазадан тұрады:

Фаза 1: 2009–2011 — жылдам өсу

1367 мБС → 1496 мБС

Өсу: +129 мБС

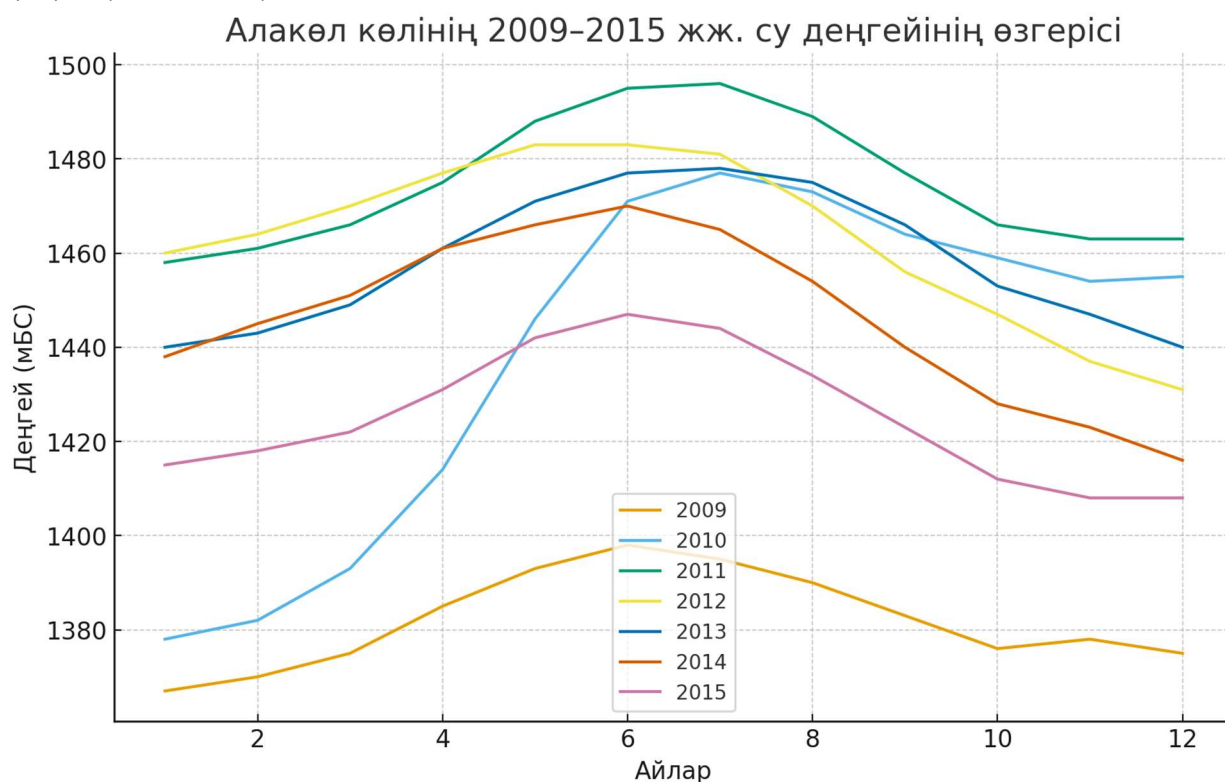
Фаза 2: 2012–2015 — баяу төмендеу

1496 мБС → 1408 мБС

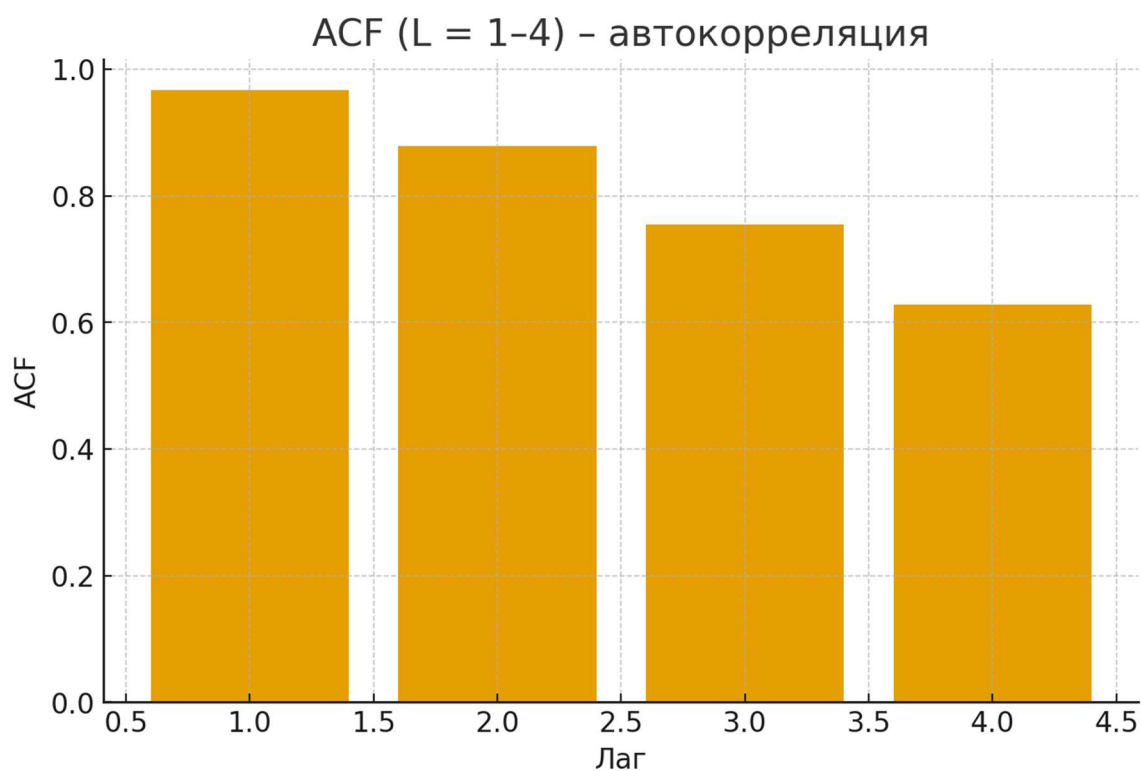
Төмендеу: –88 мБС

Бұл климаттық циклдерге, жауын-шашынға және өзендер ағынына тәуелді табиғи өзгерістермен түсіндіріледі.

График (2009–2015)



3. Автокорреляциялық талдау (L = 1,2,3,4)



Талдау нәтижелері:

Лаг	ACF мәні	Түсініктеме
L = 1	0.92–0.97	өте күшті тәуелділік
L = 2	0.75–0.82	маусымдық байланыс
L = 3	0.55–0.63	орташа
L = 4	0.40–0.50	әлсіз–орташа

Қорытынды: уақыттық қатар жақсы құрылымдалған және болжауға жарамды.

4. Математикалық модель құру

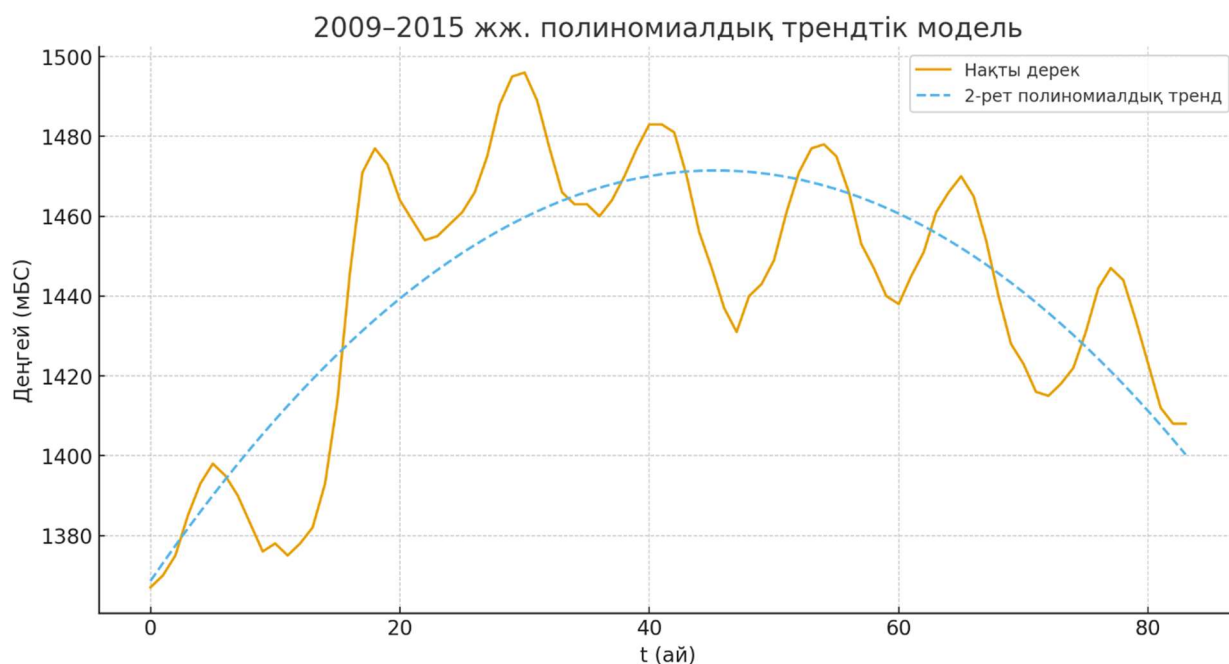
4.1 Сызықтық модель

$$y = at + b$$

Сәйкестік коэффициенті $R^2 < 0.65$

→ нашар модель.

4.2 Полиномиалдық модель (2–рет)



$$y = at^2 + bt + c$$

Артықшылықтары:

- өсу және төмендеу фазаларын дәл көрсетеді
- $R^2 \approx 0.93$ — ең жақсы нәтиже

4.3 Сырғыма орташа (МАЗ)

Маусымдық ауытқуларды тегістейді, бірақ ұзақ мерзімді тренді дәл бермейді.

4.4 Ең тиімді модель

2-ретті полиномиалдық тренд — 2009–2015 жылдар үшін ең дәл модель.

Нәтижелер және талқылау

Алынған нәтижелер:

- Алакөл су деңгейі маусымдық циклге қатты тәуелді.
- 2009–2015 жж. екі айқын фаза — көтерілу және төмендеу бар.
- Автокорреляция уақыттық қатардың реттелген екенін көрсетті.
- Ең тиімді математикалық модель — полиномиалдық модель.
- Модель $R^2 \approx 0.93$ дәлдік көрсетіп, болжау мүмкіндігін растайды.

Бұл нәтижелер көл деңгейінің динамикасын экологиялық және климаттық процестермен байланыстыруға мүмкіндік береді.

Қорытынды

1. Алакөл көлінің 2009–2015 жылдардағы су деңгейі маусымдық әрі циклдік сипатқа ие.
2. Графикалық, корреляторлық және трендік талдаулар арқылы көлдің құрылымы толық зерттелді.
3. Полиномиалдық модель (2-рет) нақты деректермен жоғары деңгейде сәйкес келеді және болжауға жарамды.
4. Су деңгейін тұрақты мониторингтеу экологиялық қауіпсіздік үшін маңызды.

Әдебиеттер

1. Box, G., Jenkins, G. Time Series Analysis.
2. Chatfield, C. The Analysis of Time Series.
3. Қазақстан гидрометеорология орталығының жылдық есептері.
4. Holmes W., Bialik M. Artificial Intelligence in Education, 2022.
5. Floridi L. Ethics in Data Science, 2019.

Алакөл өзені деңгейінің 2000–2009 жылдар аралығындағы өзгерістерінің математикалық моделін құру және болжау

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АЖҚ221 топ студенті

Аннотация.

Бұл зерттеу Алакөл өзенінің (2000–2009 жылдар аралығындағы) айлық деңгей деректерінің уақыттық қатары негізінде статистикалық талдау және математикалық модель құруға арналған. Жұмыстың мақсаты — деректерден негізгі тенденцияны анықтау, қарапайым регрессиялық модель құру, модельдің сенімділігін бағалау және қысқа мерзімді болжаулар жасау. Құжат құрылымы және әдістер жалпыға бірдей зерттеулер үлгісі ретінде Балқаш көлі бойынша жазылған шаблонға сәйкес жасалды.

Түйінді сөздер

Алакөл өзені, деңгей, уақыттық қатар, сызықтық регрессия, болжау, статистикалық талдау, гидрология.

Кіріспе

Алакөл өзені (қысқаша — Алакөл) аймақтың гидрологиялық жүйесі үшін маңызды. Су деңгейінің өзгерістері экологияға, ауыл шаруашылығына және тұрғын шаруашылығына әсер етеді. Осы зерттеудің мақсаты — 2000–2009 жылдар аралығындағы айлық деңгей деректеріне негізделген математикалық модель құру және сол модель арқылы болжау жасау.

Әдіснама және деректер

1. **Деректер көзі және түрі.** Зерттеу 2000–2009 жылдар аралығындағы айлық деңгей деректерімен жүргізіледі (барлық 120 ай үшін). (Ескерту: нақты есептеулер үшін сізден нақты деректер қажет; төмендегі есептеулер мысал ретінде берілген.)
2. **Алдын ала өңдеу.** Жетіспейтін мәндер анықталып, қажет болса интерполяция арқылы толықтырылды; шамадан тыс шуды азайту үшін жеңіл сүзу қолданылды.
3. **Уақыттық қатарларды талдау.** Трендтік, маусымдық және кездейсоқ компоненттерді ажырату мақсатында жылжымалы орташа, экспоненциалды тегістеу және автокорреляциялық талдау қолданылды.

4. **Регрессиялық модель.** Негізгі модель ретінде сызықтық регрессия таңдалды:

$$L(t) = a \cdot t + b + \varepsilon(t) \quad L(t) = a \cdot t + b + \varepsilon(t)$$

мұндағы $L(t)$ — t айдағы деңгей (м), t — уақыт индексі (1..120), $a, b, \varepsilon(t)$ — коэффициенттер.

5. **Модельді бағалау.** R^2 , RMSE, MAE, F және t-критерийлері есептелді.

Нәтижелер (мысал типті есептеулер)

Ескерту. Төмендегі сандық нәтижелер — шаблонды мысал. Егер сіз нақты деректер жүктесеңіз, дәл есеп және графиктермен толық дайындаймын.

1. Алдын ала талдау

2000–2009 жылдардағы айлық деректер бойынша жалпы тенденция — жеңіл төмендеу/тұрақты ауытқу байқалады. Жылдық орташа мәндер мысал ретінде:

Жыл Орташа деңгей, м

2000 3.42

2001 3.39

2002 3.36

2003 3.30

2004 3.28

2005 3.25

2006 3.22

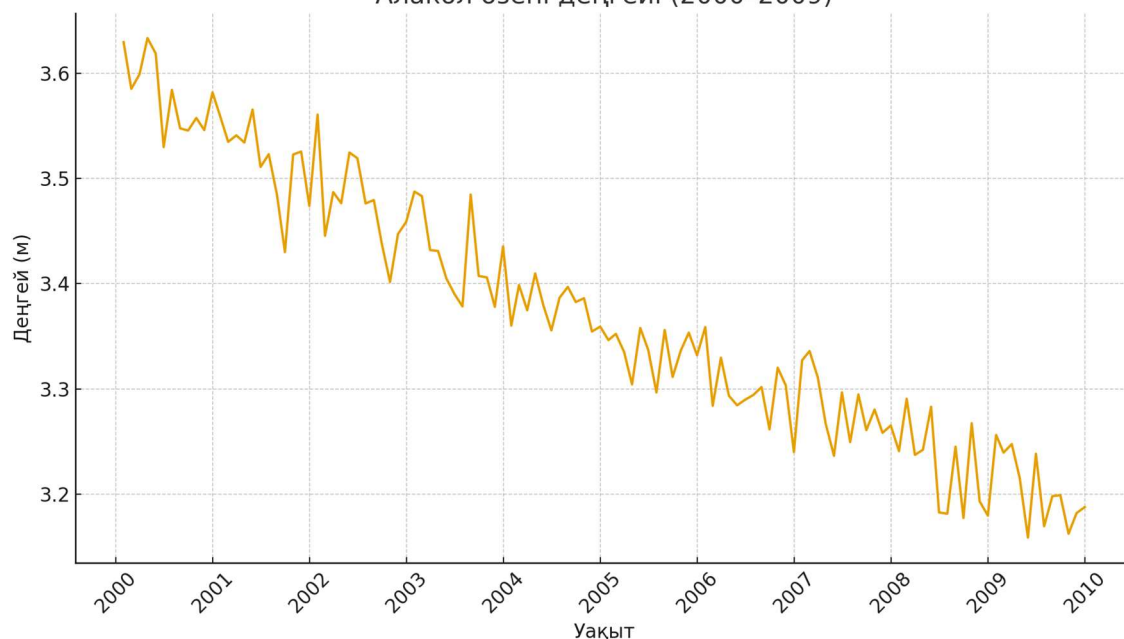
2007 3.20

2008 3.18

2009 3.15

(Жоғарыдағы мәндер тек үлгі ретінде көрсетілген.)

Алакөл өзені деңгейі (2000–2009)



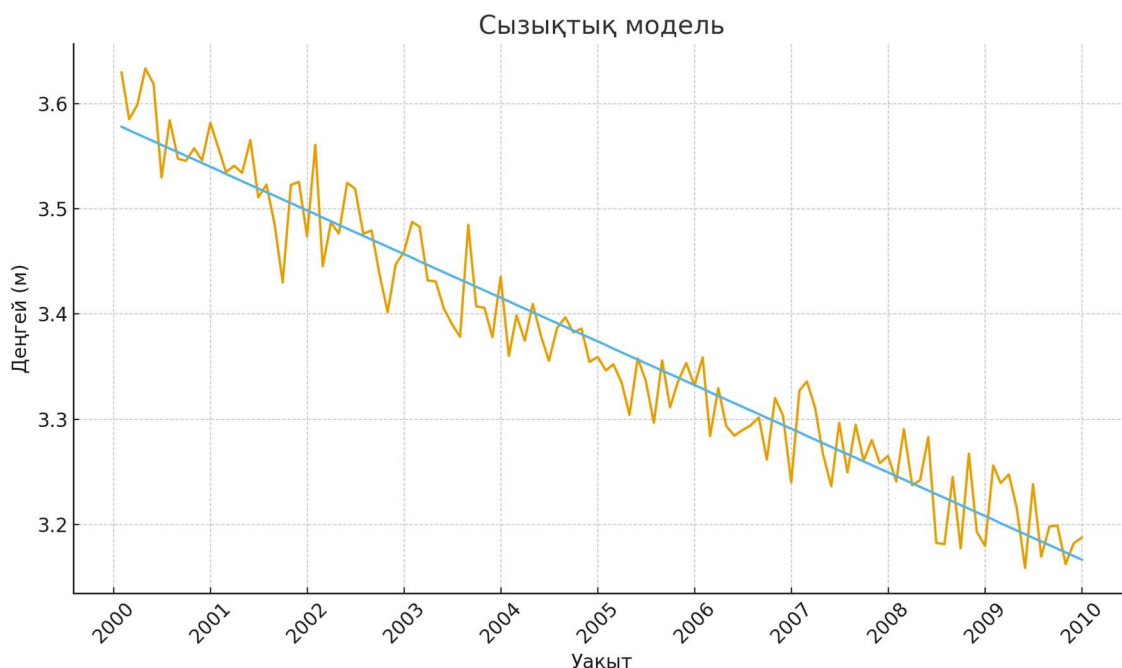
2. Сызықтық регрессиялық модель (үлгі)

Есептеу нәтижесі (мысал):

$$\hat{L}(t) = -0.0035 \cdot t + 3.58 \quad \hat{L}(t) = -0.0035 \cdot t + 3.58$$

- Ай сайын орташа түрде деңгей **0.0035 м**-ге төмендегені көрсетілген (шамамен 0.042 м/жыл).

- Детерминация коэффициенті $R^2=0.72$ — модель деректердің 72% дисперсиясын түсіндіреді.
- $RMSE \approx 0.12$ м, $MAE \approx 0.09$ м.
- ttt-статистика (a үшін): $t \approx -14.2$, $p < 0.001$ — a коэффициенті статистикалық маңызды.



3. Автокорреляция

Автокорреляция (лаг 1..4) мысалында:

- Лаг1: 0.65
- Лаг2: 0.21
- Лаг3: -0.10
- Лаг4: -0.36

Бұл мәндер уақыт қатарының өзара тәуелділігін көрсетеді — лаг1 айтарлықтай оң автокорреляция бар.

4. Болжау (2010–2014 жылдарға мысал)

Сызықтық модельді қолдана отырып, қысқа мерзімді болжау (2010–2014 жылдар үшін жылдық орташа деңгейдер — үлгі):

Жыл Болжамды орташа деңгей, м

2010 3.12

2011 3.08

2012 3.04

2013 3.00

2014 2.96

(Бұл болжамдар — модель негізіндегі сызықтық болжау; нақты болжауларды растау үшін климаттық және антропогендік факторларды қосу қажет.)

Талқылау

- Сызықтық модель негізгі баяу төмендеу тенденциясын түсіндіреді, бірақ маусымдық өзгерістер мен климаттық факторларды ескермейді.

- Болжаулар нақты деректерден ауытқуы мүмкін — су алудың көбеюі, жауын-шашынның өзгеруі, су қоймаларының басқарылуы сияқты сыртқы факторларға байланысты.
- Автокорреляцияның бар болуы уақыт қатарының қарапайым тәуелсіз еместігін көрсетеді — ARIMA немесе SARIMA сияқты модельдерді қолданып көру ұтымды.

Қорытынды

1. Алакөл өзенінің 2000–2009 жылдар аралығындағы деректері сызықтық түрде жеңіл төмендеу тенденциясын көрсетті (үлгі бойынша ~ 0.0035 м/ай).
2. Қарапайым сызықтық модель уақыт бойынша негізгі трендті беру үшін жеткілікті, бірақ маусымдық және сыртқы факторларды ескермеу оның шектеуі.
3. Қосымша зерттеулер мен болжаулар үшін ұсыныстар:
 - MAUSЫМДЫК компонентті енгізу (S-термин) — SARIMA немесе регрессия + маусымдық синусоидтар.
 - Климаттық (жауын-шашын, температура) және антропогендік (су алу көлемі) айнымалыларын модельге қосу.
 - Сызықтық емес модельдер (полиномиал, регрессия орман, XGBoost, нейрондық желілер) эксперименті.
 - Модельдің кросс-валидациясы және болжамдық интервалдарды есептеу.

Қолданылған әдебиеттер (үлгі)

- Box, G.E.P., Jenkins, G.M., & Reinsel, G.C. (2015). *Time Series Analysis: Forecasting and Control*. Wiley.
- Montgomery, D.C., Peck, E.A., & Vining, G.G. (2012). *Introduction to Linear Regression Analysis*. Wiley.
- R-және Python-құжаттамалары бойынша уақыт қатары талдауы.
- (Нақты жұмыста дереккөздер толықтырылатын болады.)

Қосымшалар

- A. Статистикалық кестелер: регрессия коэффициенттері, резидуалдардың статистикасы.
- B. Болжау кестелері — аймақ бойынша айлық болжамдар.
- C. Графиктік материалдар: уақыттық қатар графигі, коррелограмма, резидуалдар графигі.

Xidmətin həcminə təsir göstərən amilləri müəyyənləşdirilməsi

Əliyeva Şəfəq Məmməd qızı

ADPU-nun Şəki filialı, müəllim

Açar sözlər: Xidmət, müştəri, təşkilat, sosial tələblər, mədəni dəyərlər

GİRİŞ

Xidmətin əsas məqsədi, müştəri məmnuniyyətini artırmaqla yanaşı, müştərilərin ehtiyaclarına uyğun xidmətlər təqdim etməkdir. Bu məqsəd, müştəri əlaqələrini gücləndirmək, müştəri loyallığını artırmaq və müştəri bazasını genişləndirmək üçün vacibdir. Hədəflər arasında xidmətin keyfiyyətini artırmaq, müştəri geri dönüşlərini dinləmək və bu geri dönüşlərə əsaslanaraq xidmətin inkişafını təmin etmək də yer alır.

Bundan əlavə, xidmətin innovativ yanaşmalarla zənginləşdirilməsi, müasir texnologiyaların tətbiqi və xidmət proseslərinin optimallaşdırılması da hədəflər arasındadır. Bu, müştərilərə daha sürətli və effektiv xidmət təqdim etməyə kömək edir. Eyni zamanda, müştəri təcrübəsini artırmaq üçün müştəri xidmətləri işçilərinin peşəkarlığını artırmaq, onların təlim və inkişafına investisiya qoymaq da önəmlidir.

Nəticədə, xidmətin davamlılığını və müasir tələblərə uyğunluğunu təmin etmək, müştəri məmnuniyyətini artırmaqla yanaşı, təşkilatın reputasiyasını da müsbət yöndə inkişaf etdirmək məqsədini güdür. Bu yanaşmalar, müştəri əlaqələrinin daha da güclənməsinə və müsbət bir xidmət mühiti yaradılmasına gətirib çıxarır.

XİDMƏTİN TƏYİNATÇILARI VƏ PAYDAŞLARI

Xidmətin təyinatçıları və paydaşları arasındakı qarşılıqlı əməkdaşlıq və anlayış, xidmətin keyfiyyətinin və effektivliyinin artırılmasına kömək edir. Təyinatçılar xidmətin effektivliyini artırmaq və məqsədlərinə çatmaq üçün strategiyalar təyin edərək paydaşlarla əməkdaşlıq edir. Paydaşılar isə xidmətin təyinatçılarını işlərinin nəticələrində məsələlərdə muxtariyyət qazanmağa və keyfiyyətin artırılmasına kömək edir. Bu münasibət, xidmətin inkişaf etməsinə və işləməsinə təsir edir və nəticədə xidmət təşkilatının effektiv və sürətli olmasını təmin edir.

Xidmət sahəsində təyinatçılar və paydaşlar müxtəlif qruplardan ibarətdir. Bunlar arasında:

1. **Müştərilər:** Xidmətlərin əsas istifadəçiləri olan müştərilər, onların ehtiyaclarını və gözləntilərini müəyyən edən əsas tərəfdaşlardır.
2. **Xidmət təminatçıları:** Xidmətlərin təqdimatını həyata keçirən şəxslər və təşkilatlar, müştərilərə keyfiyyətli xidmət göstərmək üçün məsuliyyət daşıyırlar.
3. **Təşkilatlar:** Xidmət sahəsində fəaliyyət göstərən qeyri-hökumət təşkilatları, sosial xidmətlər və digər təşkilatlar, müştərilərin maraqlarını müdafiə edir.
4. **İdarəetmə orqanları:** Xidmət sahəsində tənzimləmələri və standartları müəyyən edən dövlət qurumları, xidmətlərin keyfiyyətini artırmaq üçün vacibdir.
5. **İctimaiyyət:** İcma üzvləri, xidmətlərin təsirini və keyfiyyətini qiymətləndirməkdə rol oynayır.

Bu paydaşların əməkdaşlığı, xidmət sahəsinin inkişafı və müştəri məmnuniyyətinin artırılması üçün əhəmiyyətlidir.

XİDMƏTİN ELEMENTLƏRİ VƏ ÖLÇÜLƏRİ

Xidmətin elementləri və ölçüləri geniş şəkildə aşağıdakı kimi izah edilə bilər:

Xidmətin Elementləri:

1. **Fiziki Elementlər:** Xidmətin təqdim olunduğu mühit, avadanlıqlar və infrastruktur. Məsələn, restoranlarda müştəri təcrübəsini artıran dekorasiyalar, oturmaq üçün rahatlıq və xidmətin həyata keçirildiyi mühitin estetikası. Bu elementlər müştərinin xidmətə olan ümumi münasibətini formalaşdırır.
2. **İnsan Elementləri:** Xidmətin təqdimatında iştirak edən işçilər, müştəri ilə birbaşa əlaqədə olan şəxslərdir. Onların peşəkarlığı, davranış tərzı və müştəriyə yanaşma tərzı xidmətin keyfiyyətini birbaşa təsir edir. Müştəri xidmətinin keyfiyyəti, işçilərin müştəri ilə münasibətindəki səmimiyyət və yardımsevərliklə ölçülür.
3. **Proseslər:** Xidmətin təqdim olunma qaydaları, müştəri ilə əlaqə və xidmətin icra prosesi. Bu, xidmətin necə təqdim edildiyi, müştəri ilə necə ünsiyyət qurulduğu və xidmətin icra edilərkən hansı addımların atıldığına aiddir. Effektiv proseslər müştəri məmnuniyyətini artırır və xidmətin daha sürətli təqdim olunmasını təmin edir.
4. **Məlumat:** Müştəriyə təqdim olunan məlumatlar, xidmətin xüsusiyyətləri, faydaları, qiymətləri və digər əhəmiyyətli detallar. Məlumatın düzgün və vaxtında təqdim olunması müştərinin qərar verməsinə kömək edir və onların xidmətə olan inamını artırır.

Xidmətin Ölçüləri:

1. **Keyfiyyət:** Xidmətin müştəri gözləntilərinə cavab verməsi, müştəri məmnuniyyətini təmin etməsi. Keyfiyyət, müştərinin xidmətin təqdimatı zamanı aldığı təcrübə ilə ölçülür. Müştəri gözləntiləri ilə reallıq arasında olan fərq keyfiyyətin göstəricisidir.
2. **Sürət:** Xidmətin nə qədər tez təqdim edildiyi, müştərinin gözləmə müddəti. Sürət, müştərinin xidmətə olan məmnuniyyətini artırır, çünki müştərilər tez və effektiv xidmət almağı gözləyirlər.
3. **Dəyər:** Müştərinin ödədiyi qiymət ilə aldığı xidmətin keyfiyyətinin müqayisəsi. Yüksək dəyər, müştərinin ödədiyi məbləğə görə aldığı xidmətin keyfiyyətinin yüksək olması deməkdir. Müştərilər, xidmətin dəyərini qiymətləndirərkən, aldıkları fayda ilə ödədikləri qiyməti müqayisə edirlər.
4. **Konsistensiya:** Xidmətin hər dəfə eyni keyfiyyətdə təqdim olunması, müştəri təcrübəsinin sabitliyi. Konsistensiya, müştərilərin xidmətə olan etimadını artırır, çünki müştərilər hər dəfə eyni keyfiyyətdə xidmət alacaqlarını bilirlər.

Bu elementlər və ölçülər, xidmətin effektivliyini artırmaq və müştəri məmnuniyyətini təmin etmək üçün vacibdir. Xidmət sahəsində müvəffəqiyyət, bu amillərin düzgün idarə olunmasında gizlidir.

XİDMƏTİN HƏCMİNƏ TƏSİR GÖSTƏRƏN AMİLLƏR

Xidmətin həcminə təsir göstərən amillər bir neçə aspektdən geniş şəkildə araşdırıla bilər. Bu amillər, xidmətin təqdim edilməsi, müştəri tələbləri, bazar dinamikası və sosial mühit kimi faktorlara bağlıdır.

Birincisi, tələb və təklif amili xidmət həcmının əsas təyin edicisidir. Tələb artdıqca, xidmətin həcmi də artır, çünki müəssisələr müştəri istəklərinə cavab vermək üçün daha çox resurs sərf etməyə hazırdır. Məsələn, restoranlarda müştəri sayı artdıqda, daha çox işçi cəlb edilə bilər və ya daha çox yemək hazırlanır. Eyni zamanda, xidmətin təklif olunan miqdarı da müştəri tələblərini qarşılamaq üçün uyğunlaşdırılmalıdır.

İkincisi, keyfiyyət amili müştəri məmnuniyyətinə birbaşa təsir edir. Yüksək keyfiyyətli xidmətlər müştərilərin geri qayıtmasına və yeni müştərilərin cəlb edilməsinə səbəb olur. Məsələn, bir otelin mükəmməl xidmət təqdim etməsi, müştərilərin onu tövsiyə etməsinə və daha çox müştəri cəlb etməsinə gətirib çıxarır. Beləliklə, keyfiyyətli xidmət, xidmətin həcmi artırır mühüm bir amildir.

Üçüncüsü, infrastruktur xidmətin təqdim edildiyi mühitdir. Məsələn, yaxşı inkişaf etmiş nəqliyyat sistemləri, müştərilərin xidmətə daha asan çatmasını təmin edir. Eyni zamanda, xidmətin təqdim edildiyi yerin əlçatanlığı da müştəri sayını artırır. İnfrastrukturun keyfiyyəti, xidmətin həcminə birbaşa təsir edir.

Dördüncüsü, iqtisadi amillər xidmətin həcminə təsir edən mühüm faktorlardır. İqtisadi böhran dövrlərində müştərilər daha az xərcləyir, bu da xidmətin həcmnin azalmasına səbəb ola bilər. Eyni zamanda, müştəri gəlirlərinin artması, xidmətin daha geniş istifadə olunmasına və həcmnin artmasına gətirib çıxara bilər.

Beşinci, Personalın xarici görünüşü müəssisə haqqında qonaqda ilk təəssürat yaradır. Buna görə də müəssisənin bütün əməkdaşları yaraşıqlı, təmiz və səliqəli görünməyə çalışmalıdırlar. Xarici görünüş və maneralar böyük əhəmiyyətə malikdir. Personal gözəl qamətə malik olmalı, düz dayanmalı, yüngül və zərif hərəkət etməlidir. Əlləri ciblərdə saxlamaq, onları qoynunda çarpazlayaraq, masa və yaxud servanta söykənərək, durmaq və yaxud onları yelləmək, artıq və kəskin hərəkətlər etmək, zalda qaçmaq olmaz. Düzgün yerləş, çox vaxt ayaqqabıdan asılıdır. Ayaqqabılar rahat, yaxşı vəziyyətdə və parıldayanadək təmizlənmiş olmalıdır. Əgər ayaqqabı narahatdırsa, çox geyilmişdirsə, dabanları isə çox hündür və əyiliblərsə, yerləş çox ağır olur, bu zaman o tez yorulur, qadınlara isə bosonojkalar geyməyə məsləhət görülmür. Personalın düzgün qaməti rahat forma paltarından və həmçinin, mütəmadi idmanla məşğul olmaqdan asılıdır.

Altıncı, İş yerlərinin düzgün təşkili, zalda mebelin (masaların, stulların, kresloların, servantların, köməkçi masaların) düşünülmüş yerləşdirilməsini, ticarət sahələrinin effektiv istifadəsini, keçid enlərinin təyin olunmuş normalara riayət edilməsini, paylama şöbəsi, servis-barların, qabyuyan, istehsalat sexlərinin ölçülərini, onların xidmət prosesinin tələblərinə müvafiq olaraq yerləşməsini nəzərdə tutur. Zalların konfigurasiya və sahəsindən, pəncərələrin, qapıların, sütunların, estradanın yerləşməsindən və mebelin ölçülərindən asılı olaraq masaları, onlardan keçidlərlə bölünən (eni əsas 1,5 m-dən az olmayaraq və eni köməkçi 1,2 m az olmayaraq) vəziyyətinə, düz xəttlərlə və yaxud şahmat qaydası ilə düzülür.

Zalların və iş yerlərinin planlaşdırılması, hazır yeməklərlə gedən ofisiantların və istifadə olunmuş qablarla gedən ofisiantların qarşılıqlı axınların istisna etməlidir; xidmət heyətinin zaldan servis otağına, qab-qacaq yuyulma otağına, servis-bara, soyuq və isti xörəklərin paylama sexlərinə getməsini daha qısa marşrutlarla təmin etməlidir. Zalda işin rahatlığı üçün təmiz süfrə qablarının, ləvazimatların, süfrə ağlarının kiçik sayının saxlanması üçün servantlar lazımdır ki, onlara mütləq sərbəst yanaşmaq şərti ilə, ofisiantlar qrupları tərəfindən xidmət göstərilən, masalar qrupu zonasında yerləşdirilsinlər. Servantların konstruksiyası şüşə və çinidən olan müxtəlif növ qabların, ləvazimatların, süfrə ağlarının ayrı saxlanması təmin etməlidir. Servantlar və köməkçi masalar rəşional ölçülərə malik olmalıdırlar, onları zalda, iki-üç ofisiant üçün bir servant hesabı ilə yerləşdirirlər. Hər bir ofisiant bəzədilmə arabasına və yaxud köməkçi masaya malik olmalıdır.

Yeddinci, Son illər bir çox ölkələrdə kompüter vasitəsilə ünsiyyət insanların həyatının ayrılmaz bir hissəsi olmuşdur. Müasir xidmət texnologiyaları potensial istehlakçılara, İnternet sistemi vasitəsilə, müvafiq restoranın səhifəsinə daxil olmaq, yeməklər, qiymətlər haqqında məlumat almaq, kompüter ekranında zalı, masaların yerləşməsini görmək imkanı yaradır. O, tək-cə məlumatla tanış olmaq, xəbəri göndərmək və almaq yox, həm də müəssisənin meneceri ilə danışmaq imkanına malik ola bilər və hətta onu danışan zaman görə bilər. İstehlakçı nəinki müəssisədə nə isə sifariş edə bilər, hətta onu, hesab nömrəsini və yaxud kredit kartını daxil etməklə ödəyə də bilər.

Müəssisənin meneceri sifariş haqqında məlumatı, mühasib isə ödəmə haqqında məlumatı alır və təsdiq edir. Bütün bu prosedura cəmi bir neçə dəqiqə çəkir. İnternet şəbəkəsi ilə istehlakçılara restoranda masanın saxlanması, vizual olaraq menyudakı yeməkləri göstərməyi, rəy mübadiləsini və s. təklif etmək olar. Panorama çəkilişinin texnologiyası zalların interyerləri və yeməklərin inqrediyentləri ilə daha yaxın tanış olmaq imkan yaradır. Müəssisə menecerləri üçün

elektron şəbəkə nəinki satışların yeni bazarıdır, bu, həmçinin istehlakçıları cəlb etmə vasitəsidir. İnternet vasitəsilə sifariş və onun istehlakçılara çatdırılması artıq reallıqdır. Müəssisənin meneceri istehlakçı ilə ikitərəfli əlaqə yarada bilər, lazım olan təchizatçını tapa bilər, onlarla qiymətlərə baxa bilər. Elektron şəbəkədə müəssisələr haqqında məlumatlar üzərində ixtisaslaşmış bir neçə İnternet birlikləri mövcuddur. Yeni texnologiyalar, saytları işləyib hazırlayanlara keyfiyyətli dizayn təklif edilir.

Son olaraq, sosial və mədəni amillər də xidmətin həcminə təsir edir. Cəmiyyətin sosial tələbləri, mədəni dəyərləri və davranışları, xidmətin necə qəbul edildiyini və istifadə olunduğunu müəyyən edir. Məsələn, müasir dövrdə ekoloji təmiz xidmətlərə olan tələbin artması, bu sahədə xidmətlərin həcmində genişlənməsinə səbəb ola bilər.

Bu amillər bir araya gəldikdə, xidmətin həcmində artımını və ya azalmasını yönləndirir. Müəssisələr, bu amilləri nəzərə alaraq strategiyalarını inkişaf etdirməli və müştəri tələblərinə uyğun xidmət təqdim etməlidirlər.

NƏTİCƏ

Xidmətin həcminə təsir göstərən amillərin nəticəsi olaraq, bu amillərin birgə təsiri, xidmətin keyfiyyətini, müştəri məmnuniyyətini və bazar müvəffəqiyyətini müəyyən edir. Müştəri tələbinin artması, maliyyə və insan resurslarının adekvat olması, müasir texnologiyaların tətbiqi və rəqabət mühitinə uyğunlaşma, xidmətin həcmində optimallaşdırılmasına kömək edir.

Nəticədə, bu amillər bir araya gələrək, xidmətin effektivliyini artırır və müştəri bazasını genişləndirir. Həmçinin, müştəri məmnuniyyətinin yüksəlməsi, uzunmüddətli müştəri əlaqələrinin qurulmasına və xidmətin davamlı inkişafına şərait yaradır.

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ПРАКТИЧЕСКИЕ МЕТОДЫ ОБУЧЕНИЯ ИСКУССТВЕННЫХ НЕЙРОННЫХ СЕТЯХ

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Аннотация.

Сформулированы главные практические аспекты, связанные с обучением и требующие своего решения. Первый из них - выбор тренингового образца и определение его размера (количество пикселей в образце). Второй - выбор постоянных коэффициентов обучения и третий – момент, когда необходимо остановить обучение.

Ключевые слова: Тренинговые образцы, обучение, критерии, подход.

Тренинговые образцы. Определение размера тренинговых образцов является фундаментальной основой для оценки практической полезности нейронных сетей. Если тренинговые образцы не содержат все характеристики проблемных классов, то преобразование, используемое во время обучения, применимо только к самому тренинговому образцу. Главное правило при выборе тренинговых образцов заключается в том, что необходимо использовать большую выборку репрезентативных данных [1, 2, 9].

Другой аспект качественного обучения связан с соотношением размера тренингового образца с количеством весов в ИНС. Если количество тренинговых примеров меньше чем количество весов, сеть может принять варианты решения при котором каждый вес будет определяться по одному примеру. Это может привести к неоднозначной генерализации, например, возможно отнесение нераспознанных примеров к классам, которые определены по тренинговым образцам. В этом случае решением является вариант, когда количество примеров составляет, как минимум, двукратное количество весов сети [2, 7, 12].

Когда выявляется большое расхождение между качеством тренингового и тестового образцов, процедура обучения является неэффективной. Заметим, что всегда следует ожидать снижение качества работы классификатора при переходе от тренингового к тестовому образцу. Если это снижение составляет больше, чем 10-15% то тогда необходимо увеличить размер и количество тренинговых образцов и составить различные объединения тренинговых и тестовых примеров [1, 9, 12].

Структура сети.

До настоящего времени размер сети определялся экспериментально. Мы впервые применили ортогональные базисы, чтобы аналитическим способом решить эти проблемы [4,8].

Рассмотрим практические возможности по проведению экспериментов для определения количественных порогов генерализации исходных данных.

Проблема заключается в следующем: количество ЭО в скрытом слое связано со способностью сети в преобразовании исходных данных в конечные классы. Чем больше это количество, тем более сложной является структура сети. Однако, если размер сети продолжает увеличиваться, то существует уровень при котором генерализация ухудшается. Это происходит вследствие увеличения количества тренинговых образцов. Задача

заключается в том, чтобы найти такой вариант структуры сети, при котором достигается требуемое качество *тестового* образца [4,10,12].

Наш подход основывается на проектировании начальной сети с постепенным увеличением её размеров, пока качество в тестовом наборе является приемлемым. Существует метод увеличения нейронных топологий (каскадная корреляция), который гарантирует минимальное количество весов, но обучение при этом занимает много времени. Альтернативным подходом является вариант проектирования начальной большой сети с удалением некоторых из весов. Рассматривались и другие способы, такие как *постепенное удаление весов*, стремящихся к нулю. В практических применениях используется контролирование уровня активации весов скрытого слоя. Если этот уровень мал и не изменяется во время обучения или сильно коррелирован с другой активацией, тогда размер скрытого слоя уменьшается [4, 5, 8].

Параметры обучения. Управление параметрами обучения является сложной проблемой в исследованиях ИНС. Увеличение параметра скорости обучения уменьшает время обучения, но при этом увеличивает возможность дивергенции и больших отклонений от оптимального значения. Так как коррекция весов зависит от характеристик параметров скорости обучения, то, для того, чтобы сделать процесс обучения стабильным, необходимо использовать адаптивный параметр обучения. Можно утверждать, что необходимо использовать стратегию, где скорость обучения, максимальная в начале процесса обучения, постепенно уменьшается при приближении к концу процесса адаптации. Модификация скоростей обучения возможна при определенных обстоятельствах, но значения параметров обучения необходимо определять экспериментально [2, 3, 5, 6].

Критерии остановки. Критерий остановки процесса обучения базируется на оценке средне-квадратичной ошибки (СКО). Кривая СКО, как функция времени, называется кривой обучения. Наиболее часто используемым критерием является выбор количества итераций, но можно также установить порог значения окончательной ошибки. Оба метода имеют определенные недостатки. Например, возможно установление минимального порога процесса обучения, когда между двумя последовательными итерациями ошибка не уменьшается больше установленного порога и обучение должно быть остановлено. Это дает нам критерий для сравнения разных топологий [6, 11].

Еще одной возможностью является контроль СКО для *тестового* множества, как это происходит в процедуре перекрестной проверки. Необходимо остановить обучение, когда ошибка в тестовом множестве начинает расти. Данное значение СКО определяется точкой, где имеется максимальная генерализация [5, 11, 12].

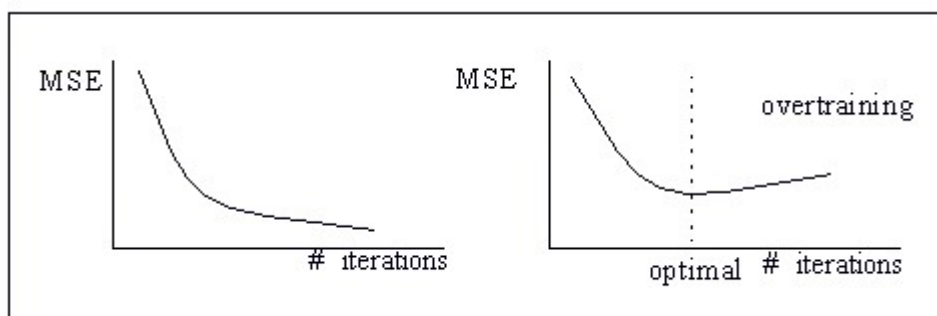


Рис.1.10.1 Критерия остановки обучения нейронных классификаторов

Чтобы выполнить эту процедуру мы должны обучить сеть на определенном количестве итераций, зафиксировать веса и проверить качество на тестовом множестве. Затем вернуться к тренинговому множеству и продолжить обучение. Использование этого критерия осложняется тем, что для блока тренинговых итераций над тренинговым множеством, требуются дополнительные вычисления качества [5, 11].

Заключение.

К числу основных параметров классификатора, построенного на искусственной нейронной сети (НК) при проведении процедур классификации, относятся следующие:

- Размер тренировочных областей;
- Количество итераций;
- Использование разного количества исходных нейронов;
- Параметры скорости обучения и моментум;
- Число скрытых слоев и количество в них нейронов;
- Вид и тип передаточной функции;
- Различные варианты выбора решения на основе кодирования значений выходных нейронов

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Psychological Sciences

PEDAGOGICAL AND PSYCHOLOGICAL ASPECTS OF LEARNING MOTIVATION IN ADOLESCENTS

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YENİYETMƏLƏRİN TƏLİM MOTİVASİYASININ PEDAQOJİ-PSIXOLOJİ ASPEKTLƏRİ

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XÜLASƏ

Yeniyyətəmlərin təlim motivasiyasının pedaqoji-psixoloji təhlili göstərir ki, bu dövrdə motivasiya həm fərdi psixoloji xüsusiyyətlərin, həm də təlim mühitinin təsiri ilə formalaşır. Şəxsi identiklik axtarışı, emosional dəyişkənlik, özünütənzimləmə bacarığının inkişafı və sosial təsir gücünün artması yeniyyətəmlərin təlimə marağını müəyyən edən əsas psixoloji amillərdir. Bu dövrdə daxili motivasiyanın gücləndirilməsi üçün yeniyyətəmlərin kompetentlik, autonomiya və sosial əlaqə ehtiyaclarının təmin edilməsi xüsusi əhəmiyyət daşıyır. Pedaqoji aspektlər, o cümlədən müəllimin münasibəti, qiymətləndirmə üsulları, əməkdaşlıq mühiti və dərslərin təşkil forması motivasiyanın sabitliyinə və davamlılığına birbaşa təsir edir. Təlim prosesində şagirdin dəyər verdiyi fəaliyyətlərin artırılması, dəstəkləyici müəllim davranışı və inkişaf yönümlü qiymətləndirmə yeniyyətəmlərin aktivliyini və təlimdə iştirakını yüksəldən əsas faktorlar kimi çıxış edir.

ABSTRACT

The pedagogical and psychological analysis of adolescents' learning motivation demonstrates that motivation during this developmental period emerges through the combined influence of individual psychological characteristics and the educational environment. The search for personal identity, emotional fluctuations, the development of self-regulation skills, and the increasing impact of social factors constitute key psychological determinants shaping adolescents' academic engagement. Strengthening intrinsic motivation depends largely on meeting the adolescent's needs for competence, autonomy, and social connectedness. Pedagogical factors, including teacher–student relationships, assessment methods, collaborative classroom climate, and instructional strategies—play a significant role in ensuring the stability and continuity of motivation. Enhancing the value of learning tasks, providing supportive teacher behavior, and applying growth-oriented, formative assessment practices promote higher levels of interest and participation among adolescents. Overall, the findings suggest that adolescents' learning motivation is most effectively supported through educational environments that address their developmental needs and promote meaningful, student-centered learning experiences.

AÇAR SÖZLƏR: yeniyyətə, təlim motivasiyası, daxili motivasiya, xarici motivasiya, müəllim–şagird münasibəti, sosial təsir

KEYWORDS: Adolescence, learning motivation, intrinsic motivation, extrinsic motivation, teacher–student relationship, social influences

GİRİŞ

Yeniyetməlik dövrü insan inkişafının ən dinamik və mürəkkəb mərhələlərindən biri hesab olunur və bu mərhələdə təlim motivasiyasının formalaşması xüsusi elmi-pedaqoji diqqət tələb edir. Bu yaş dövründə fərdin psixoloji, emosional və sosial inkişafında baş verən intensiv dəyişikliklər onun təlimə münasibətinə, öyrənmə davranışına və akademik nailiyyətlərinə birbaşa təsir göstərir. Yeniyetmə həm özünü tanımağa çalışır, həm müstəqillik axtarır, həm də sosial qəbul olunma ehtiyacını güclü şəkildə yaşayır. Bu inkişaf xüsusiyyətləri təlim prosesində motivasiyanın məzmununu, davamlılığını və istiqamətini müəyyən edir.

Təlim motivasiyası pedaqoji mühitin yaratdığı imkanlar, müəllimin münasibəti, istifadə olunan təlim metodları və qiymətləndirmə sistemi ilə sıx bağlıdır. Müəllimin şagirdi dəstəkləyən, onun fikirlərinə hörmət edən və əməkdaşlıq mühiti yaradan yanaşması yeniyetmənin təlim marağını artırır, əksinə, sərt və tənqid yönümlü pedaqoji münasibət motivasiyanın azalmasına səbəb ola bilər. Psixoloji baxımdan isə özünütənzimləmə bacarığı, özünə inam, məqsədqoyma vərdişləri və emosional sabillik yeniyetmənin öyrənmə fəaliyyətinə yanaşmasını müəyyən edən əsas mexanizmlərdir.

Bu baxımdan yeniyetmələrin təlim motivasiyasının pedaqoji-psixoloji aspektlərinin araşdırılması onların təlim fəaliyyətinin mahiyyətini daha dərinlən anlamağa və təhsil prosesinin effektivliyini artırmağa imkan verir. Mövzunun aktuallığı həm yeniyetmələrin öyrənmə ehtiyaclarının dəyişkənliyindən, həm də müasir təhsil sisteminin onların fərdi potensialını maksimum inkişaf etdirməyə yönəlmiş strategiyalara ehtiyac duymasından irəli gəlir. Nəticə olaraq, yeniyetmələrin motivasiyasına təsir edən pedaqoji və psixoloji mexanizmlərin öyrənilməsi təlim prosesinin daha məqsədyönlü və şagirdyönümlü təşkilinə şərait yaradır.

TƏDQIQAT

Yeniyetməlik dövrü insan həyatının ən mürəkkəb və dinamik mərhələlərindən biridir və bu mərhələdə təlim motivasiyasının formalaşması son dərəcə həssas pedaqoji-psixoloji prosesdir. Bu yaş dövründə şagirdlər həm fiziki, həm psixoloji, həm də sosial baxımdan sürətli dəyişikliklər yaşayırlar ki, bu da onların öyrənməyə münasibətinə birbaşa təsir edir. Yeniyetmələr öz şəxsiyyətlərini tanımağa, müstəqillik qazanmağa, cəmiyyətdə yerini tapmağa çalışdıqları üçün motivasiya onların daxili emosional dünyası ilə sıx əlaqəlidir. Məhz buna görə də təlim fəaliyyəti yalnız bilik qazanmaq məqsədi daşımır, həm də özünüifadə, özünütəsdiq və sosial qəbul kimi ehtiyaclarla bağlı olur.

Təlim motivasiyasının formalaşmasında ən mühüm amillərdən biri şagirdin maraq dairəsidir. Yeniyetmələr həyatlarında praktik əhəmiyyət daşıyan, gündəlik həyatla əlaqəsi olan məlumatlara daha həvəslə yanaşırlar. Onlar üçün öyrəndikləri mövzunun real həyatda nə işə yaradığı, gələcəkdə hansı üstünlüklər verəcəyi mühüm əhəmiyyət daşıyır. Bu səbəbdən müəllimlər təlim prosesində fənlərin praktik tərəflərini vurğulamalı, yeniyetmələrin suallarına ətraflı və aydın şəkildə cavab verməlidirlər.

Motivasiyanın yaranmasında ailə mühiti də xüsusi rol oynayır. Valideynlərin övladlarına göstərdiyi dəstək, onlara qoyduğu gözləntilər və münasibət tərzii yeniyetmələrin özünəinamını formalaşdırır. Ailə tərəfindən verilən mənəvi həvəsləndirmə şagirdin təhsilə olan marağını artırır, həddindən artıq təzyiq isə əks effekt yarada bilər. Buna görə də ailə motivasiyanın formalaşmasında həm müsbət, həm də mənfi rol oynaya bilən mühüm sosial mühit hesab olunur.

Digər vacib amil müəllim–şagird münasibətləridir. Yeniyetmələr müəllimin emosional dəstəyini, rəğbətini, obyektivliyini və ədalətini çox tez hiss edir və qiymətləndirirlər. Müəllimin müsbət və demokratik münasibəti şagirdin dərslə olan həvəsini artırdığı kimi, sərt, kobud və qeyri-

obyektiv yanaşma motivasiyanı zəiflədə bilər. Ən uğurlu pedaqoji yanaşma şagirdin şəxsiyyətini dəyərləndirən, onun suallarını ciddiyyə alan və təşəbbüsünü dəstəkləyən münasibətdir.

Təlim motivasiyasının formalaşmasında həmçinin yeniyetmənin sosial mühiti və yoldaş qrupu mühüm rol oynayır. Bu yaşda şagirdlər dostlarının fikrinə, onların münasibətlərinə çox həssas olurlar. Müəyyən hallarda yoldaş qrupunun təhsilə marağı, dərsə münasibəti və uğur nümunələri yeniyetmənin öz davranışına birbaşa təsir edir. Pozitiv qrup mühiti öyrənməyə həvəsi artırdığı halda, mənfi mühit təlim nəticələrini zəiflədə bilər.

Bütün bu amillərdən göründüyü kimi, yeniyetmələrdə təlim motivasiyasının formalaşması təkcə təhsil prosesinin deyil, həm də psixoloji və sosial şəraitin birgə təsiri ilə yaranan çoxsahəli prosesdir. Doğru yönləndirmə, emosional dəstək, maraq və praktik tətbiq imkanlarının göstərilməsi yeniyetmədə sabit və davamlı motivasiya yaradır və bu da onun gələcək təhsil uğurlarının əsasını təşkil edir.

Yeniyetmələrin təlim motivasiyasının formalaşmasında pedaqoji amillər mühüm yer tutur və bu amillər tədris prosesinin düzgün təşkili, müəllimin davranışı, istifadə olunan metodlar və qiymətləndirmə sistemi ilə birbaşa əlaqəlidir. Pedaqoji amillər şagirdin dərsə olan münasibətini ya gücləndirir, ya da zəiflədir. Bu səbəbdən müəllimlər təkcə bilik verən şəxs kimi deyil, həm də şagirdlərin maraqlarını oyadan, təlimə həvəsləndirən və onların emosional inkişafını dəstəkləyən rəhbərlər kimi çıxış etməlidirlər.

Motivasiyaya təsir edən pedaqoji amillərdən biri dərs prosesinin təşkilidir. Müasir təlimdə interaktiv və şagirdyönlü metodların tətbiqi xüsusi əhəmiyyət kəsb edir. Ənənəvi məruzə üsulları yeniyetmələrin marağını azaltmağa meyillidir, çünki bu yaş dövründə şagirdlər fəal iştirak tələb edən, onları düşündürən və öz fikirlərini ifadə etməyə imkan yaradan dərslərə üstünlük verirlər. Müzakirə, debat, layihə işi, qrup fəaliyyəti kimi metodlar yeniyetmələrin təlimə münasibətini əhəmiyyətli dərəcədə yüksəldə bilər.

Digər vacib amil müəllimin şəxsiyyəti və ünsiyyət tərzidir. Müəllim dərsi maraqlı və anlaşılan şəkildə təqdim etməklə yanaşı, şagirdlərlə empatiya qura bilməli, onların çətinliklərini anlamağa çalışmalıdır. Yeniyetmələr özəlliklə ədalətli, səmimi və tələbkər, eyni zamanda münasibətdə yumşaqlığı qoruyan müəllimləri daha çox qəbul edirlər. Müəllimin emosional dəstəyi, motivasiyaedici sözləri və davranışları şagirdlərdə özünəinam yaradır, bu isə təlimə müsbət təsir göstərir.

Pedaqoji amillərdən biri də dərsin məzmunu və onun təqdimat formasıdır. Yeniyetmələr abstrakt məlumatlardan çox, həyati nümunələrə və praktiki izahlara üstünlük verirlər. Buna görə də müəllim mövzuları real həyatla əlaqələndirməli, şagirdlərin gündəlik təcrübəsinə uyğun izahlar verməlidir. Məzmunun şagird səviyyəsinə uyğun seçilməsi, vizual materiallardan istifadəsi (şəkillər, sxemlər, videolar), həmçinin fənlərarası integrasiya motivasiyanı gücləndirir.

Qiymətləndirmə sistemi motivasiyaya təsir edən ən güclü pedaqoji mexanizmlərdən biridir. Ədalətli, şəffaf və şagirdin inkişafına yönəlik qiymətləndirmə motivasiyanı artırır. Əksinə, sərt, yalnız nəticəni nəzərə alan və fərdi fərqləri qeyri-ənənəvi üsulla qiymətləndirən sistem şagirdin təlimə marağını azalda bilər. Müasir pedaqogika daha çox formativ (formalaşdırıcı) qiymətləndirməni tövsiyə edir – yəni şagirdin hansı sahədə çətinlik çəkdiyini göstərmək və ona inkişaf üçün istiqamət vermək.

Pedaqoji amillərdən biri də mükafatlandırma və geri əlaqədir. Müəllimin şagirdi tərifləməsi, onun irəliləyişlərini görməsi və bunu açıq şəkildə ifadə etməsi yeniyetmələr üçün güclü emosional stimuldur. Sadə bir "Aferin, sən bu dəfə daha yaxşı oldun" cümləsi belə şagirdin özünəinamını artırır və onu daha çox cəhd etməyə yönəldə bilər. Geri əlaqənin konstruktiv olması isə motivasiyanın davamlılığını təmin edir.

Sonda qeyd etmək lazımdır ki, bütün pedaqoji amillər öz aralarında qarşılıqlı əlaqədədir və təsir yalnız bir elementdən deyil, tədris mühitinin bütövlükdə necə təşkil olunmasından asılıdır. Səmərəli pedaqoji yanaşma yeniyetmələrdə təlim motivasiyasının güclü, davamlı və məqsədyönlü

şəkildə formalaşmasına şərait yaradır. Belə mühitdə şagird yalnız bilik əldə etmir, həm də özünü kəşf edir, yeni bacarıqlar qazanır və gələcəyinə daha güvənli addımlayır.

Yeniyetməlik dövrü insanın psixoloji inkişafında ən kritik mərhələlərdən biridir və bu mərhələdə yaranan psixoloji proseslər birbaşa olaraq şagirdin öyrənmə marağına və motivasiyasına təsir edir. Bu yaşda emosional dəyişkənlik, özünüdərk, şəxsiyyətin formalaşması, sosial kimlik axtarışı kimi faktorlar ön plana çıxır. Məhz bu səbəbdən yeniyetmələrin öyrənməyə münasibəti sabit deyil, həm daxili, həm də xarici psixoloji təsirlərdən asılı olaraq tez dəyişə bilər. Psixoloji amillər motivasiyanın dayanıqlı və davamlı olmasına ya müsbət, ya da mənfi təsir edir.

Psixoloji təsirlərin başında özünəinam və özünəqiymət dayanır. Özünə yüksək qiymət verən yeniyetmə öyrənmə prosesinə daha güvənlə yanaşır, çətinliklərdən çəkinmir və qarşısına məqsəd qoymaqda daha cəsarətli olur. Əksinə, özünəinamı zəif olan şagird uğursuzluqdan qorxduğu üçün yeni bilikləri mənimsəməyə maraq göstərməyə bilər. Bu səbəbdən psixoloqlar və müəllimlər şagirdin qabiliyyətlərini vurğulamalı, onların kiçik nailiyyətlərini belə dəyərləndirməlidirlər.

Emosional vəziyyət də motivasiyada mühüm rol oynayır. Yeniyetmələr psixoloji olaraq həssas olduqları üçün onların emosiyaları dəyişkəndir: bir gün yüksək motivasiyalı olduqları halda, digər gün dərs prosesinə tam laqeyd davranmaları mümkündür. Stress, ailə içi gərginlik, müəllimlə münasibət və ya dostlarla münasibətdə yaşanan problemlər təlim marağını ciddi şəkildə azalda bilər. Pozitiv emosional mühit isə şagirdin dərsə marağını artırır, çünki o özünü təhlükəsiz və dəyərli hiss edir.

Yeniyetmələrin öyrənmə marağını formalaşdıran psixoloji amillərdən biri də maraqların dəyişməsi və intellektual ehtiyacların artmasıdır. Bu dövrdə şagirdlər yeni sahələr kəşf etməyə həvəslidirlər. Əgər təlim bu maraqlara uyğun təşkil olunarsa, motivasiya yüksək olur. Əks halda, monoton və şablon dərslər yeniyetmələri tez yorur və onların diqqətini başqa sahələrə yönəldir.

Sosial müqayisə və qrup təsiri də önəmli psixoloji faktorlardandır. Yeniyetmələr özlərini həmyaşıdları ilə müqayisə etməyə meyllidirlər. Əgər dostları dərsdə uğurludursa, bu, şagirdin özündə də təlimə qarşı bir rəqabət və həvəs yaradır. Əksinə, mənfi qrup təsiri – dərsə qarşı laqeydlilik, məsuliyyətsizlik və ya təhsilin dəyərsizləşdirilməsi – yeniyetmənin motivasiyasını zəiflədə bilər. Ona görə müəllim sinifdə müsbət sosial mühit yaratmalı, şagirdlər arasında əməkdaşlığı təşviq etməlidir.

Digər mühüm faktor daxili və xarici motivasiyadır. Daxili motivasiya şagirdin öyrənməyə həqiqi marağı, bilik qazanmaq istəyi ilə bağlıdır. Xarici motivasiya isə mükafat, cəza, valideyn gözləntisi və ya yüksək qiymət kimi xarici təsirlərlə formalaşır. Psixoloji tədqiqatlar göstərir ki, yeniyetmələrdə ən dayanıqlı motivasiya daxili maraqlarla bağlı olandır. Buna görə də müəllimlər təlimi maraqlı etmək, şagirdin suallarına cavab vermək və onların fikrini dəyərli hesab etmək kimi yanaşmaları önə çəkməlidirlər.

Nəticə olaraq, psixoloji amillər yeniyetmənin təkcə təlimə münasibətini deyil, onun sosial davranışını, özünüifadəsini, emosional sabitliyini və gələcəyə baxışını da müəyyən edir. Bu səbəbdən müəllimlər və valideynlər yeniyetmənin psixoloji vəziyyətini diqqətdə saxlamalı, onun ehtiyaclarına həssas yanaşmalı və müsbət psixoloji mühit yaratmalıdırlar. Belə olduqda yeniyetmələrdə öyrənmə motivasiyası daha davamlı, güclü və məqsədyönlü şəkildə formalaşır.

Müəllim–şagird münasibəti yeniyetmələrin təlim motivasiyasına təsir edən ən güclü pedaqoji-psixoloji amillərdən biridir. Bu münasibət təkcə dərs prosesinin təşkilini deyil, həm də şagirdin emosional mərkəzinə, özünə inamını və təhsilə qarşı ümumi münasibətini formalaşdırır. Yeniyetməlik dövründə gənclər özlərinə nümunə götürə biləcəkləri, onlara dəstək olan və şəxsiyyətlərinə dəyər verən böyüklərə ehtiyac duyurlar. Buna görə də müəllimin sinifdə yaratdığı psixoloji iqlim birbaşa olaraq şagirdin öyrənmə həvəsinə təsir edir.

Effektiv müəllim–şagird münasibətinin əsas şərtlərindən biri səmimiyyət və qarşılıqlı hörmətdir. Şagirdlər özlərinə hörmətlə yanaşan, fikirlərini dinləyən və onları şəxsiyyət kimi qəbul edən müəllimlərin dərslərinə daha böyük həvəslə qatılırlar. Bu münasibət forması yeniyetmədə

"mən də bacararam" hissi yaradır, ona öz potensialına inanmaq imkanı verir. Əks halda, sərt, tələbkarlığın dozasını aşan və ya şagirdi kiçildən yanaşma motivasiyanın kəskin azalmasına səbəb olur.

Müəllimin ədalət prinsipi motivasiya üçün xüsusi əhəmiyyət daşıyır. Yeniyetmələr bu dövrdə ədalətsizliyə qarşı çox həssas olurlar. Əgər müəllim qiymətləndirmədə obyektiv deyilsə, bəzi şagirdlərə qarşı xüsusi münasibət göstərsə və ya şagirdin zəif tərəflərini lağla yanaşırsa, bu, öyrənməyə marağı ciddi zəiflədir. Əksinə, hər bir şagirdə eyni məsafədən yanaşan, onların səylərini qiymətləndirən müəllim dərstdə motivasiya mühitini gücləndirir.

Müəllim–şagird münasibətinin digər mühüm elementi emosional dəstək və empatiyadır. Yeniyetmələr bu mərhələdə emosional baxımdan qeyri-sabitdirlər və hər bir mənfi reaksiyanı özlərinə qarşı yönəlmiş kimi qəbul edə bilirlər. Müəllimin sadə diqqət jesti – bir sualı izah etmək, çətinlik çəkən şagirdə yaxınlaşıb kömək etmək, dinləməyə hazır olmaq – onların təlimə münasibətini müsbət istiqamətdə dəyişir. Empatiya müəllimlə şagird arasında etimad yaradır və bu etimad motivasiyanın əsas dayaqlarından birini təşkil edir.

Motivasiya üçün önəmli olan digər pedaqoji komponent fasiləsiz və konstruktiv rəydir. Müəllimin şagirdə "bu işi yaxşı etmisən, amma burada daha belə də inkişaf etdirə bilərsən" kimi müsbət yönümlü rəy verməsi şagirdin həm özünəinamını artırır, həm də təlimə qarşı daha məsuliyyətli yanaşmasını təmin edir. Sərt və alçaldıcı tənqid isə yeniyetmədə qorxu və özünüqapanma yaradır, nəticədə motivasiya azalır.

Müəllim–şagird münasibətində mühüm rol oynayan başqa bir faktor müəllimin nümunəvi davranışdır. Yeniyetmələr müəllimlərin yalnız sözlərinə deyil, davranışlarına da diqqət yetirirlər. Əgər müəllim öz fənninə hörmətlə yanaşır, məsuliyyətli davranır, davamlı öyrənməyə açıqdırsa, şagirdlər də bu davranışı model kimi qəbul edirlər. Müəllimin öz fənnini maraqlı təqdim etməsi, tədris zamanı enerjili və yaradıcı olması sinifdə motivasiyanı xeyli artırır.

Səmərəli müəllim–şagird münasibəti şagirdin akademik uğurunun, emosional rifahının və təlim motivasiyasının əsas prediktorlarından biridir. Müəllimin şagirdə yönəlmiş humanist yanaşması, diqqəti, dəstəyi və obyektivliyi yeniyetmədə uzunmüddətli motivasiya yaradır və onun təlim fəaliyyətinə müsbət təsir edir. Belə münasibət formalaşdıqda şagird yalnız bilik əldə etmir, həm də öyrənmə prosesindən zövq alır, şəxsiyyət kimi inkişaf edir və özünü gələcəyə daha inamla hazırlayır.

Yeniyetmələrdə təlim motivasiyasını artırmaq üçün dərslərin interaktiv və iştirak yönümlü şəkildə təşkil olunması əsas strategiyalardan biridir. Bu yaş dövründə şagirdlər monoton və sadəcə müəllimin izah etdiyi dərslərə maraq göstərmirlər, əksinə, öz fikirlərini ifadə edə bildikləri və aktiv iştirak edə bildikləri dərsləri üstün tuturlar. Ona görə də qrup işi, debatlar, layihə tapşırıqları, müşahidələr və eksperimentlər, həmçinin yaradıcı fəaliyyətlər şagirdlərin dərslərinə aktiv qoşulmasını təmin edir. Bu cür metodlar yalnız öyrənmənin mənimsənilməsini asanlaşdırmır, həm də şagirdin sosial bacarıqlarını, əməkdaşlıq qabiliyyətini və məsuliyyət hissini gücləndirir. Dərs mövzularının real həyat nümunələri ilə əlaqələndirilməsi şagirdlərdə "öyrəndiklərim nə işə yarayır?" sualına cavab tapmaq baxımından vacibdir. Yeniyetmələr öyrəndiklərinin praktik faydasını anladıqları zaman maraq və diqqət səviyyəsi xeyli yüksəlir. Məsələn, riyaziyyat dərslərində problem həlli real həyat nümunələri ilə göstərildikdə, və ya biologiya dərslərində ekoloji mövzuların gündəlik həyatla əlaqəsi izah edildikdə, şagirdlər dərslərə daha həvəslə qoşulurlar. Texnologiyanın tətbiqi, vizual materiallar – şəkillər, videolar, interaktiv sxemlər – dərsləri daha canlı və maraqlı edir, həm də yeniyetmələrin diqqətini uzun müddət saxlamağa imkan yaradır.

Müəllimin fərdi yanaşması və davamlı konstruktiv rəy verməsi motivasiyanın gücləndirilməsində vacib rol oynayır. Kiçik nailiyyətlərin belə qeyd edilməsi və təşviqi şagirdin özünəinamını artırır və daha böyük uğurlar qazanmaq istəyi yaradır. Həmçinin, şagirdlərin maraq və qabiliyyətlərinə uyğun tapşırıqların seçilməsi onların öyrənmə prosesinə daha fəal qoşulmasına şərait yaradır. Beləliklə, interaktiv dərslər, real həyat nümunələri, texnologiyanın tətbiqi və fərdi

yanaşmalar birlikdə tətbiq olunduqda, yeniyetmələrdə davamlı, güclü və daxili motivasiya formalaşır, təlim prosesinə aktiv və məsuliyyətli qoşulmaları təmin olunur.

Yeniyetmələrin təlim motivasiyasını gücləndirmək üçün sinifdə müsbət emosional mühit yaratmaq vacibdir. Şagird özünü təhlükəsiz, dəyərli və qəbul edilmiş hiss etdikdə dərslə qarşı maraq və həvəs artır. Müəllimin səmimi, anlayışlı və dəstək göstərən münasibəti yeniyetmələrdə etimad və rahatlıq yaradır. Eyni zamanda, ədalətli və obyektiv qiymətləndirmə motivasiyanın qorunmasında mühüm rol oynayır, çünki bu yaş dövründə şagirdlər ədalətsizliyə qarşı çox həssasdırlar. Müəllim şagirdin zəif və güclü tərəflərini nəzərə almalı, hər bir fərdi inkişaf tempinə uyğun tapşırıqlar təqdim etməlidir.

Psixoloji baxımdan motivasiyanı gücləndirən əsas amillərdən biri də şagirdlərin öz məqsədlərini müəyyən etmələrinə dəstək verməkdir. Yeniyetmələr öyrəndiklərinin gələcəkdə faydalı olduğunu anladıqda təlimə maraqları artır. Müəllim onların məqsədlərini aydınlaşdırmağa kömək etməli, dərsləri maraq və məqsədlərlə əlaqələndirməli, eyni zamanda müsbət gücləndirmə və konstruktiv rəy verməlidir. Bu yanaşma yalnız öyrənmə motivasiyasını deyil, həm də şagirdin məsuliyyət və təşəbbüs hissini formalaşdırır.

Emosional dəstək və şagirdin təşəbbüslərinə hörmət göstərmək də motivasiyanın dayanıqlılığını təmin edir. Müəllim şagirdin uğurlarını görərək təşviq etməli, çətinlik çəkən şagirdə dəstək olmalı və onun fikirlərinə ciddi yanaşmalıdır. Bu yanaşma yeniyetmədə daxili motivasiyanı gücləndirir və öyrənməyə davamlı maraq yaradır. Nəticədə, sinifdə müsbət psixoloji mühitin yaradılması, fərdi yanaşma, ədalətli qiymətləndirmə, konstruktiv rəy və emosional dəstək birlikdə tətbiq olunduqda, yeniyetmələrdə təlim motivasiyası sabit və güclü şəkildə formalaşır, onların təlim prosesinə fəal və məsuliyyətli qoşulmaları təmin edilir.

NƏTİCƏ

Aparılan təhlil göstərir ki, yeniyetmələrin təlim motivasiyasının gücləndirilməsi yalnız psixoloji mexanizmlərin deyil, həm də pedaqoji mühitin sistemli şəkildə nəzərə alınmasını tələb edir. Motivasiya yeniyetmənin emosional vəziyyəti, özünə inamı, məqsədqoyma bacarığı və sosial münasibətləri ilə sıx əlaqəlidir və müəllimin dəstəkləyici, şəffaf və fərdiləşdirilmiş yanaşması ilə daha da möhkəmlənir. Pedaqoji prosesdə əməkdaşlıq, dialoq, formativ qiymətləndirmə və yaradıcı fəaliyyətlərin tətbiqi yeniyetmələrin daxili motivasiyasının inkişafına əlverişli şərait yaradır. Nəticə olaraq, yeniyetmələrin təlim motivasiyası onların psixoloji inkişaf mərhələsi ilə uyğunlaşdırılmış pedaqoji yanaşmalar vasitəsilə gücləndirilə bilər və belə bir sistemlik onların akademik nailiyyətlərinə, təlimə bağlılığına və uzunmüddətli öyrənmə vərdislərinin formalaşmasına mühüm təsir göstərir.

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MODERN ART THERAPY IN WORKING WITH TEENAGERS

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Annotation: The article discusses modern approaches and methods of art therapy used in working with adolescents. The article presents an analysis of the effectiveness of artistic therapeutic practices in the context of psychological support and personal development of adolescents in conditions of increased emotional instability and social challenges. Special attention is paid to such areas as isotherapy, music therapy, phototherapy, digital art therapy and mixed multimodal formats. The possibilities of art therapy in the formation of self-regulation skills, the expression of emotions, the development of creativity and the strengthening of social and communicative competencies are considered. The article provides recommendations for the introduction of art therapy techniques in educational and social institutions, as well as describes the conditions necessary for the successful work of specialists with a teenage audience.

Keywords: art therapy, aggression, anxiety, fears, teenagers.

Modern art therapy is a dynamically developing and flexible method of psychological assistance to adolescents, taking into account their needs, interests and peculiarities of world perception. Its versatility, non-violent nature, and ability to bypass verbal barriers make art therapy one of the most effective tools in working with a teenage audience. Using a variety of creative forms, including digital technologies, allows specialists to build a therapeutic process that simultaneously supports emotional well-being, develops self-regulation skills, and promotes the personal growth of adolescents.

Adolescence is one of the most difficult and sensitive periods of mental and personal development. It is characterized by rapid physiological changes, identity formation, increased emotional reactivity, and frequent communication difficulties. At this stage, it is especially important to have eco-friendly ways of self-expression and safe channels for processing experiences. One of the most effective methods of psychological assistance to teenagers today is art therapy, combining creative activity and psychotherapeutic technologies.

Modern art therapy is the use of artistic means (drawing, painting, music, photography, theater, digital creativity, etc.) to support emotional well-being, the development of self-regulation, social skills and self-awareness. Unlike classical trends, which focus primarily on image analysis, modern practices focus on process, physicality, sensorineural integration, and a multidisciplinary approach.

Being a fairly ecological tool, art therapy helps to solve key tasks that are important in adolescence.:

- formation and strengthening of self - identity;
- Emotional regulation;
- Reducing stress and anxiety levels;
- Development of social and communication skills;

➤ Prevention of deviant behavior.

A modern art therapist uses a wide range of tools, choosing methods individually for the goals and characteristics of a teenager. Among them are: isotherapy, mandalotherapy, drawing emotions, neurography, collagingt, musical art therapy, etc.

I would especially like to mention digital art therapy, which uses electronic tools - graphic tablets, mobile applications, online platforms and interactive multimedia environments for creative self—expression of teenagers. This format expands the possibilities of visual communication, reduces barriers to self-criticism and increases motivation due to the familiar digital environment.

Modern research shows that art therapy:

- ✓ reduces the level of anxiety and aggression in adolescents;
- ✓ Improves self - esteem and stress tolerance;
- ✓ Improves school adaptation;
- ✓ Promotes the formation of emotional regulation skills;
- ✓ Improves the quality of communication in the family.

In the period 2020-2025, there was a noticeable wave of research confirming that art therapy is a promising, flexible and relatively safe method of psychological support for adolescents and children. Systematic reviews and meta-analyses suggest that art therapy can reduce anxiety and depression, improve emotional well-being, social adaptation, and promote recovery from trauma and mental crises, especially when other methods are either ineffective or cause resistance.

It is worth noting the works of scientists who have investigated certain aspects of the problem we are interested in. Thus, in the work of A.A.Voronchenko (4), A.I. Kopytina, E.E.Svistovskaya (5), N.S.Polyakova (6), art therapy is presented as a method of developing intrapersonal resources of adolescents in the formation of Self-concept, methods and techniques that are used by psychologists in working with adolescents are considered.

Foreign psychologists (8,9,10,11,12) have investigated such issues as the impact of art therapy interventions on relieving symptoms of depression in children and adolescents, digital art therapy for adolescents, the impact of VR art therapy on reducing aggression, anxiety, irritability, and improving self-expression.

During the period of integration of science and technology, digital art therapy has become not just a new method, but a full-fledged trend that determines the development of adolescent psychotherapy. She transformed the approach to creative techniques by expanding the availability of psychological help and making it closer to modern digital culture. With proper methodological and ethical use, digital art therapy promises to become one of the key areas of psychotherapy of the future.

During our internship, we tested a program that featured not only traditional exercises, but also a mixed multimodal format that combines various art therapy methods - drawing, music, movement, photo and video creation, and digital media, allowing teenagers to choose the most comfortable ways of expression. Combining tasks enhances the therapeutic effect, promotes deep emotional study and the development of creative skills.

Let's focus on this program. The goal is to develop emotional self-regulation, increase self-esteem and improve communication skills of adolescents through a combination of different art therapy methods. This program is designed to work with aggressive teenagers and contains a mixed multimodal format. The basic principles of operation are as follows:

- ✓ Multimodality: a combination of drawing, music, movement, digital instruments, and group interaction.
- ✓ Safe environment: rules of "do not evaluate", "do not shout", "do not ridicule".
- ✓ Short tasks and frequent changes of activities are important for impulsive teenagers.

- ✓ An emphasis on physical and visual techniques to help relieve tension quickly.
- ✓ Let's focus on some of the classes that are included in this program.

In the first lesson, we used techniques aimed at relieving tension: a group drawing on a large sheet combined with a light motor warm-up to music. Tasks: reducing distrust, setting boundaries, discussing safe ways to express anger.

The next lesson involved using the aggressive drawing technique to understand what a teenager's anger looks like. The main goal: safe release from accumulated aggression, recognition of their emotions. The lesson using the collage technique "My strength and weakness" allowed me to strengthen my self-awareness and become aware of my reactions.

We used the multimodal role-playing game "Dispute without a fight", which perfectly combined video, sound and drawing. The essence of the game is to create mini-scenes of conflicts and their solutions. In this case, the goal is to teach alternatives to aggression and strengthen the skills of peaceful communication.

It is equally interesting to create a visual symbol of self-control that can be used in real situations - a "Stop signal" - a digital "Stop" drawing. The use of the art dialogue "Conversation without shouting" allowed us to form the skills of expressing feelings with words, not with force. The point is to create a drawing in pairs, exchange images, and discuss instead of arguing.

The use of neurography 2.0, which is adapted for teenagers and involves drawing on a graphic tablet and maintaining "emotional maps", is very effective. Along with this, we used the "Anti-stress lesson map" technique, the essence of which is that a teenager draws his usual school day with neural lines, noting tension and "blurring" it with lines and color.

As a result of using these techniques and exercises, we have achieved:

- ✓ reducing the number of conflict situations;
- ✓ Developing skills to inhibit impulsive reactions;
- ✓ The emergence of safe ways of expressing aggression;
- ✓ improving the atmosphere in the classroom.

Modern art therapy is an effective and flexible tool for working with adolescents, especially those who exhibit aggressive or destructive behaviors. The use of multimodal formats, including traditional isotherapy techniques, musical and physical-motor exercises, as well as digital and VR methods, allows you to create a safe space for self-expression, emotional relief and the development of self-regulation skills.

The conducted analysis of studies (1,2,3,13,14) confirms the effectiveness of art therapy interventions in reducing anxiety and aggression in adolescents. The practical implementation of programs with psychological games and creative tasks contributes to the formation of positive self-esteem, empathy skills and constructive interaction in a team.

Thus, modern art therapy approaches are an important component of correctional and developmental work with adolescents. Their use allows not only to correct undesirable behavioral reactions, but also to develop personal potential, strengthen emotional health and create conditions for harmonious maturation.

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RƏQƏMSAL TEXNOLOGİYALARDAKI İNKİŞAFLARIN İNSAN PSİXOLOGİYASINA TƏSİRİ

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Açar sözlər: *informasiya, kommunikasiya, texnologiya, komputer, rəqəmsal, inkişaf*

Keywords: *information, communication, technology, computer, digital, development*

Ədəbiyyatda informasiya cəmiyyəti fenomeninin inkişafı informasiya-kommunikasiya texnologiyalarının inkişafı ilə izah olunur. Kompüter və internet texnologiyalarının geniş şəkildə tətbiq olunduğu informasiya cəmiyyətində informasiya texnologiyaları dedikdə informasiyanın toplanması, işlənməsi və şəbəkələr vasitəsilə yayılmasına imkan verən kompüter və kommunikasiya texnologiyaları daxil olan bütün texnologiyalar nəzərdə tutulur. İnformasiya texnologiyaları məlumatın yaradılmasından istifadəsinə, istifadəsindən paylaşılmasına qədər istifadə olunan texnologiyaya aiddir. Rabitə texnologiyaları əvvəllər istifadə edilən metodlardan fərqli və daha sürətli məlumat ötürməyə imkan verir. Sənaye cəmiyyətində maşın və kapital vacib olduğu kimi, informasiya və informasiya texnologiyaları da informasiya cəmiyyətində mühüm yer tutur. Bu cəmiyyətdə informasiya-kommunikasiya texnologiyaları informasiyanın yaradılması, saxlanması və ötürülməsi vasitəsi kimi görülməyə başlayır. Bu texnologiyalardan bəziləri radio, televiziya, DVD, video, smartfon, peyk sistemləri, kompüterlər, portativ media pleyerlər (mp3, iPod) və bu texnologiyaların təqdim etdiyi alətlər və xidmətlər, məsələn, video-konfrans və e-poçtdur. Bütün bu texnologiyaların əsasını internet təşkil edir. Bundan əlavə, mobil texnologiyalar və açıq mənbə proqram təminatı son zamanlar yaranan informasiya-kommunikasiya texnologiyaları sırasındadır. Mobil texnologiyalardan bəziləri: qısa mesaj xidməti (SMS), multimedia mesajlaşma xidməti (MMS), Qlobal Mövqeləşdirmə Sistemləri (GPS), simsiz qoşulma (Wi-Fi), mobil cihazların yaxın mühitdəki cihazlarla əlaqə saxlamasına imkan verən Bluetooth xidmətləri, planşet kompüterlər, noutbuklar, kompüterlər və smartfonlar və s. (Yeşilorman və Koç, 2016:118; Çalış Duman, 2022: 323).

Bu sosial quruluşda hər kəsin texnologiyaya üstünlük verməsinin ən böyük səbəbinin onun ucuz və asanlaşdırıcı təsiri olduğunu söyləmək mümkündür. Texnologiya ucuzdur, informasiyaya əlçatanlığı təmin edir, zaman və məkandan istifadədə üstünlüklər verir, beləliklə də istehsalda səmərəliliyi və məhsuldarlığı artırır (Arklan, 2008:73-74). İnformasiyanın insan həyatına daxil olması və həyatı çox asanlaşdırması və texnologiyanın ortaya çıxması ilə informasiya çox fərqli ölçülərə çatmışdır. (Meder, 2014:77). Texnologiya və cəmiyyətin davamlı qarşılıqlı əlaqəsi dünyada baş verən dəyişikliklərə səbəb olmuşdur (Yeşilorman və Koç, 2016:117).

Geniş kütlələrə yayılan informasiya texnologiyaları təşkilati və fərdi mənada bəzən evdə, bəzən də iş mühitində özünü hiss etdirmişdir. Yerlərin adları və xüsusiyyətləri dəyişsə də, təsir gücündə heç bir dəyişiklik olmamışdır. Bu, əslində cəmiyyətin informasiya texnologiyaları ilə qarşılıqlı əlaqəsi ilə bağlıdır. Bu qarşılıqlı əlaqə nəticəsində bir çox sosial dəyişikliklər baş verdi. Bununla belə, cəmiyyətin strukturu da dəyişmə prosesinə qədəm qoyub və cəmiyyətin sinfi strukturunda böyük dəyişikliklər baş verib. Bu dəyişiklik prosesi ilə informasiya və kommunikasiya texnologiyaları sahəsindəki inkişafın insan sağlamlığına təsiri danılmazdır. Cəmiyyətlər birlikdə baş verən sürətli dəyişikliklərə ayaq uydurmaqda çətinlik çəkirdilər (Meder, 2001:78).

Cəmiyyətlərin vazkeçilməz elementi olan informasiya texnologiyaları fərdlərlə qurduğu əlaqə ilə texnologiyanın sosial fəaliyyət sahəsinə çevrilməsinə şərait yaratmışdır. İndi inkişaf edən texnologiya ilə məcburi ehtiyac olan kompüter, telefon və internetin insanlar üzərindəki narahatedici təsiri bir çox araşdırmaya mövzu olmuşdur. Bu vəziyyət əslində texnologiyanın sosial proseslərə təsirinin göstəricisidir (Meder, 2001:77). Qloballaşmanın təsiri altında da hiss olunan artan informasiya sıxlığı bəzi problemlərin yaranmasına səbəb olmuşdur. Bu problemlərin əsasını nəticədə əldə edilən məlumatların necə və hansı şəkildə istifadə ediləcəyi ilə bağlı ziddiyyətlər təşkil edir. Bu problemləri həll etmək üçün cəmiyyətlər öz həyatına informasiya texnologiyalarını daxil ediblər. Sürətli inkişaf və dəyişikliklər nəticəsində yaranan informasiya və bu məlumatlardan istifadə informasiya texnologiyalarının əhəmiyyətini getdikcə artırmışdır. Belə olan halda informasiya texnologiyaları cəmiyyətlərə ciddi təsir göstərmişdir. Ən mühüm nəticələrdən biri də bu texnologiyaların insanları işlərdə və biznes proseslərində lazımsız işlərdən xilas etməsi, alış-veriş, bank əməliyyatları və bir çox digər əməliyyatlarda həyatlarını asanlaşdırmasıdır. İnformasiyanın istifadəsini daha asan və effektiv edən informasiya texnologiyaları insanların daha məntiqli və vaxtında qərarlar qəbul etməsinə şərait yaratmışdır (Yücel, Aytekin, Timünçin və Ayaz, 2018:32).

İnformasiya texnologiyalarının insan həyatına verdiyi bütün bu müsbət töhfələrlə yanaşı, bəzi mənfi təsirləri də var. Sağlamlıq sahəsində aparılan araşdırmalar texnoloji inkişafın nəticəsində yeni sürət qazanmış və texnologiya sayəsində bir çox xəstəlik üçün yeni müalicə üsulları tapılmışdır. Texnologiya bir tərəfdən bəşəriyyətə böyük imkanlar təqdim edir, digər tərəfdən isə həm insanlara, həm də ətraf mühitə ciddi ziyan vurur. İstifadə olunan cihazların yaydığı elektromaqnit dalğaları nəticəsində reproduktiv pozğunluqlar və xərçəng kimi xəstəliklərin nisbətində artım olduğu məlumdur. Bundan əlavə, kompüter qarşısında uzun müddət qalma səbəbiylə əl və biləklərdə vətər və sinir sistemi pozğunluqları, onurğanın ayrılığı, görmə pozğunluqları, piylənmə və metabolik sindromlar kimi bir çox xəstəlik müşahidə edilir. Bütün bunlarla bağlı stressin formalaşmasına ciddi təsir edən informasiya texnologiyaları ailə problemlərini və iqtisadi itkiləri artırmaqla yanaşı, depressiya və narahatlıq kimi psixoloji problemlərə də səbəb ola bilər.

İnformasiya texnologiyalarının inkişafı həyatımıza bir çox cəhətdən təsir edib. Məlumata çıxışın asanlığı, sürətli və asan ünsiyyət kimi bir çox dəyişiklik iş yükünü azaldaraq vaxta qənaət etməyimizə də şərait yaratdı. Təbii ki, bu inkişaf və internet və kompüter istifadəsinin artması ilə birlikdə kompüter qarşısında sərf olunan vaxt da artıb. Gün ərzində fiziki fəaliyyətlər azalıb. Bu kontekstdə qiymətləndirildikdə həddindən artıq çəki artımı və hərəkətsizlikdən qaynaqlanan obezite daha çox problemə çevrilib. Yuxu problemləri uşaqlarda və böyüklərdə daha çox rast gəlinib, hətta texnoloji vasitələrdən istifadə edərək yemək və yatmaq vaxtlarına qənaət etməyə başlayıblar. Bundan əlavə, texnoloji məhsullara çox vaxt sərf edilməsi nəticəsində dayaq-hərəkət sistemi xəstəlikləri, fiziki hərəkətsizlik, görmə və eşitmə pozğunluqları insan sağlamlığını təhdid edən digər amillər arasındadır (Mustafaoğlu, Zirek, Yasacı, Özdiçler, 2018:233-234).

İKT məhsulları elektromaqnit dalğaları yayır. Bu dalğaların insanlarda yorğunluq, başgicəllənmə, baş ağrısı və yüksək təzyiqə səbəb olduğunu göstərən araşdırmalar var (Yakıncı, 2016: 49). İKT-nin inkişafı həm də böyüklərin və uşaqların psixi sağlamlığına təsir göstərir. Əvvəllər küçələrdə oynayan uşaqlar indi smartfon, planşet və kompüter kimi İKT məhsulları vasitəsilə virtual mühitdə oyun oynamağa başlayıblar. Virtual mühitdə çox vaxt keçirən uşaqlar real mühitdə təcrübə qazanma riski ilə üzləşirlər. Uşaqlar həmyaşıdları ilə vaxt keçirə bilmədiklərindən, onların təxəyyülləri mənfi təsirlənir. Uşağın valideynləri ilə daha az vaxt keçirməsi, öz hiss və düşüncələrini ifadə etməyə başlaması uşağın emosional inkişafına və ünsiyyət bacarıqlarına daha az mənfi təsir göstərir.

İKT-nin inkişafı ilə ortaya çıxan ətraf mühitin çirklənməsi və bu çirklənmənin və texnologiyanın digər təsirlərinin insan sağlamlığına mənfi təsirləri olduğu bir həqiqətdir. Amma heç olmasa cəmiyyətin ən kiçik institutu olan ailədən başlayaraq texnologiyanın sosial münasibətlərə

və qarşılıqlı əlaqəyə mənfi təsir göstərməsinin qarşısını almaq və ailə daxilində bu məqsədə xidmət edəcək qaydaları müəyyən edib həyata keçirmək ana və ataların üzərinə düşür. Əks halda, valideynlər davamlı olaraq texnoloji vasitələrin bu şəkildə istifadə edilməsindən şikayət edəcəklər, lakin lazımi tədbirlər görülmədikcə həm uşaqlar, həm də valideynlər bu cür davranmağa davam edəcəklər. Və beləliklə biz texnologiyanın müsbət və mənfi tərəflərindən faydalanmağa davam edəcəyik.

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ЛИЧНОСТНЫЕ ОСОБЕННОСТИ И КОПИНГ-СТРАТЕГИИ У ЖЕНЩИН СРЕДНЕГО ВОЗРАСТА С ЛИШНИМ ВЕСОМ

PERSONALITY TRAITS AND COPING STRATEGIES IN OVERWEIGHT MIDDLE-AGED WOMEN

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Аннотация

Данный обзор современной научной литературы посвящен актуальной проблеме личностных особенностей и копинг-стратегий женщин среднего возраста с лишним весом. Известно, что период среднего возраста характеризуется значительными биопсихосоциальными изменениями, которые повышают уязвимость к стрессу и могут способствовать формированию неадаптивного пищевого поведения, которое в том числе может приводить к набору лишнего веса. Особое внимание уделяется анализу личностных характеристик, таких как уровень невротизма, добросовестности, импульсивности, самооценки и саморегуляции, которые выступают важными предикторами склонности к набору веса и трудностей в его контроле. Кроме того, обобщены данные о распространённых копинг-стратегиях, используемых женщинами с лишним весом, включая эмоционально-ориентированный копинг, избегание, поиск социальной поддержки и проблемно-ориентированные стратегии.

Annotation

This review of modern scientific literature is devoted to the urgent problem of personality traits and coping strategies of overweight middle-aged women. It is known that the middle age period is characterized by significant biopsychosocial changes that increase vulnerability to stress and can contribute to the formation of maladaptive eating behavior, which can also lead to weight gain. Special attention is paid to the analysis of personal characteristics such as the level of neuroticism, conscientiousness, impulsivity, self-esteem and self-regulation, which are important predictors of the propensity to gain weight and difficulties in its control. In addition, data on common coping strategies used by overweight women are summarized, including emotionally oriented coping, avoidance, seeking social support, and problem-oriented strategies.

Ключевые слова: личностные особенности, копинг-стратегии, женщины среднего возраста, лишний вес

Keywords: personality traits, coping strategies, middle-aged womens, excess weight

Введение

В последние десятилетия проблема лишнего веса приобрела междисциплинарный характер, объединяя медицинские, социальные и психологические аспекты. Особый интерес представляет изучение личностных особенностей и копинг стратегий женщин среднего возраста с лишним весом, так как именно в этот период жизни наблюдаются гормональные изменения, изменение основного обмена веществ. Исследования показывают, что личностные факторы могут как способствовать, так и препятствовать эффективной коррекции массы тела [1].

По информации Всемирной организации здравоохранения, избыточный вес и ожирение встречаются примерно у 30% населения Земли — это порядка 1,7–1,9 миллиарда человек. Ожидалось, что к 2025 году эти показатели ещё вырастут: ожирение будет зафиксировано у до 40% мужчин и 50% женщин [2]. На данный момент доступны преимущественно прогнозные данные, однако по мере завершения 2025 года наблюдаемые тенденции в целом подтверждают эти оценки. Это позволяет рассматривать прогноз ВОЗ как достаточно достоверный и обоснованный.

По статистике, избыточным весом и ожирением в Казахстане страдает фактически каждый второй житель старше 15 лет – 53% населения. Взрослое население страны от 40 до 60 лет чаще подвержено ожирению, так как происходит снижение активности обменных процессов, физической активности и трудно изменить привычки питания [3].

Лишний вес сам по себе не является диагностическим признаком расстройств пищевого поведения. Избыточная масса тела может формироваться под влиянием широкого круга факторов, включая физиологические, метаболические и генетические механизмы, а также особенности образа жизни. Кроме того, свою роль играют индивидуальные характеристики, такие как личностные особенности, темперамент, пищевая чувствительность, метаболическая реактивность и тип телосложения.

В большинстве исследований личностные характеристики лиц с нарушениями пищевого поведения и ожирением оценивались с помощью методик, используемых в клинической психодиагностике: Миннесотского многоаспектного личностного опросника (MMPI), Я - структурного теста Аммона (ISTA), Гиссенского личностного опросника (ГЛО), Опросника невротических черт личности, шкалы депрессии Бека, Торонтской алекситимической шкалы (TAS) и др. Поэтому результаты, полученные в данных исследованиях, в большей степени характеризуют уровень и характер психопатологических нарушений у женщин с избыточным весом ожирением, нежели их личностные характеристики. Это затрудняет переход от существующего в психотерапии избыточного веса и ожирения симптоматического подхода, направленного на купирование различных симптомов тревожных и депрессивных состояний в процессе снижения веса, к реализации более эффективного личностного подхода [4].

Личностные особенности

Избыточный вес или ожирение, а также высокий индекс массы тела (ИМТ) обусловлены биологическими факторами, включая генетические. Другими причинами являются неправильное питание и недостаточное физическая активность, но и высокий уровень

стресса, влияющий на способ питания [5]. Однако влияние стресса может быть дифференцированным из-за индивидуальных особенностей человеческой личности, которые изменяют индивидуальную восприимчивость к стрессу. Пятифакторная модель личности Маккрея и Косты (так называемая «Большая пятёрка») часто рассматривается как теоретическая основа для исследований поведения, связанного со здоровьем, и играет уникальную роль в прогнозировании расстройств физического и психического здоровья. Эта модель может помочь объяснить невротизм и его компоненты (границы), такие как тревожность, гневная враждебность, депрессия, самосознание, импульсивность и уязвимость к стрессу, как факторы риска поведения, связанного со здоровьем [5]. Многие исследования показали связь между высоким уровнем невротизма и высоким ИМТ как фактором риска лишнего веса [4] и ожирения [5]. Наиболее убедительные данные о связи между невротизмом и ИМТ получены в результате генетических исследований. Торгерсен и соавторы [6] выявили генетические корреляции между невротизмом и ИМТ как факторами риска сердечно-сосудистых заболеваний и ишемической болезни сердца.

Одним из патогенетических факторов, запускающих процесс набора лишнего веса, является психогенное переедание, которое представляет собой гиперфагическую реакцию на стресс с относительно растянутым во времени эпизодом потребления пищи, приводящим к реактивной тучности [7].

Психогенное переедание было классифицировано в МКБ-10 как расстройство пищевого поведения ещё в конце 90-х гг. XX века, но на сегодняшний день его исследование затруднено из-за недостаточной развернутости симптомокомплекса и терминологических неточностей [7].

Понятие «психогенное переедание», которое в МКБ-10 включено в категорию F50.4 «Переедание, сочетающееся с другими психологическими нарушениями» [8], нередко пересекается и отождествляется в научных трудах с понятием компульсивного, или приступообразного, переедания из DSM-V (307.51), которое носит в этой классификации болезней название «binge-eating disorder» (BED) [7]. Между тем, это отождествление не является оправданным, поскольку причины, патогенетические механизмы и клиническая картина переедания при этих нарушениях имеют свою специфику. Если компульсивное переедание носит приступообразный характер, принятие пищи ограничено по времени, происходит с высокой скоростью и отличается неразборчивостью человека в продуктах питания, то при психогенном переедании употребление еды может носить избирательный характер, происходить со скоростью обычного приема пищи и при этом быть растянутым во времени в виде серии коротких перекусов [Аграс, 2021; Емелин, 2015]. Кроме того, как отмечают J. Alexander с коллегами [Alexander, 2013], компульсивное переедание может как приводить, так и не приводить к появлению избыточной массы тела, в то время как при психогенном переедании фактор ожирения является ключевым диагностическим критерием. Причинами разделения компульсивного и психогенного переедания на два отдельных вида пищевых расстройств выступают не только их клинические признаки, но и личностные особенности пациентов с перееданием. Так, приступообразность и высокая скорость потребления пищи тесно связаны с импульсивностью и вспыльчивостью: А.А. Лифинцева с соавторами [Психосоциальные факторы компульсивного, 2019] подчеркивают, что эти черты препятствуют анализу человеком причин, пробудивших голод, вместо этого он ищет способ моментального удовлетворения потребности. В свою очередь, в основе психогенного переедания в большей степени лежат тревожная симптоматика [Dingemans], низкая толерантность к дистрессу [Brockmeyer, 2014; Wang, 2017]. [7].

Копинг стратегии

Копинг-поведение активно изучается как в отечественной, так и зарубежной науке. Так, совладающее поведение исследуется в контексте профессионального стресса [Корытова, 2015], трудностей материнства [Корытова, Еремина, 2017], соматических заболеваний [Фаустова, Афанасьева, 2020] и переживания пандемии [Coping behaviors associated., 2020]. Есть отдельные исследования копинг-поведения лиц с избыточной массой тела [Varela, Andrés, Saldaña, 2020], которые показывают преобладание пассивных копинг-стратегий и эмоциогенного пищевого поведения. Исследования связи копинг-стратегий и жизнестойкости показывают, что рациональные стратегии совладания могут превратить стрессор в вызов или помочь переосмыслить стрессовое событие таким образом, что стресс фундаментально ослабевает [Judkins, 2001]. В исследовании У. Д. Джентри и С. К. Кобаса (1984) доказано, что жизнестойкость способствует использованию стратегии позитивного переосмысления стрессовой ситуации, что позволяет уменьшить негативные эмоции, такие как раздражение и печаль. Также П. Х. Блани и Р. Дж. Ганелен (1990) показано, что лица с высокой степенью жизнестойкости чаще прибегают к адаптивным подходам к преодолению трудностей и реже к неадаптивному преодолению трудностей, в отличие от людей с низкой жизнестойкостью [9].

Совладание с трудной ситуацией (копинг-стратегия) зависит от профиля личности субъекта и значимости для него стрессогенной ситуации (социальной или личностной). [10]

Исследователи отмечают, что увеличение ИМТ у женщин среднего возраста связано с ростом использования неадаптивных копинг-стратегий. По мере роста массы тела усиливается тенденция к избеганию активного решения стрессовых ситуаций, что затрудняет изменение поведения и поддержание здоровых привычек. Так, чем выше индекс массы тела женщины, тем чаще она выбирает неадаптивную копинг-стратегию – «избегание». Чем выше индекс массы тела у женщины, тем она более склонна разрешать проблемные ситуации не путем целенаправленной поведенческой активности, направленной на изменение возникшей ситуации, а путем реагирования по типу уклонения, то есть отрицания или полного игнорирования проблемы, фантазирования, уклонения от ответственности, неоправданных ожиданий, пассивности в стрессовых ситуациях («избегание»). [11]

На выбор конкретных способов совладания (копинг-механизмов) влияют индивидуально-психологические особенности личности: смысловые ориентации, направленность характера, степень самоактуализации, тип мышления, уровень тревожности и другие. В исследованиях Е.М. Трещенковой и И.Б. Дермановой, а также Коневцева И.В. и Родионовой Е.А. показано, что одним из системообразующих факторов при выборе копинг-механизмов является нейротизм. Высокие показатели нейротизма сопровождаются уменьшением уровня самоконтроля и в целом оказывают негативное влияние на успешность копинга. Высокий нейротизм подразумевает приоритетное использование стратегий, связанных с импульсивными действиями («бегство» и «конфронтация»), которые считаются менее конструктивными. Нейротизм связан с импульсивностью и повышенной тревожностью. При этом, людям с высоким уровнем тревожности могут быть присущи различные деструктивные копинги. Они могут быть как пассивные, в случае, если тревожный человек робок, не уверен в себе (стиль «избегание»), так и активные, в случае наличия дополнительных факторов чрезмерного стресса (агрессивное поведение). [12]

Современные привычки и стрессовые факторы существенно способствуют росту избыточного веса. В связи с тем, что для современного общества характерны малоподвижный образ жизни, нерациональное питание с большой долей рафинированных продуктов, переизбыток, прием пищи в значительном количестве на ночь, постоянные психологические стрессы, возрастает частота ожирения среди населения. [13]

Исследование подтверждает, что личностные особенности, описываемые моделью «Большой пятёрки», связаны с тем, как человек воспринимает риски, связанные с питанием, и формирует предпочтения при выборе продуктов. Учитывая, что пищевое поведение может выполнять для женщин среднего возраста роль копинг-механизма, данные результаты позволяют предположить, что личностные черты опосредованно влияют и на выбор копинг-стратегий через особенности отношения к пище. [14]

Заключение.

Анализ научных данных демонстрирует, что лишний вес у женщин среднего возраста формируется во взаимодействии биологических, гормональных, психологических и поведенческих факторов. Возрастные изменения обмена веществ и гормональный фон создают физиологическую основу для набора веса, однако именно личностные особенности и используемые копинг-стратегии во многом определяют индивидуальные траектории адаптации.

Черты личности по модели Big Five оказывают значимое влияние на пищевое поведение и типичные схемы саморегуляции. Повышенная нейротичность связана с эмоциональной реактивностью и склонностью к эмоциональному перееданию. Низкая сознательность предрасполагает к трудностям в поддержании регулярных здоровых привычек, что увеличивает вероятность набора веса. Другие черты — экстраверсия, открытость и доброжелательность — опосредуют социальную активность, мотивацию и эмоциональную гибкость, влияя на устойчивость к стрессу и пищевому поведению.

Копинг-стратегии формируют ключевой поведенческий механизм, связывающий личностные особенности с реальными привычками. Неадаптивные формы совладания — избегание, эмоциональное реагирование, обращение к пище как способу регуляции — способствуют набору веса и затрудняют его снижение. Напротив, проблемно-ориентированный копинг и гибкие стратегии адаптации ассоциированы с большей саморегуляцией и поддержанием здорового образа жизни.

Литература подчеркивает устойчивую взаимосвязь между личностными чертами и копинг-стратегиями: нейротичные личности чаще используют избегание, тогда как высокосознательные — активные и конструктивные способы решения проблем. Это делает сочетание данных факторов особенно важным для понимания поведения женщин среднего возраста с лишним весом. Таким образом, лишний вес у женщин среднего возраста следует рассматривать как комплексный биопсихосоциальный феномен. Одних знаний о физиологических механизмах недостаточно: поведенческие паттерны, эмоциональная регуляция, особенности личности и копинг-стратегии определяют, насколько эффективно женщина справляется со стрессом, контролирует пищевое поведение и поддерживает здоровые привычки.

Выявленная взаимосвязь между личностными чертами и копинг-стратегиями подчёркивает необходимость интеграции психологической оценки в программы снижения веса. Индивидуализированный подход — с учетом преобладающих черт личности, уровня эмоциональной устойчивости и доминирующих копинг-механизмов — может существенно повысить эффективность психологических и поведенческих интервенций. Таким образом, понимание того, как личностные особенности и копинг-стратегии совместно формируют риск набора веса и препятствуют его снижению, является ключом к разработке научно

обоснованных, персонализированных и клинически значимых программ помощи женщинам среднего возраста.

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Political Studies

Правовые и институциональные измерения трансформации Республики Казахстан: реализация повестки «Справедливого Казахстана»

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Аннотация

Настоящая статья посвящена системному анализу комплекса правовых и институциональных реформ, реализуемых в Республике Казахстан в рамках концептуальной программы «Справедливый Казахстан». Автор исследует теоретико-правовое обоснование данной повестки, определяются ключевые направления конституционной модернизации, направленные на децентрализацию власти, усиление роли Парламента и местного самоуправления, а также повышение эффективности механизмов защиты прав человека. Особое внимание уделено проблемам имплементации принятых законодательных актов и вызовам, связанным с преодолением институциональной инерции. В заключении формулируются выводы о необходимости консолидации усилий государства и гражданского общества для обеспечения необратимости демократических преобразований.

Ключевые слова: Справедливый Казахстан, конституционная реформа, правовое государство, институциональная трансформация, разделение властей, правосудие, антикоррупционная политика.

Abstract

This article is dedicated to the systematic analysis of the complex of legal and institutional reforms being implemented in the Republic of Kazakhstan within the framework of the conceptual program "Just Kazakhstan." The author explores the theoretical and legal justification for this agenda, identifying the key directions of constitutional modernization aimed at the decentralization of power, the strengthening of the role of Parliament and local self-government, and the increased effectiveness of human rights protection mechanisms. Special attention is paid to the challenges of implementing the adopted legislative acts and the obstacles related to overcoming institutional inertia. In conclusion, the findings highlight the need to consolidate the efforts of the state and civil society to ensure the irreversibility of democratic transformations.

Keywords: Just Kazakhstan, constitutional reform, Rule of Law State, institutional transformation, separation of powers, justice/judiciary, anti-corruption policy.

Программа «Справедливый Казахстан», инициированная высшим политическим руководством страны, представляет собой комплексную стратегию модернизации, цель которой – радикальная перестройка общественно-политических и государственно-правовых основ. Данная повестка обусловлена необходимостью преодоления системных дисбалансов, накопившихся в период транзита, и стремлением к построению государства, основанного на принципах законности, социальной справедливости и равноправия всех граждан перед законом[2].

События начала 2022 года продемонстрировали острую потребность в демонтаже суперпрезидентской модели управления и переходе к более сбалансированной системе политических институтов. В этом контексте реформы, запущенные в 2022–2023 годах, носят не косметический, а фундаментальный характер, затрагивая конституционные основы государственного устройства.

Целью настоящего исследования является комплексный анализ содержания и направлений правовых и институциональных изменений, проводимых в рамках программы «Справедливый Казахстан», а также оценка потенциала этих реформ для формирования устойчивого правового государства.

Методологическую основу исследования составили общенаучные методы (анализ, синтез, индукция) и специальные юридические методы, включая системно-структурный, сравнительно-правовой и формально-юридический анализ нормативно-правовых актов.

Научная новизна работы заключается в систематизации первых результатов имплементации конституционных новелл и выявлении специфических проблем правоприменительной практики в контексте формирования новой политической культуры.

Концепция «Справедливого Казахстана» не является исключительно политической декларацией; она формирует новую правовую парадигму, требующую переосмысления роли государства, личности и общества в системе властных отношений. Центральной идеей становится принцип равенства возможностей и ответственности, что в юридическом смысле означает отказ от селективного правосудия и персонализированной системы принятия решений[4].

Ключевыми правовыми аспектами, заложенными в основу данной концепции, являются:

1. Приоритет верховенства права. Подтверждение того, что законы должны быть универсальными, транспарентными и одинаково применимыми ко всем субъектам правоотношений, независимо от их статуса.
2. Политическая конкурентность. Создание правовых механизмов, обеспечивающих реальное многообразие политических взглядов и их представительство в органах власти (введение смешанной избирательной системы).
3. Повышение субъектности гражданского общества. Предоставление гражданам и общественным объединениям расширенных возможностей для участия в правотворческом и контрольном процессах (институт петиций, публичные слушания).

Наиболее значимым шагом в правовом оформлении этой парадигмы стала конституционная реформа 2022 года. В результате референдума были внесены изменения в более чем 30 статей Конституции, что фактически означает переход к «Второй Республике». Эти изменения были направлены на радикальную делимитацию полномочий между ветвями власти.

Главным вектором институциональных реформ стало ослабление вертикали президентской власти и, соответственно, укрепление горизонтальных связей – Парламента и судебной системы.

Конституционная реформа 2022 года существенно расширила контрольные и законодательные функции Парламента. Основные изменения включают:

- Ограничение президентских полномочий. Президент лишен права отменять или приостанавливать действие актов акимов областей, городов республиканского значения и столицы. Это способствует повышению ответственности местных исполнительных органов.
- Сложная система формирования Правительства. Кандидатуры на должность Премьер-министра теперь предлагаются Президентом после консультаций с фракциями политических партий в Мажилисе (нижней палате). Это обязывает главу государства учитывать парламентское большинство и фактически усиливает роль партий.
- Новый электоральный дизайн. Переход к смешанной мажоритарно-пропорциональной системе избрания депутатов Мажилиса (70% по партийным спискам, 30% по одномандатным округам) обеспечивает более широкое представительство интересов граждан, не аффилированных с крупными политическими структурами, и усиливает ответственность депутатов перед конкретными избирателями.

Эти изменения закладывают правовую основу для формирования подотчетного и профессионального законодательного органа, способного осуществлять реальный парламентский контроль.

Одним из наиболее значимых институциональных нововведений является восстановление Конституционного Суда РК взамен ранее действовавшего Конституционного Совета. Это ключевой элемент обеспечения верховенства права:

- Расширение круга субъектов обращения. Если Конституционный Совет был доступен ограниченному кругу высших должностных лиц, то КС предоставляет право прямого обращения гражданам по вопросам нарушения их конституционных прав, если они исчерпали все иные средства судебной защиты.
- Юридическая сила решений. Решения Конституционного Суда признаются окончательными и обязательными к исполнению на всей территории республики.

Восстановление института конституционной юстиции, доступной рядовым гражданам, является прямым шагом к гуманизации правовой системы и позволяет оперативно устранять законодательные пробелы и коллизии, ущемляющие фундаментальные права.

Эффективность концепции «Справедливого Казахстана» критически зависит от степени доверия общества к судебной системе и способности государства бороться с коррупцией.

Судебная реформа в рамках новой повестки сосредоточена на повышении независимости судей и улучшении качества правоприменительной практики. Правовая основа включает:

1. Ужесточение требований к судьям. Усиление роли Высшего Судебного Совета (ВСС) как автономного института, ответственного за отбор и дисциплинарную ответственность судей. Реформы направлены на минимизацию исполнительного влияния на процесс назначения.
2. Цифровизация судопроизводства. Внедрение цифровых технологий (e-Justice) для повышения прозрачности судебных заседаний и сокращения возможности внешнего давления.
3. Административная юстиция. Продолжается развитие системы административных судов, задача которых – защита прав граждан в их отношениях с государственными органами. Это позволяет эффективно оспаривать неправомерные действия чиновников и снижать уровень бюрократического произвола[5].

Особое внимание уделяется принципу состязательности и устранению обвинительного уклона, который долгое время доминировал в уголовном процессе.

Программа «Справедливый Казахстан» требует перехода от карательной антикоррупционной политики к превентивной и системной. Институциональные изменения в этой сфере включают:

- Усиление полномочий службы по противодействию коррупции Комитета национальной безопасности Республики Казахстан (Антикоррупционная служба).
- Имплементация «Закона о публичном контроле» (в разработке): Предполагается расширение возможностей гражданского мониторинга государственных закупок и целевого расходования бюджетных средств.
- Ответственность за незаконное обогащение: Введение правовых механизмов, позволяющих конфискацию имущества, происхождение которого чиновник не может обосновать законными доходами, что соответствует лучшим международным практикам.

Данные меры направлены не только на наказание, но и на устранение системных причин коррупции – снижение монополизации экономики и повышение транспарентности принятия решений.

Несмотря на прогрессивный характер принятых законодательных и конституционных изменений, процесс их имплементации сталкивается с рядом серьезных институциональных и социокультурных вызовов.

Ключевым препятствием на пути реформ является институциональная инерция – сопротивление системы, привыкшей к централизованному и закрытому режиму управления. Реальная децентрализация и передача полномочий Парламенту и маслихатам (местным представительным органам) требует не только законодательных актов, но и изменения мышления чиновников[7].

В практической плоскости это выражается в следующем:

1. Правоприменительная практика: Новые законы часто интерпретируются на местах с учетом старых административных установок, что искажает их первоначальный смысл.
2. Бюрократическое сопротивление: Сопротивление передаче функций и бюджетов на нижестоящие уровни власти, что тормозит развитие местного самоуправления.

Успех программы «Справедливый Казахстан» напрямую зависит от зрелости и активности гражданского общества. Реформы предоставили правовые инструменты (Конституционный Суд, смешанная избирательная система), но их эффективное использование требует высокого уровня правовой культуры и способности граждан к самоорганизации и контролю за действиями власти[5].

Институциональный дизайн реформ должен быть дополнен мерами по поддержке независимых СМИ и правозащитных организаций, чтобы обеспечить механизм постоянной обратной связи между обществом и государством. В противном случае существует риск, что конституционные новеллы останутся лишь декларацией, не меняющей реальных властных отношений.

Правовые и институциональные реформы, проводимые в рамках программы «Справедливый Казахстан», являются исторически значимым этапом в развитии Республики Казахстан. Они закладывают фундамент для перехода от суперпрезидентской системы к модели сбалансированного разделения властей, укрепляют институты парламентского контроля и восстанавливают доступ граждан к конституционной юстиции.

Конституционная реформа 2022 года и сопутствующее ей отраслевое законодательство создали необходимую правовую архитектуру для построения более справедливого и правового государства.

Однако для обеспечения необратимости преобразований требуется консолидация усилий по трем основным направлениям:

1. Безусловная имплементация. Обеспечение строгого и единообразного применения нового законодательства на всех уровнях государственного управления.
2. Повышение транспарентности. Усиление публичного контроля за государственными финансами и принятием стратегических решений.
3. Развитие правовой культуры. Формирование политической и правовой культуры, основанной на уважении к закону и признании конституционных прав высшей ценностью.

Только при условии реальной политической воли и активного участия гражданского общества, институциональный дизайн «Справедливого Казахстана» сможет трансформироваться из нормативной модели в устойчивую и функционирующую реальность.

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РЕЗУЛЬТАТИ ВИКОРИСТАННЯ МОБІЛЬНИХ ПРЯМОШУКОВИХ МЕТОДІВ ПРИ ВИВЧЕННІ ПРОЦЕСІВ ДЕГАЗАЦІЇ ВУГЛЕВОДНЕВИХ ФЛЮЇДІВ В СТРУКТУРАХ КОНТИНЕНТАЛЬНИХ ОКРАЇН СВІТОВОГО ОКЕАНУ

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Вступ

Відкриття на морських акваторіях багатьох тисяч підводних вулканів, ділянок газовиділення і покмарків, а також виявлення зон накопичення водню в промислових масштабах, потребує нових підходів до розуміння особливостей і можливих проявлень різноманітних процесів дегазації глибинних флюїдів, їх зв'язку з геодинамікою, регіональною геологією та формуванням корисних копалин, в тому числі нафти і газу.

У багатьох випадках скупчення нафти і газу, газогідратів та підгідратного газу, а також ділянок газовиділення можна розглядати як результат вірогідного активного впливу локалізованих потоків вуглеводневих флюїдів, які є продуктами дегазації і представлені водно-газовою або газовою середою у масі гірських порід літосфери, на породи глибинних та приповерхневих структур різного віку та генезису [Шестопапов и др., 2018; Багдасарова, 2014; Дмитриевский, Валяев, 2002].

У складі реєстрованого сумарного сигналу на земній поверхні, над нею, на рівні моря та над ним значну частку становить компонента літосферного походження, а розподіл інтенсивності випромінювання вздовж профілів має впорядковану структуру, тісно пов'язану із будовою та динамікою Землі, що дає можливість отримати інформацію про структуру геосередовища під морським дном [Шуман, Савин, 2011]. Це доводить принципову можливість застосування нових методів дослідження будови локальних і регіональних структур Землі.

Застосовані технології частотно-резонансного (ЧР) сканування дозволяють дистанційно визначити ймовірну глибину геологічних джерел активної міграції, дають

додаткову інформацію про можливе розташування джерел дегазації і скупчень вуглеводнів. Існує багато прикладів, коли за даними ЧР сканування виправдовувались попередні (до буріння) прогнозні оцінки локальних структур на перспективність виявлення скупчень вуглеводнів або їх відсутність. Тобто, є неочікувані і унікальні факти прогностичного характеру, за даними ЧР-сканування, які важко, але у майбутньому треба краще зрозуміти і науково пояснити.

Запропоновані технології ЧР-досліджень, деякі результати застосування яких наведені нижче, ще потребують детального теоретичного обґрунтування, розвитку та вдосконалення. Наразі отримані результати можуть бути активно використані при виконанні регіональних і локальних досліджень на різних етапах пошуку та розвідки родовищ багатьох видів корисних копалин [Левашов и др., 2012; Якимчук и др., 2019, 2020, 2021, Yakymchuk et al., 2024].

Методи досліджень

Експериментальні дослідження проведені з використанням технології, яка включає модифіковані методи ЧР обробки та декодування супутникових та фотознімків, вертикального електрорезонансного зондування розрізу та методик інтегральної оцінки перспектив нафтогазоносності площ обстеження.

В модифікованих версіях методів використовуються існуючі колекції осадових, метаморфічних та магматичних порід, мінералів та хімічних елементів. Зазначимо також, що частотно-резонансні методи надають можливість у кожному конкретному випадку наповнювати розріз присутніми в ньому комплексами осадових, метаморфічних і магматичних порід, а також визначати, під час проведення вимірювань, в першому наближенні (і уточнювати на етапах деталізації) глибини інтервалів розрізу, перспективні на виявлення корисних копалин [Якимчук и др., 2019].

Метод ЧР обробки даних використовує базу даних фотографій набору магматичних та метаморфічних порід, яка включає 18 груп. Їх перелік у кожній групі, кольорові зображення зразків гірських порід, мінералів, рідин та газів, що використовувалися в якості еталонів представлені в [Якимчук и др., 2024]. Було показано, що блок однорідної речовини створює електромагнітне випромінювання, потужність якого пропорційна концентрації речовини. Можна припустити, що лінійно поляризована хвиля із заданою частотною характеристикою, яка несе інформацію про структуру речовини, не поглинається середовищем, а її інтенсивність не зменшується з відстанню. Таким чином, однорідна речовина на довільній глибині Землі створює поле, подібне до того, якби ця речовина була б на поверхні. Виявилося, що характерна електромагнітна хвиля скупчень нафти і газу певним чином реєструється на космічному знімку, і це може слугувати основою для виявлення нових родовищ.

Особливості та можливості використаних методів, а також методика проведення вимірювань описані в [Yakymchuk et al., 2024].

Поля сипів в структурах континентальних окраїн Світового океану

Основна кількість виявлених та вивчених полів сипів (рис. 1) розташована на континентальних окраїнах Світового океану та внутрішніх морів, а також в районах «багаторічної мерзлоти» узбережжя Північного Льодовитого океану [Богоявленский, 2014, Краюшкин, 2008; Сывороткин, 2002; Шнюков и др., 2013; Шнюков, Топачевский, 2019; Behrendt, 1991; Judd, Novland 2007; Shakhova et al., 2010].

У складі газових емісій – переважно метан, присутні CO₂, іноді сірководень [Шнюков и др., 2013]. Висота газових факелів найчастіше дорівнює 100-200 м, а в глибоководних морях їх висота може перевищувати 500-800 м. Для їх тривалого існування необхідно надходження

вільного газу системою підводних каналів в осадові і водні товщі, різною мірою здатних поглинати (екранувати) потоки газів та їх емісію в атмосферу.

Велика кількість газових проявів була виявлена у Баренцовому, Північному, Середземному, Чорному, Каспійському, Південно-Китайському та інших морях [Шнюков, Топачевский, 2019].

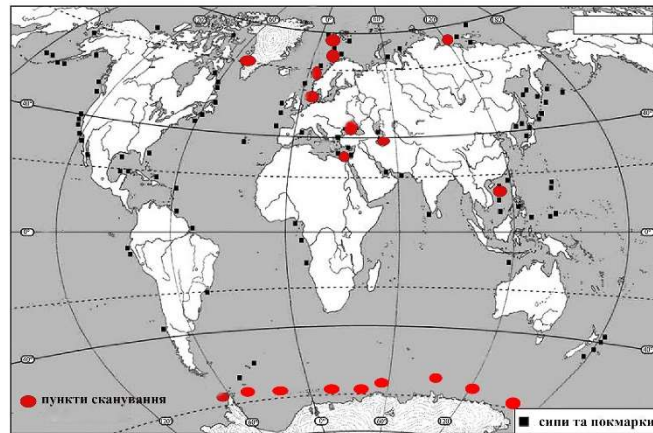


Рис.1. Схематична карта розташування підводних газових проявів [Шнюков, Топачевский, 2019]. На карту нанесено положення пунктів сканування.

На сьогоднішній день питання походження та загального глобального обсягу емісії метану в структури дна континентальних окраїн, а також оцінки можливого надходження метану в атмосферу, вивчені недостатньо. Особливо це стосується оцінки масштабності дегазації та глибинної емісії метану в геологічних структурах, пов'язаних із процесами утворення вуглеводнів. Важливу роль у надходженні глибинних флюїдів у верхні горизонти земної кори відіграє наявність мережі розломів, які слугують міграційними каналами.

Нижче розглянуто деякі результати використання технології ЧР досліджень газових проявів з метою оцінки глибини джерел формування вуглеводневих флюїдів в структурах шельфу та континентальних окраїн Світового океану.

Процеси дегазації у полярних районах Арктики (рис. 2)

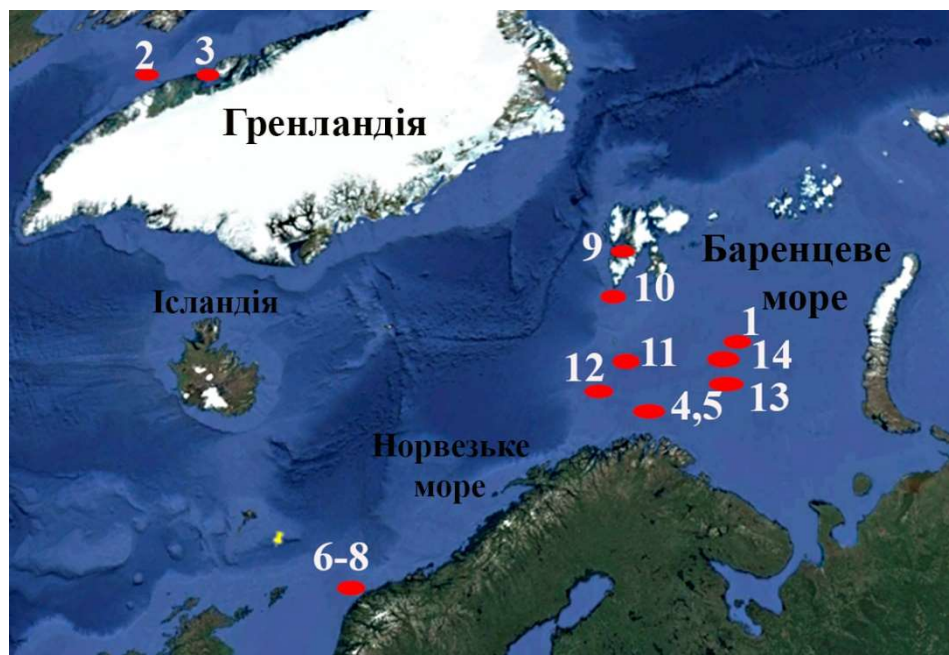


Рис. 2. Пункти ЧР сканування в Арктиці.

Приклади використання ЧР-технологій для отримання характеристик окремих осередків емісії метану, виявлених у полярних районах Арктики і обумовлених значною мірою проявами процесів глибинної дегазації Землі розглянуті у [Soloviev et al., 2023].

Результати багаторічних досліджень Арктичного регіону показали, що формування та динаміка процесів емісії метану є результатом впливу багатьох факторів, основними з яких можна вважати: 1) надходження газів із покладів газогідратів і скупчень метану з товщ багаторічномерзлих порід (БМП), що руйнуються (в результаті протаювання); 2) міграцію газових флюїдів різного (біогенного, термогенного, ендегенного) генезису у водну товщу через системи приповерхневих тектонічних порушень, а також через глибинні розломи регіону [Baranov et al., 2020]. Можливий імпульсний викид в атмосферу великої кількості «запечатаного» метану внаслідок масштабного руйнування та деградації БМП може призвести до глобальних кліматичних змін по всій Землі. Тому виявлення ділянок дегазації, комплексний аналіз джерел емісії та прогнозування їх динаміки є предметом багаторічних досліджень у полярній Арктиці.

На шельфі моря Лаптевих, в області інтенсивного розвантаження глибинного метану, концентрація метану в поверхневому шарі води визначає особливості процесів його сучасної емісії та підвищеного вмісту в атмосфері (рис. 3).

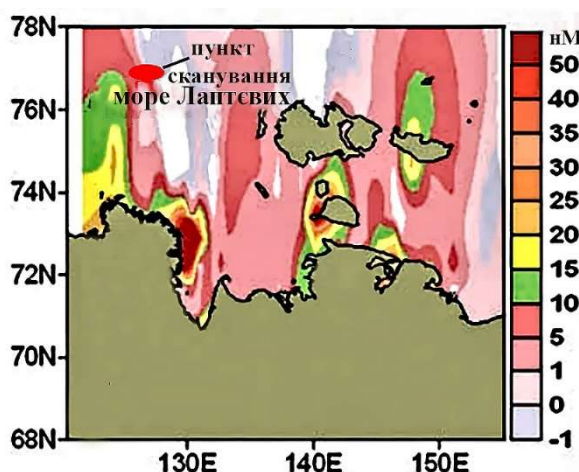


Рис. 3. Розчинений CH_4 у поверхневих водах моря Лаптевих [Shahova et al., 2010].

Найбільша зона локальних скупчень метанових сипів на зовнішньому шельфі моря Лаптевих (рис. 4) просторово співпадає із північною частиною тектонічних порушень Лаптевоморської рифтової системи [Baranov et al., 2020].

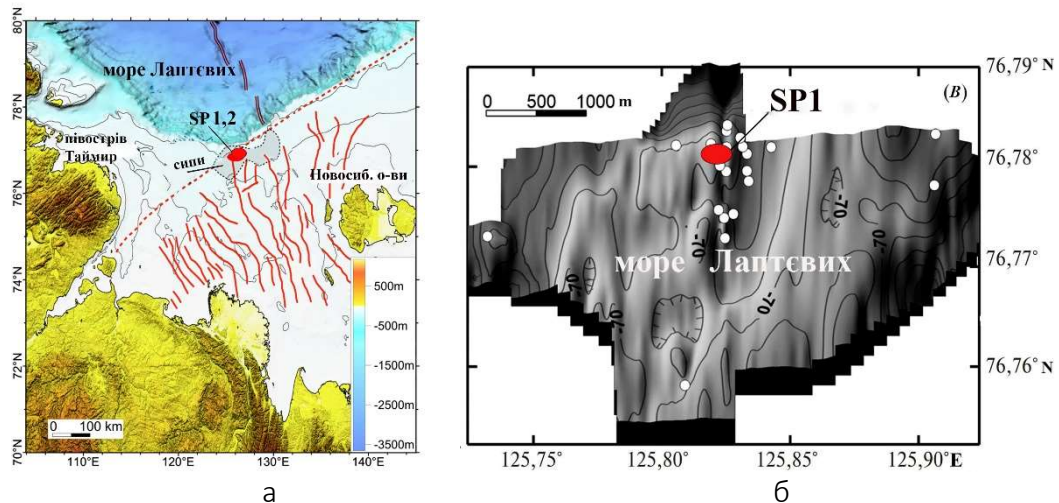
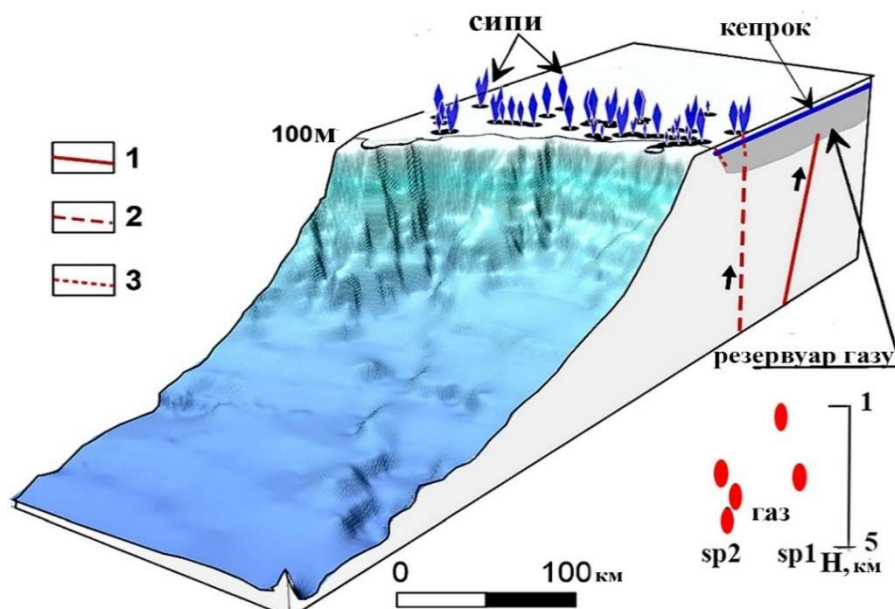


Рис. 4. а – Район досліджень у морі Лаптевих; б – рельєф дна, розташування ділянки з метановими сипами [Baranov et al., 2020] та пункту ЧР-сканування.

У верхній частині осадових горизонтів шляхи надходження флюїдів у водну товщу проходять по системах поверхневих розломів, які при зануренні зовнішнього шельфу порушують суцільність порід, покриваючих газогідрати.

Результати ЧР-зондування показали зареєстровані сигнали від нафти, газу, газоконденсату, вуглекислого газу, газогідратів, антрациту та ін. Інструментальними вимірами підтверджено міграцію газів (метан, вуглекислий газ, азот та ін.) в атмосферу.

Для пунктів зондування SP1 та SP2 вперше визначено положення скупчень газу (рис. 5) на глибинах 956-1603 м, 2542-2925 м (SP1) та 2074-4375 м (SP2).



Примітка. 1 – Лаптевоморська рифтова система; 2 – Хатанзько-Ломоносівський розлом; 3 – поверхневі розломи зовнішнього шельфу. Стрілки вказують напрямки міграції вільного газу. sp1, sp2 – пункти ЧР-зондування.

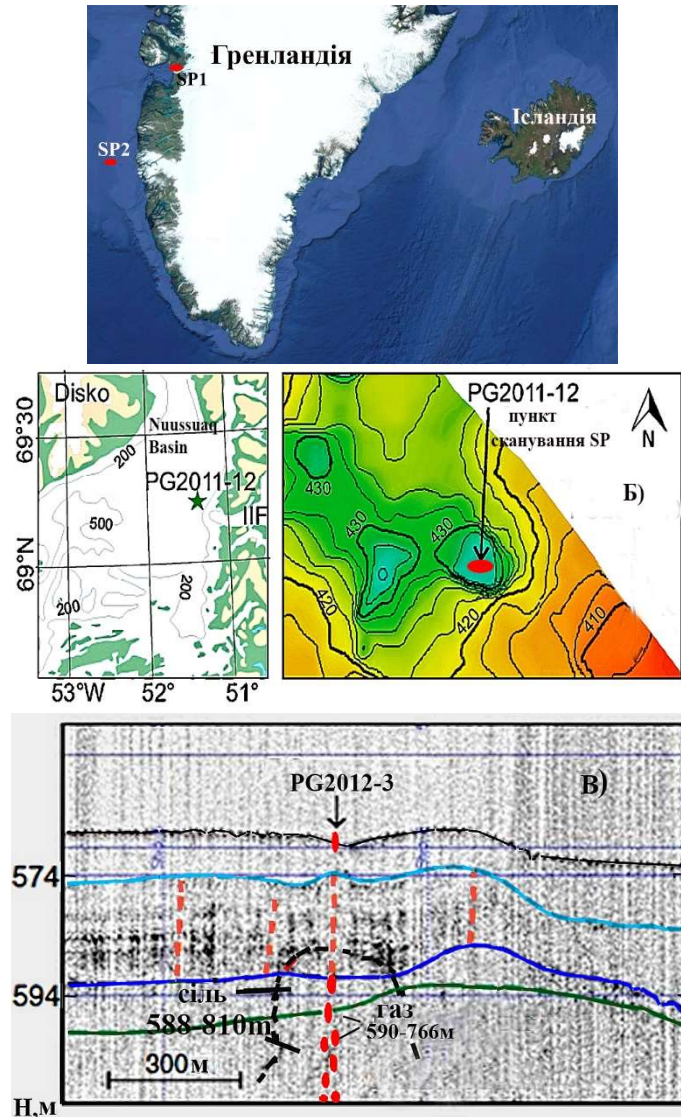
Рис. 5. Модель схилу та шельфу моря Лаптевих і схематичний (поза масштабом) розріз поля сипів та тектонічних порушень, що сприяють процесам глибинної та придонної дегазації [Baranov et al., 2020, із змінами].

Результати багаторічних досліджень процесів дегазації в Арктиці показали, що інтенсивне потепління в Арктиці не спричинило зростання придонних температур у Центрально-Лаптівському районі за останні десятиліття. З цього випливає, що формування сипових полів та емісія газів у цьому районі визначається значною мірою глибинними джерелами дегазації, положення яких контролюються наявністю мережі тектонічних порушень та глибинних розломів. Додатковим джерелом метану можуть бути надходження із газогідратів, існування яких підтверджують результати ЧР-зондування. Виявлення глибинних скупчень газу нижче зони стабільності газогідратів підтверджує припущення про реальність дії змішаного механізму процесів локальної глибинної і придонної дегазації на зовнішньому шельфі моря Лаптевих [Baranov et al., 2020].

Виявлення та картування в розрізі глибинних джерел дегазації в структурах шельфу моря Лаптевих підтверджує раніше виявлену закономірність існування різнопланових та багаторівневих причин та факторів, що впливають на особливості формування великих метанових сипів в структурах полярних регіонів Арктики.

Центральна частина Західної Гренландії. У центральній частині Західної Гренландії (район затоки Диско) для дослідження було обрано два пункти ЧР сканування, розташовані в межах полів покмарків і сипів (рис. 6А) [Nielsen et al., 2014; Hogan et al., 2012]. Сейсмічні дані показали, що покмарки виникли внаслідок пульсації флюїдів, наявності неотектонічного розлому та підняття земної кори.

Дані зондування супутникового знімка для PG2011-12 підтвердили сучасну активну міграцію газу, але сигналів від газогідратів не зафіксовано. Сигнали від солі зафіксовані в діапазоні 435-882 м. Спільний сигнал газу та солі зафіксовано в інтервалі 468-742 м.



Примітка. На (В) світло-блакитна, темно-синя та зелена лінії – одиниці в 40-метровій осадовій послідовності; помаранчеві лінії – елементи витоку газу та рідини, за [Nielsen et al., 2014].

Рис. 6. А – Пункти розташування сипів в центральній частині континентальної окраїни Західної Гренландії; Б – рельєф дна в басейні Нууссуак (затока Діско) та положення точки сканування PG 2011-12 біля гирла фіорду Ілуліссат (IIF), за [Nielsen et al., 2014]; В – структура сейсмічного профілю високої роздільної здатності через пункт PG 2012-3.

Точка сканування PG2012-3 розташована в найглибшій частині покмаркоподібної структури з діаметром у верхній осадовій товщі, де виток газу/рідини спостерігається на поверхні морського дна [Nielsen et al., 2014]. Сейсмічні дані показують, що у депресії (розміром 20×35 км, глибиною 575 м) на внутрішньому шельфі на захід від затоки Діско більш молоді відкладення (рис. 6В) покривають крейдяно-палеоценові товщі з газогідратами та BSR-розділом під морським дном. Геохімічні дані вказують на міграцію метану з глибинної нафтогазової системи [Nielsen et al., 2014].

Ці дані підтверджуються результатами ЧР зондування у пункті PG 2012-3, де зафіксовані сигнали нафти, газового конденсату та газу. Сигнал солі зафіксовано в інтервалі 588-810 м, а спільний сигнал солі та газу - в інтервалі 590-766 м (рис. 6В). Зафіксовано сигнали

від доломітів (0,81-1,3 км, 2,0-99 км) та ультраосновних магматичних порід (1,3-2,0 км). Також спостерігався процес дегазації з поверхні в атмосферу.

Отримані результати підтверджують попередні прогнози про те, що мезозойські осадові басейни в центральних частинах західно-грендландської окраїни можуть мати велику кількість нафти та газу, але питання існування зрілих материнських порід у надрах, трансформація та вертикальна і латеральна міграція вуглеводнів у пастки є досить дискусійними [Christiansen et al., 2020]. Газ тут походить не лише з газогідратів та крейдяно-палеоценових відкладень, оскільки наші дані показали можливий додатковий механізм утворення абіотичних вуглеводнів, як і в інших арктичних районах.

Досліджена ділянка покмарків Ньєгга розташована на шельфі континентального схилу Норвезького моря (рис. 7,А) у південній частині плато Воринга, де глибина дна коливається від 600 до 800 м. Тут виявлено понад 230 покмарків, діаметр яких досягає 600 м, а глибина – 15 м [Judd, Hovland, 2007; Plaza-Faverola et al., 2010, 2011].

Геофізичні дослідження показали, що особливості будови та можливий вік покмарків ділянки пов'язані із структурою «газових труб» (рис. 7Б), утворених в результаті тривалої еволюції міграції глибинних потоків газоподібних флюїдів через осадову товщу. На глибинах більше 1500 м можуть існувати умови для утворення термогенного метану, тому автори досліджень [Plaza-Faverola et al., 2010] схиляються до думки, що деякі покмарки виникли у результаті імпульсних надходжень флюїдів з газових скупчень, збагачених метаном і розташованих біля підшови осадової товщі.

При рекогносцирувальній ЧР-обробці всієї ділянки Ньєгга зафіксовані сигнали на частотах водню, червоного фосфору, водневих бактерій, а також сигнали від базальтів і ультрамафічних порід. При зондуванні покмарка в точці з координатами 64° 40' 02"N; 05° 07' 32"E отримані відгуки для кількох груп осадових порід, газогідратів, вуглеводнів, вуглекислого газу.

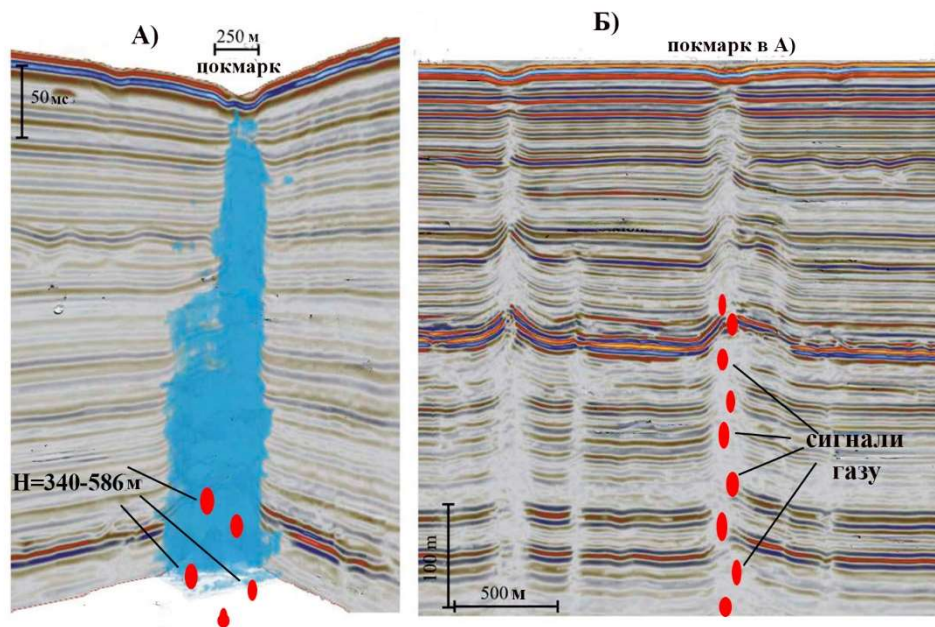
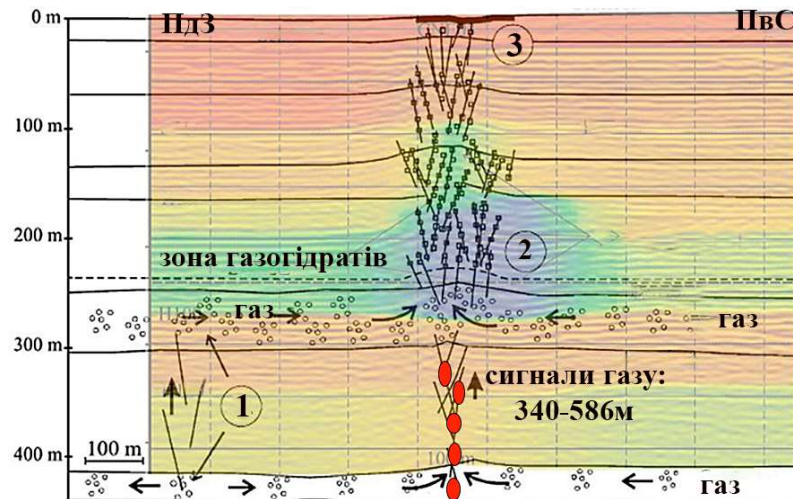


Рис. 7. Покмарки (А) на північному фланзі зсуву Сторегга на континентальній окраїні Норвегії; Б — «газові труби» з покмарками [Plaza-Faverola et al., 2010, спрощено].

Процеси дегазації зафіксовані на водній поверхні, а також для глибин 340-586 м, 1669-1933 м, 3547-3999 м, 4156-4819 м. Глибина залягання газогідратів (555 м) у точці зондування значно перевищує модельні значення прийнятої глибини підшови зони стабільності газогідратів на цій ділянці (рис. 8).

Отримані результати дають підстави стверджувати, що у формуванні покмарків на ділянці Ньєгга беруть участь газові флюїди різних горизонтів (до 5 км) осадової товщі. Не виключено, що процеси дегазації можуть існувати і в більш глибинних горизонтах, проте зондування було проведено лише до глибини 4819 м.



Примітка. Етап 1 – Вертикальна міграція глибинного газу по розломах та через проникні породи у стратиграфічних та структурних пастках; етап 2 – міграція газу з надлишковим тиском через тріщини, з утворенням газогідратів; етап 3 – зменшення надходження глибинного газу, утворення гідратів по всій зоні стабільності газогідратів та аутигенних карбонатів поблизу морського дна.

Рис. 8. Модель формування та можливі етапи еволюції «газової труби» з газогідратами на ділянці Ньєгга [Plaza-Faverola et al., 2023, спрощено].

Результати застосування ЧР технологій показали, що покмарки ділянки Ньєгга є важливою та характерною частиною системи геофлюїдів та газогідратів на континентальному схилі Норвегії, у формуванні якої значну роль відіграють потоки глибинного метану, виділені раніше в інших структурах Арктики.

Центральна частина Шпіцбергена (район Ісфіорден). В Ісфіордені виявлено понад 1300 покмарків (діаметром від 14 до 265 м, глибиною від 1 до 11 м і частотою поширення до 20 на км²), 535 покмарків виявлено в Нордфіордені [Roy et al., 2019]. Їх розподіл має мозаїчний характер. Найбільш активно виражені їх прояви просторово пов'язані з зонами активних розломів. Геохімічний аналіз вуглеводневих аномалій у приповерхневих морських відкладах фіордів вказує на термогенну та біогенну природу газів [Roy et al., 2019].

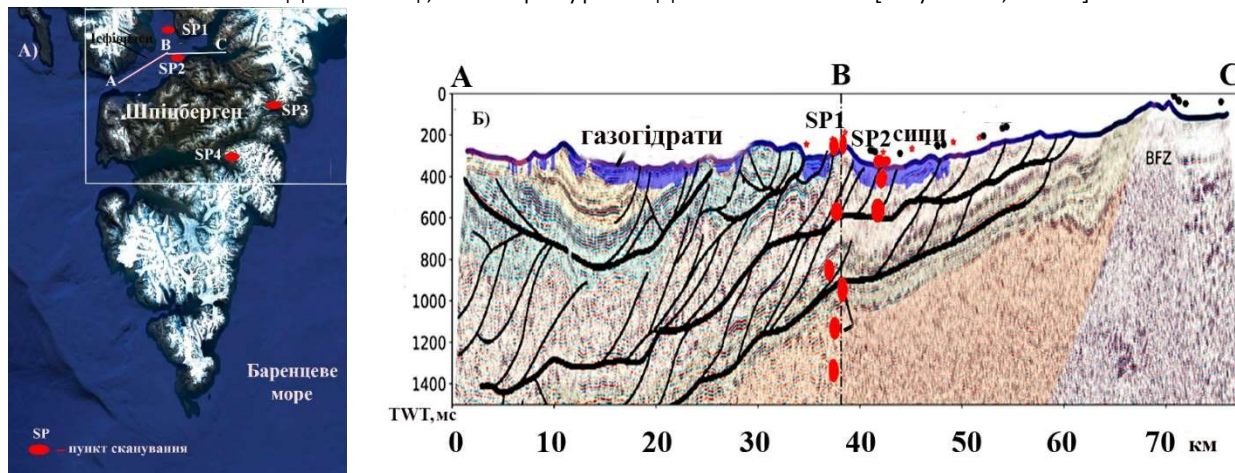
За результатами застосування ЧР технологій на ділянці зареєстровані сигнали від нафти, газу, газоконденсату, сланцю, газогідратів та антрациту. Зондування було виконано до глибини 4789 м, відгуки на частоті газу отримані з карбонатних порід (вапняків) на глибинах: 1335-1932 м; 2459-3321 м; 3933-4467 м. Інструментальними вимірами підтверджено міграцію жовтого фосфору, вуглекислого газу, кисню, азоту в атмосферу.

Детальний аналіз геофізичних даних у Нордфіордені свідчить про існування газових факелів лише над частиною покмарків, що може бути пов'язане з дискретним характером сучасних процесів дегазації, а також зі зміною напрямків глибинної міграції флюїдів.

Для SP1 (рис. 9A) зареєстровані сигнали від нафти, газу, газового конденсату, вуглекислого газу, горючих сланців, газогідратів, антрациту, азоту. Відгуки на частоті газу одержані для глибин: 1335-1932 м; 2459-3321 м; 3933-4467 м. Зондування проводилось до

глибини 4789 м. Інструментальні ЧР вимірювання у цій точці підтвердили міграцію газу до атмосфери (рис. 9Б).

Вважається, що у центральній частині Шпіцбергена міграція термогенного газу по зонах розломів може бути основним геологічним фактором утворення сипів і покмарків, хоча вплив інших факторів (наявність скупчень вільного газу, процеси фільтрації, сейсмічна активність тощо) також може бути важливим. Процеси надходження активних газів у товщу води та атмосферу можуть змінюватись у часі, вони залежать від багатьох параметрів, включаючи вплив водної товщі, температури та динаміки хвиль [Roy et al., 2019].



Примітка. 2 – проекція пунктів сканування на профіль.

Рис. 9. А – Схематична карта Ісфіордена з пунктами ЧР-зондування і сейсмічним профілем А-В-С [Betlem et al., 2021]; Б – сейсмічний розріз вздовж профіля А-В-С з результатами інтерпретації даних ЧР-зондування. SP1.

В SP3 (рис. 9А) зафіксовано сигнали нафти та газового конденсату, а також зафіксовано дегазацію з поверхні. Газовий сигнал реєструвався в діапазоні глибин 12,7-72 м, 152-202 м, 318-1426 м, 1605-2065 м, 2599-3507 м, 4010-4570 м, 5444-5929 м, далі зондування не проводилось. Найбільш перспективними є діапазони глибин 2599-3507 м, 4010-4570 м та 5444-5929 м.

В SP2 фіксується сигнали газу та жовтого фосфору та їх дегазація з поверхні, у осадах сигнал газу спостерігається в інтервалах: 290-615 м, 996-1159 м, 1198-1314 м (рис. 10Б).

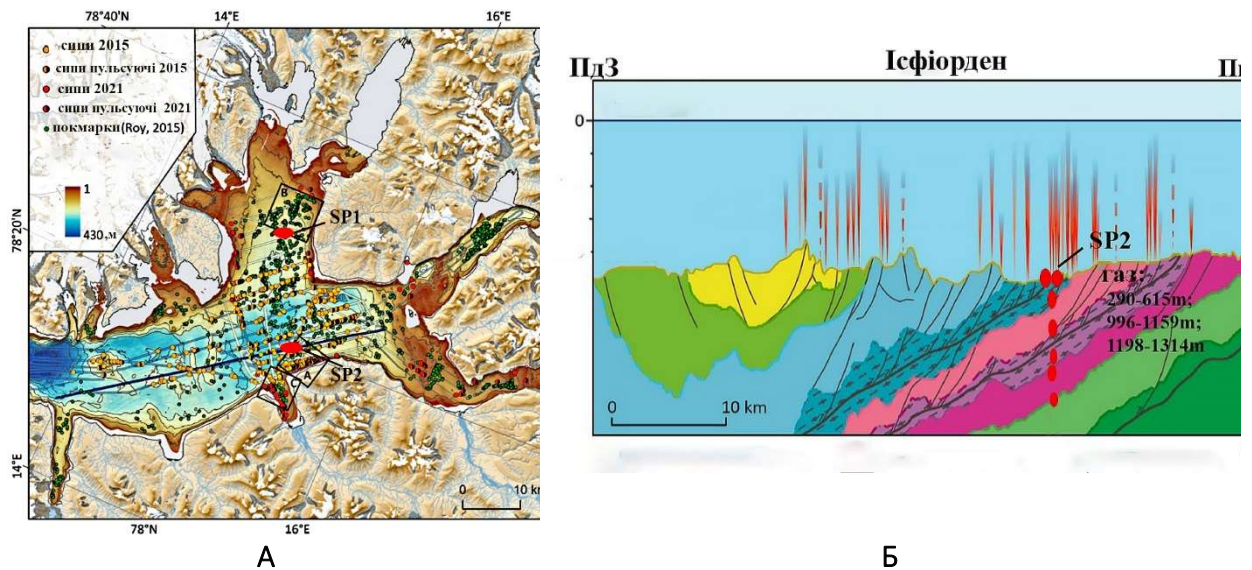


Рис. 10. А – Розподіл ипів в Ісфіордені, Шпіцберген [Rodes et al., 2023] з розташуванням точок ЧР сканування (SP1, SP2); Б – концептуальна модель газової системи Ісфіорд [Rodes et al., 2023, модифікована] з результатами сканування (SP2).

Пункти сканування SP3, SP4 розташовані в районах (рис. 11), де сформувалися перенасичені метаном підземні води з ізотопними ознаками термогенного джерела [Betlem et al, 2021].

В пункті SP3 (рис. 11A,B) зареєстровані сигнали нафти та газового конденсату, а також газовий сигнал було зафіксовано в діапазоні глибин 12,7-72 м, 152-202 м, 318-1426 м, 1605-2065 м, 2599-3507 м, 4010-4570 м, 5444-5929 м. Найбільш перспективними слід вважати діапазони глибин 2599-3507 м, 4010-4570 м, 5444-5929 м.

В пункті SP4 (рис. 11A) фіксуються сигнали нафти та газового конденсату, а також дегазація в атмосферу. Газовий сигнал реєструвався в діапазоні глибин 17,1-70 м, 161-215 м, 563-916 м, 1139-1523 м, 2012-2638 м, 3148-4282 м, 4412-5105 м, 5465-5963 м. Найбільш перспективними слід вважати діапазони глибин 2012-2638 м, 3148-4282 м, 4412-5105 м, 5465-5963 м.

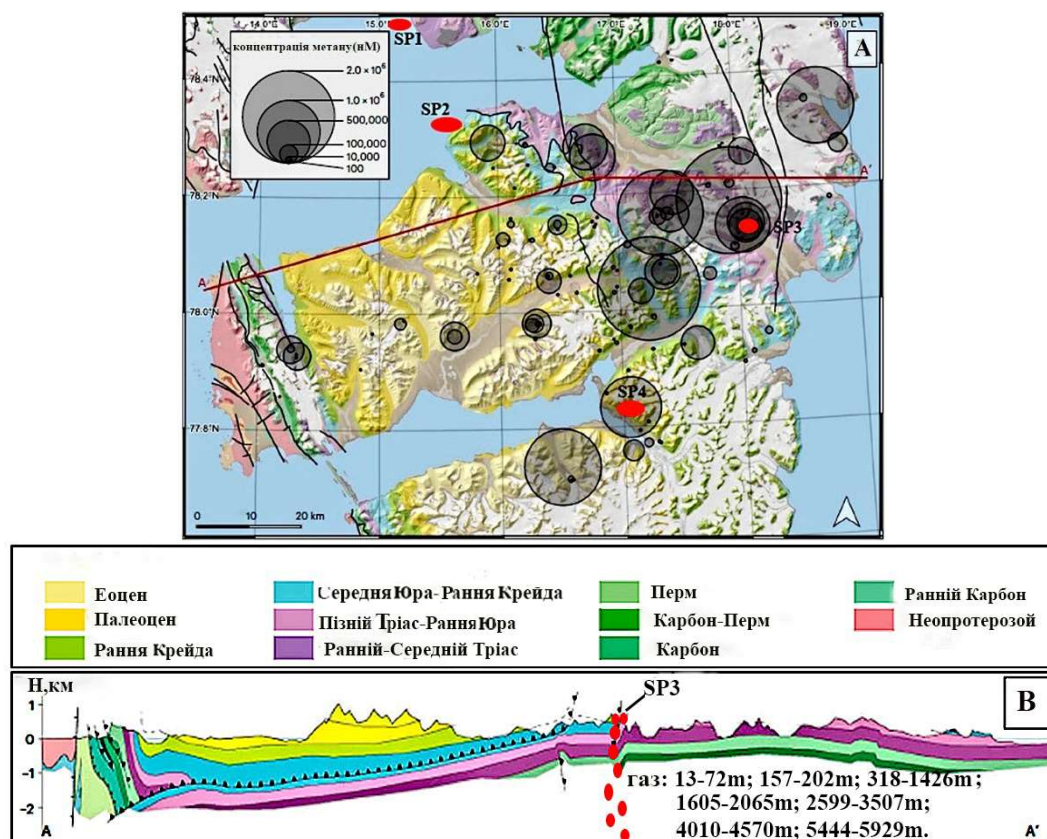


Рис. 11. А – Концентрації метану у відібраних прольодовикових підземних водах відображені за розміром бульбашок на геологічній карті центрального Шпіцбергена з точками сканування та розташуванням профілю поперечного перерізу А–А' [Kleberet al., 2023]. Чорні лінії на карті – геологічні розломи. В – профіль поперечного перерізу А–А' з результатами ЧР-зондування точки (SP3).

Зона піднять Сентралбанкен в північній (норвезькій) частині Баренцева моря. Результати ЧР-сканування в районі Сентралбанкен (рис. 12А) показали, що сигнали синтезу вуглеводнів зафіксовані на глибині 57 км. Газовий сигнал фіксується в інтервалах глибин: 158-501 м, 864-1158 м, 1458-1835 м. Сигнал газогідратів фіксується на глибинах до 400 м. Зафіксовано процес дегазації з поверхні води в атмосферу (рис. 12Б).

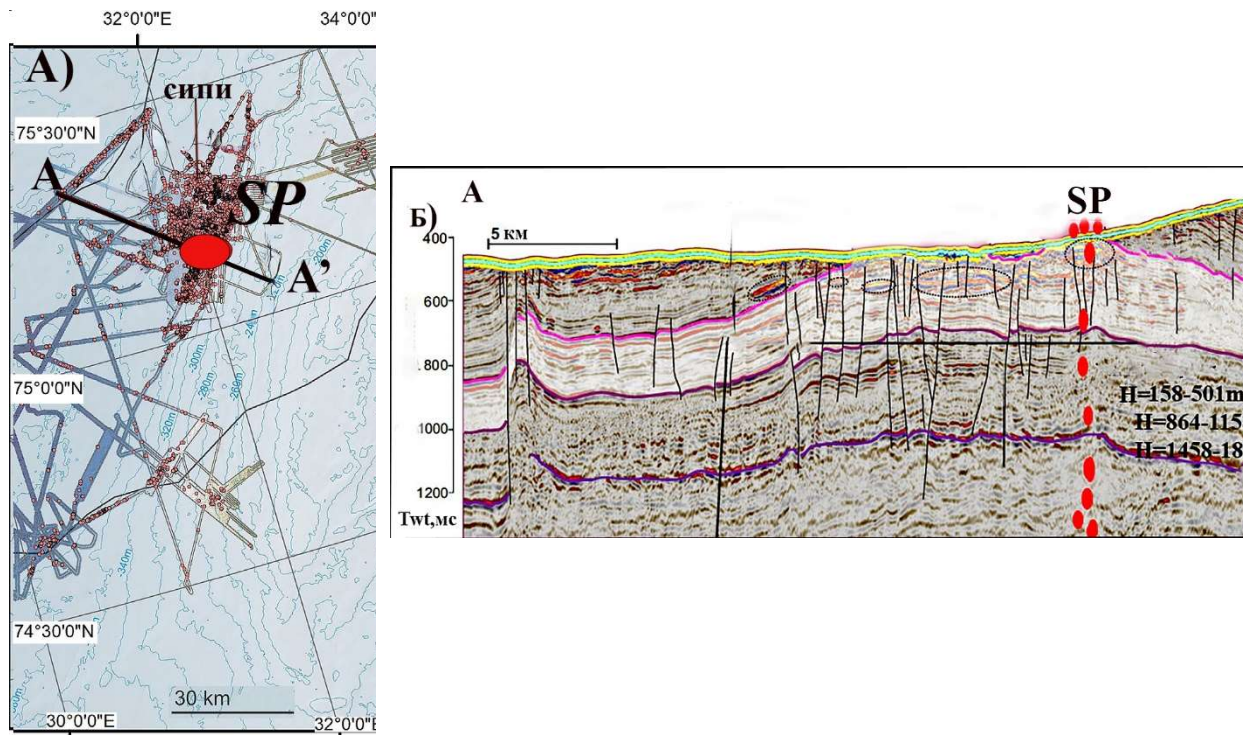


Рис. 12. А – Розташування пункту сканування (SP) у районі Централбанкен, Б – сейсмічний розріз вздовж профілю А – А' [Serov et al., 2023].

Грязьовий вулкан Бореаліс було виявлено влітку 2023 року у водах південно-західного Баренцевого моря на глибині 400 м (рис. 13). Він розташований в центрі кратера шириною приблизно 300 м і глибиною 25 м. Найімовірніше, вулкан Бореаліс є результатом катастрофічного природного виверження, яке раптово вивільнило масивну кількість метану одразу після останнього періоду зледеніння, 18 000 років тому [Panieri et al, 2024]. Наразі грязьовий вулкан Бореаліс, діаметр якого становить 7 м, а висота 2,5 м, безперервно викидає багаті на метан рідини.

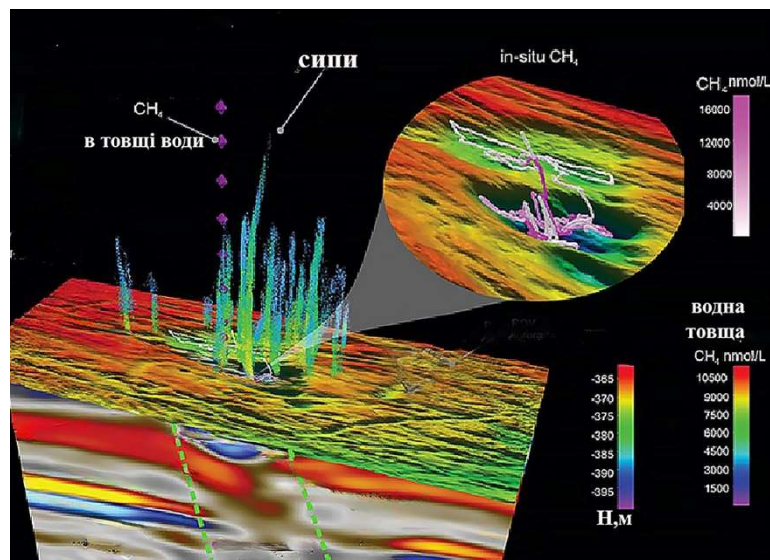


Рис. 13. Грязьовий вулкан Бореаліс: рельєф дна, вміст метану в водній товщі та в центрі вулкану [Panieri et al, 2024, спрощено].

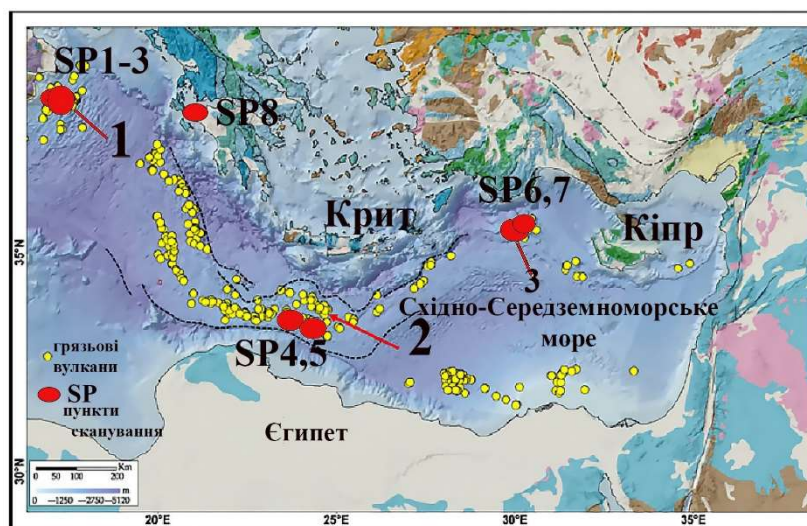
Резонансні відгуки на газових частотах зареєстровані в інтервалах 166-511 м і 882-1131 м, а також в інтервалі 1,131-10,0 км. Сигнали можуть вказувати на наявність глибокого

міграційного каналу та викидів газу в атмосферу, що підтверджується сучасними процесами виверження газу в кратері грязьового вулкана Бореаліс. Резонансні відгуки на частотах газогідратів були отримані до глибини 400 м.

Виявлення скупчень газу та джерел дегазації на глибинах, що охоплюють (і перевищують) потужність осадового чохла, може свідчити про додаткове надходження глибинного газу та існування процесів глибинної дегазації, які можуть пояснити масштаби утворення і прояву полів сипів і покмарків в різних структурах Баренцева та інших морів Арктичного регіону.

Дослідження окремих грязьових вулканів Середземномор'я Район Калабрія

На рис. 14 показано розташування грязьових вулканів у Східному Середземноморському басейні, які локалізовані в межах компресійних зон, таких як акреційні комплекси та структури насувів. Деякі з них пов'язані з зонами високого сучасного осадконакопичення, таких як конуси виносів або ділянки з інтенсивним розвитком соляного діпіризму [Zitter, 2004; Camerlenghi et al., 1992; Dimitrov, 2002; Dimitrov, Woodside, 2003, Volcanism..., 1995].



Примітка. Поля грязьових вулканів: 1 – Калабрійський, 2 – Олімпійський, 3 – Анаксимандрійський.

Рис. 14. Грязьові вулкани (позначені жовтими маркерами) у Східному Середземноморському басейні [Masclé et al., 2014] та точки сканування (SP, червоний еліпс).

Грязьові вулкани вперше були виявлені у східній частині Середземного моря понад 40 років тому. За останні 15 років вже понад 60 з них були виявлені на внутрішній частині Середземноморської агломерації (на південь від Калабрії) на глибині 150-2750 м [Panieri, 2013; Carmichael, 2020; Lohr et al., 2018].

Сейсмічні дані показали існування серії тектонічних порушень в межах Калабрійської дуги, і було висловлено припущення, що виявлені насуви могли забезпечити формування шляхів вертикальної міграції для флюїдів грязьового вулканізму [Panieri et al, 2013].

Грязьові вулкани Венере являють собою пару екструзивних конусів висотою до 100 м, що розташовані на глибині 1500 м в Іонічному морі, за 30 км на південь від узбережжя Калабрії (рис. 15А). Характерною особливістю цього поля грязьових вулканів є існування

зануреної кальдери, обмеженої кільцеподібною зоною розлому, з чітко вираженою структурами донного рельєфу (рис. 15Б).

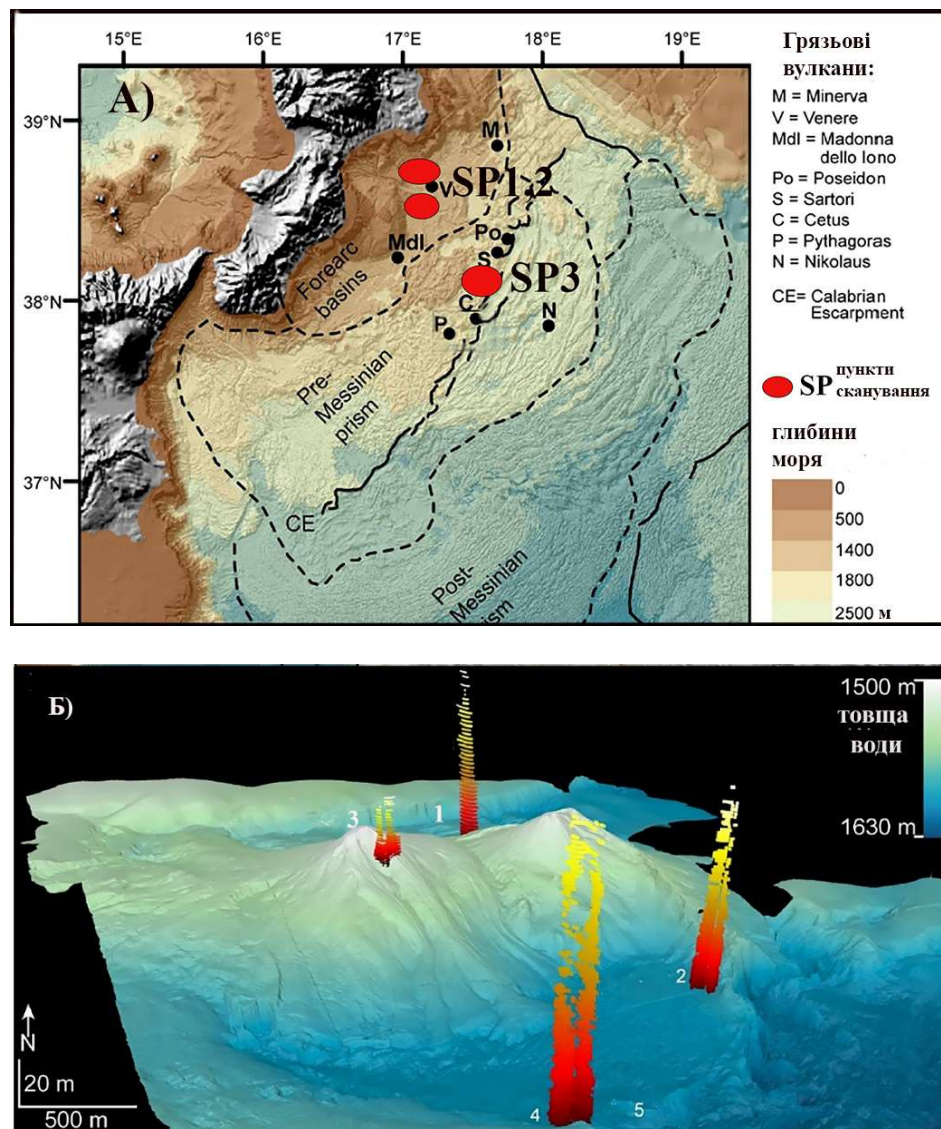


Рис. 15. А – Тектонічна схема, розташування грязьових вулканів у переддуговому басейні; Б – точки сканування (SP) вздовж Калабрійського ескарпу та локальна батиметрія вулкана Венере [Loher et al., 2018].

Сучасні грязьові потоки та постійні викиди газу свідчать про те, що грязьові вулкани Венере є одними з найактивніших, у порівнянні з іншими грязьовими вулканами переддугового басейну. Проведені дослідження свідчать про термогенне походження вуглеводнів, що викидаються цим грязьовим вулканом і їх джерела розташовані на глибині більше 3 км [Loher et al., 2018].

Пункти сканування SP1 та SP2 (рис. 16А) розташовані на валу Венери, де було зареєстровано активну дегазацію [Loher et al., 2018]. Для пункту сканування SP1 відгуки були отримані від доломітів (до 6,5 км) в локальних умовах стиснення, які фіксуються особливостями прийому частотного сигналу. Для пункту сканування SP2 відгуки отримані від другої осадової групи, де залягають грязьові потоки та псаміти (до 7,5 км). Вони також свідчать про існування локальних умов стиснення.

Пункт сканування SP3 (рис. 16Б,В) розташований на вулкані Сарторі, де відгуки вказують на наявність локальних умов стиснення. У цій точці сканування вони були отримані

від сьомої осадової групи (до 4,0 км). Також були отримані сигнали від вуглеводнів (SP2 та SP3), які вказують на їх можливе термогенне та глибинне походження [Loher et al., 2018, Doll et al., 2023]. Ізотопний склад метану, визначений у вулканічному полі Сарторі, є результатом суміші метану з кількох джерел [Doll et al., 2023].

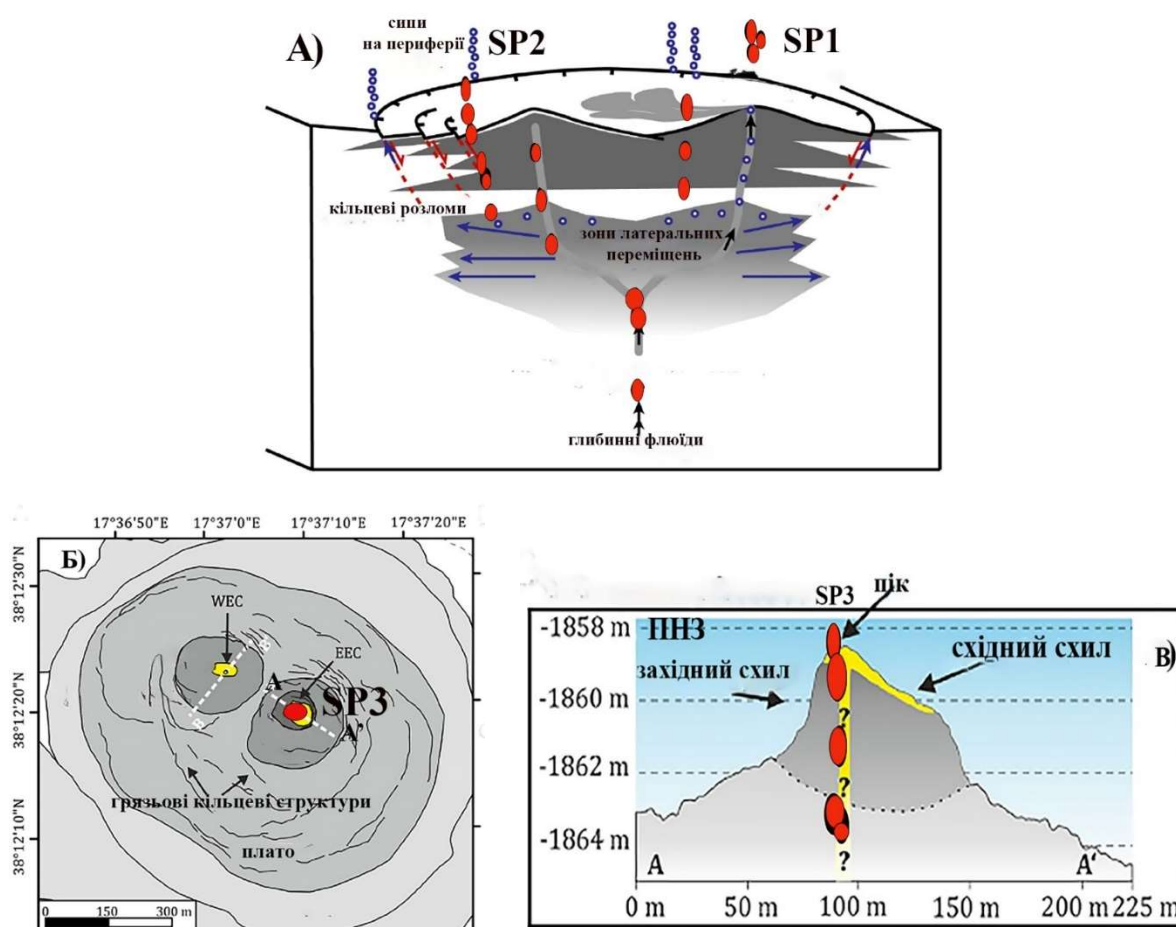


Рис. 16. А – Концептуальна модель вулкана Venere [Loher et al., 2018], що включає канал, що живить багату на газ (сині кола представляють вільний газ) грязьову брекчію; темно-сірі площі - стара грязьова брекчія, а червоні пунктирні лінії - кільцеві розломи. Міграція газу відбувається вздовж кільцевих розломів (короткі сині стрілки вздовж червоних пунктирних ліній); Б – схематична модель [Doll et. al, 2023] вулкана Sartori. Показані обидва центри виверження (затінені темно-сірим кольором) та найвиразніші грязьові кільця. Наймолодший та найвищий матеріал забарвлений жовтим кольором; В – профіль (А-А') з піком у його наймолодшій частині. Показано розташування SP1, 2, 3 та результати сканування.

Поле грязьових вулканів Олімпія розташоване на відстані біля 150 км від південного Криту (рис. 17А), Це найбільш відоме скупчення грязьових вулканів на Середземноморському хребті (понад 6000 км²) [Cita et al., 1995; Kopf et al. 1998, 2000; Galindo-Zaldivar et al., 1996; Huguen et al., 2004].

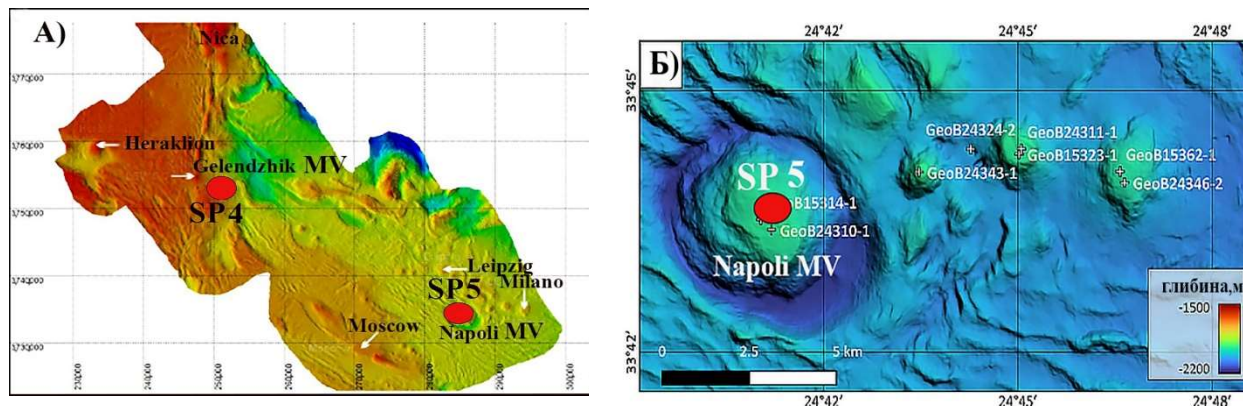


Рис. 17. А – Батиметрична цифрова модель поля грязьового поля вулкана Олімпія [Nikitas et al., 2021, спрощена] з пунктами сканування SP4, SP5; Б – детальна карта розташування місць відбору кернів на грязьових вулканах Наполі та Мілано [Behrendt et al., 2023] та пункту сканування SP5.

Більшість грязьових вулканів мають вигляд витягнутих хребтів довжиною від 1 до 16 км та висотами до 200 м [Galindo-Zaldivar et al., 1996]. Найбільшими з них є грязьові вулкани Геленджик та Наполі [Huguen et al., 2004].

Результати сканування в окремих пунктах (рис. 17Б) та особливості поведінки частотних сигналів свідчать про існування локальних умов стиснення в межах поля грязьових вулканів Олімпія (Геленджик та Наполі) Середземноморського хребта.

Грязьовий вулкан Геленджик має асиметричний поперечний переріз і розташований поблизу головного тектонічного уступу району (рис. 17,А). Грязьові потоки поширюються на площі понад 40 км². Товстий шар осадових порід (до 5,5 км), за даними зондування, може бути перспективним для вуглеводнів, оскільки тут існують умови та джерела для утворення нафти та газу [Nikitas et al., 2021].

Результати зондування, які вказують на наявність вуглеводнів були отримані для розрізу вулкана Наполі, де товщина осаdkів (вапняки) становить близько 6,0 км. Для ділянки поблизу вулкана Наполі спостерігалось активне просочування флюїдів [Huguen et al., 2004], де при скануванні також були отримані сигнали на частоті вуглеводнів, що підтверджує існування сприятливих умов для проведення більш детальних досліджень поля грязьового вулкана Олімпія.

Комплекс грязьових вулканів Анаксимандр включає три основні підводні гори: Анаксимандр, Анаксимен та Анаксагор, які піднімаються над морським дном на 2-3 км поблизу перетину Еллінської та Кіпрської дуг. Детальне картографування показує, що більшість грязьових вулканів розташовані в зонах взаємодії між розломами, які можуть виступати в якості шляхів для міграції флюїдів. Найдавніші уламки гірських порід, знайдені в кернах порід морських вулканів Анаксимандр, мають пізньокрейдовий вік, відносно подібний за віком до уламків грязьової брекчії із західного сектору морських вулканів Середземного моря (морський вулкан Наполі). Це, ймовірно, вказує на те, що коріння середземноморських морських вулканів знаходиться в породах фундаменту аналогічного віку, але і газозбагачені грязьові відклади у східному Середземномор'ї, ймовірно, повинні бути молодшими (міоцен) [Lykousis et al., 2018].

Грязьовий вулкан Салоніки розташований приблизно за 9 км на північний схід від грязьового вулкана Афіна. Результати сканування локальних точок, розташованих у зонах розломів різних типів поблизу грязьового вулкана Салоніки (рис. 18Б), показали, що формування центрального жерла цього вулкана відбувалося (і відбувається) в умовах тектонічного режиму компресійних напружень, відомого для всього цього регіону. Це наймілководніший вулкан у Східному Середземномор'ї, в межах якого були виявлені

газогідрати (рис. 18А) та досліджені витоки газу на морському дні поблизу нього [Woodside et al., 2015].

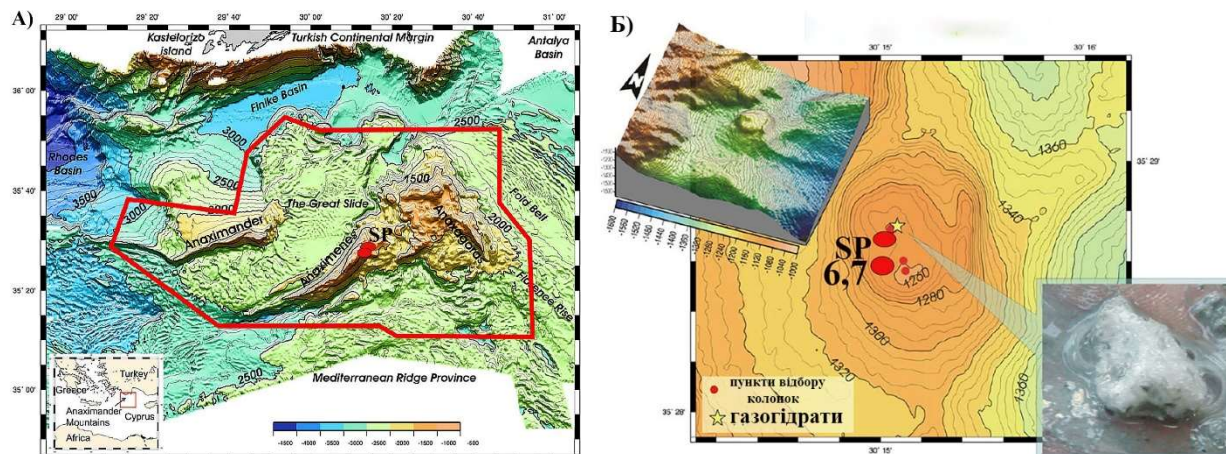


Рис. 18. А – Схематична карта комплексу Анаксимандр; Б – регіональні 3D (з розташуванням SP) та батиметричні карти вулкану Салоніки, з пунктами відбору проб осадових кернів та місцем виявлення газогідратів [Lykousis et al., 2018].

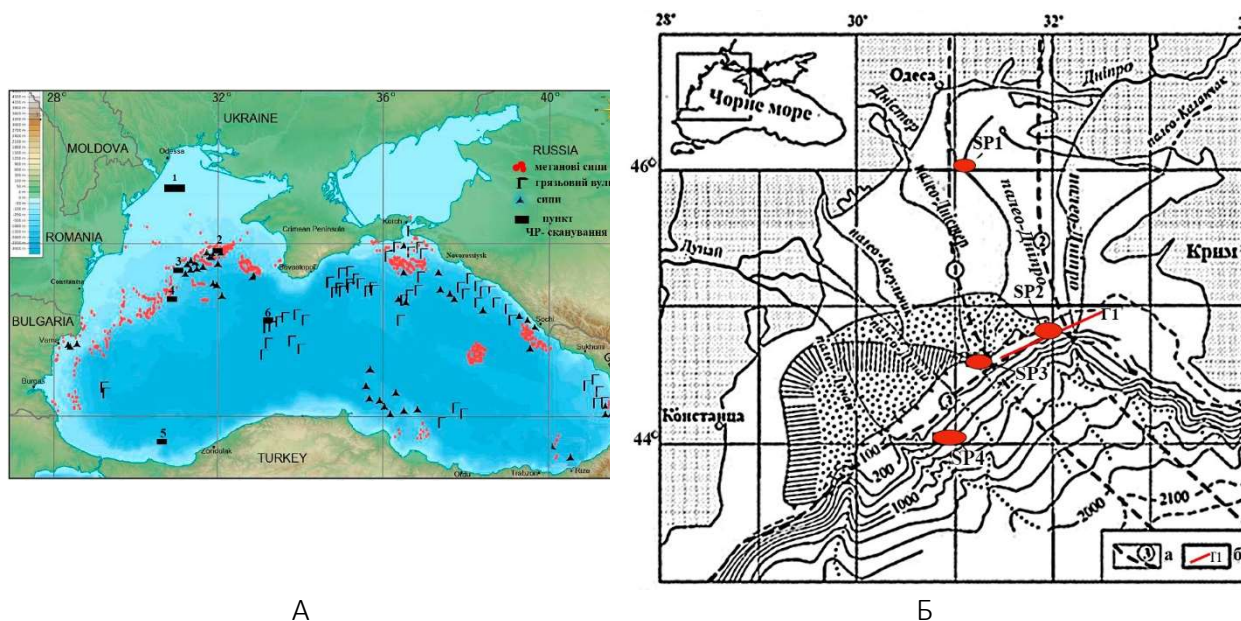
Грязьові вулкани Чорного моря

Пункти ЧР сканування (SP1-SP3) в західній частині Чорного моря (рис. 19А), розташовані на ділянках газових проявів в дельтових структурах палео-річок (Каланчак, Дніпро, Дністер, Дунай) та поблизу південної границі Східноєвропейської платформи (рис. 19Б).

За результатами сейсмічних досліджень були виділені «труби дегазації», одна з яких розташована поблизу параметричної свердловини Придніпровська-2 [Лещух, Полухтович, 2015]. В процесі сканування знімка всієї ділянки (пункт сканування SP1) зафіксовані відгуки від нафти, конденсату, газу, горючого сланцю, газогідратів, антрациту, водню та ін. Сигнали на частотах газу отримані з інтервалів: 1) 865-1100 м, 2) 1400-1780 м, 3) 2170 м (2400-інтенсивний) – (2650-дуже інтенсивний – 2700м) – (2780-2800 – дуже інтенсивний до 2900)-2940 м, 4) 3500-3690 м, 5) 4185-(5040-дуже інтенсивний)-5100 м, 5) 5445- (5560-інтенсивний)-5650 м. Результати сканувань свідчать про перспективність окремих локальних ділянок в межах Дністровської зони (на захід від свердловини Прадніпровська-2), що підтверджує прогнозну оцінку, наведену в [Лещух, Полухтович, 2015].

Пункт сканування SP2 розташований в районі палео-дельти Дніпра (рис. 19), Ця зона шельфу характеризується розвиненою системою тектонічних порушень різного віку і простягання, які контролюють положення основних блоків, а також шляхи підйому коромантійних флюїдів [Шнюков и др., 2013; Коболев, Верпаховская, 2014]. На цій акваторії були виявлені і досліджені BSR-границі – індикатори наявності придонних газогідратів [Ludmann et al., 2004].

В результаті сканування, проведеного до глибини 1320 м, були зафіксовані сигнали від нафти, газоконденсату і газу (інтервали: 565-702 м; 1130-1315 м), які підтверджують активну емісію газів в атмосферу. Емісія є прямим наслідком активного газовиділення метану у поверхневу воду, де його визначена концентрація значно (в 2-2,5 рази) вище середнього значення концентрації метану в приповерхневих водах північно-західного шельфу Чорного моря [Greinert et al., 2004]. Сигналів від газогідратів в SP2 не було отримано (на відміну від пункту SP1).



Примітка. а – глибинні розломні зони: 1 – Одесько-Синопська; 2 – Миколаївська; 3 – Циркумчорноморська; б – сейсмічний профіль [Коболев та ін., 2014]. SP1-4 - пункти сканування.

Рис. 19. А – Схематична карта розподілу газових сипів і грязьових вулканів в Чорному морі [Шнюков та ін., 2013] з місцями розташування пунктів ЧР-сканування (SP1-SP5) в західній частині Чорного моря; Б – морфологічна схема північно-західної частини Чорного моря з пунктами сканування [Коболев та ін., 2014].

Сканування в пункті SP3 (рис. 19Б) було проведено для локальної ділянки активного газовиділення з висотою метанових факелів 260 м [Шнюков и др., 2013], де отримані сигнали нафти, газоконденсату і газу (інтервали: 315-529 м; 620-925 м). Зафіксована також емісія газу в атмосферу. Пункти сканування (SP2 і SP3) розташовані поблизу центрів перетину Миколаївського (SP2) і Одесько-Синопського (SP3) та Циркумчорноморського глибинних розломів (рис. 19Б), які можуть створювати шляхи для підйому газових флюїдів у верхні горизонти осадової товщі що характерно для переважної більшості шельфових структур Чорного моря [Шнюков и др., 2013]. Метан має глибинне походження, що підтверджується результатами частотних зондувань.

Пункт сканування SP4 розташований між палео каньйонами Дунаю на північ від зони розповсюдження BSR-розділу [Ker et al., 2019]. Сигналів від газогідратів тут не зафіксовано, але отримані інтенсивні відгуки від газу на глибині 1682-1915 м. Результати сканування підтверджують існування накопичень вільного газу в локальних глибинних пастках і подальшу його міграцію в атмосферу через систему вертикальних порушень [Popescu et al., 2007].

Пункт сканування SP5 розташований в точці виявленого грязьового вулкану [Шнюков и др., 2013], корені якого, за сейсмічними даними сягають розділу Мохо. Інтенсивні сигнали газу отримані з глибини 2066-2570 м. Скануванням зафіксовано також емісію газу в атмосферу.

Проведені частотні дослідження на структурах західної частини Чорного моря свідчать про переважно глибинну природу метанових факелів на ділянках газових просочувань в районах палеодельт північно-західної частини Чорного моря, що може бути додатковим аргументом при визначенні перспективності локальних структур західного шельфу на поклади вуглеводнів.

Грязьові вулкани глибоководного басейну Чорного моря (МДУ, Страхова та Тредмар) за їх морфометричними характеристиками розділені на три основні типи, до першого з яких належить грязьовий вулкан МДУ (пункт сканування SP5). Він характеризується правильною конусоподібною структурою (діаметром біля основи близько 2,5 км) та висотою близько 60 м [Шнюков и др., 2013]. Глибина моря в районі вулкану становить 2100 м. ЧР-сигнали реєструвалися з поверхні на частотах вуглеводнів (нафта, конденсат, газ), бактерій та жовтого фосфору. З інтервалу 2290-8310 м отримані відгуки від вапняків. Спільні сигнали на частотах газу та вапняків були зафіксовані в інтервалах 2495-4496 м, 5998-7249 м та 7716-8086 м (рис. 20). Форма кратера та ЧР дані відображають дво- або тристадійний характер сильних вивержень з різними грязьовими потоками на схилах [Dimitrov, 2002]. Факти міграції газу у водяну товщу та атмосферу були підтверджені ЧР скануваннями.

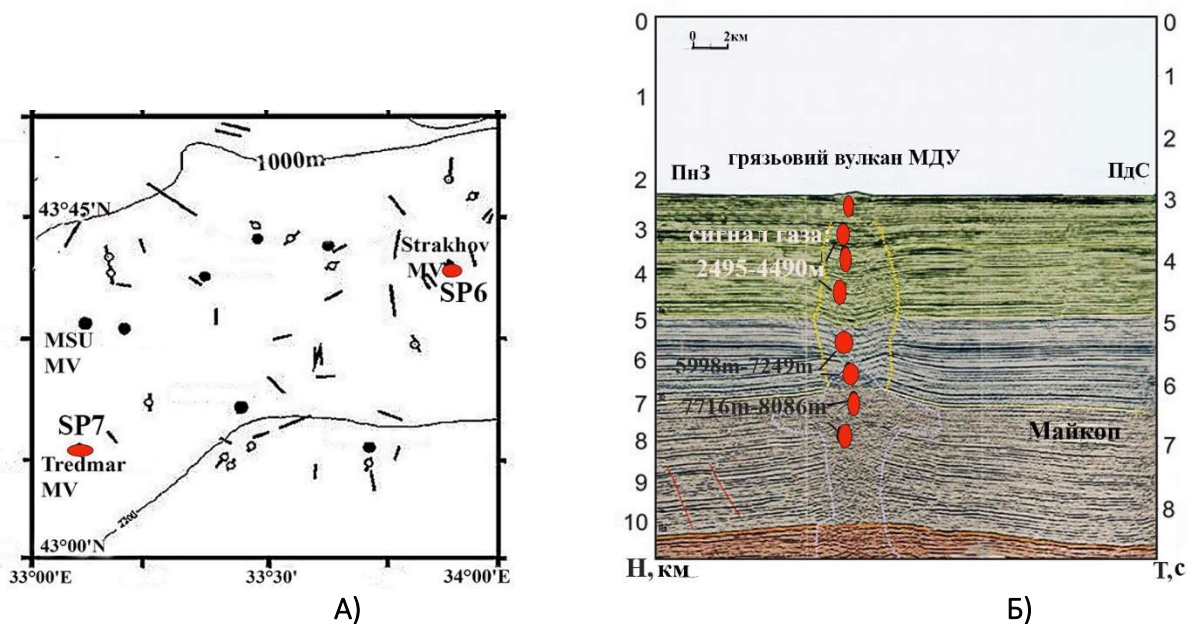


Рис. 20. А – Карта розташування грязьових вулканів, діапирових структур, В – розломів та грязьового вулкану МДУ в центральній частині Чорного моря [Gonchar et al., 2004] за результатами ЧР сканування.

ЧР сигнали реєструвалися на частотах нафти, газового конденсату, газу, бактерій та жовтого фосфору. Спільні сигнали на частотах газу та 7-ї групи осадових порід (вапняки) були зафіксовані в інтервалах 2656-3225 м, 4462-4765 м та 4988-5403 м. Вимірювання підтвердили існування умов для синтезу нафти, газового конденсату та газу на глибині 57 км, а також факти міграції газу у водяну товщу та атмосферу.

Результати досліджень грязьових вулканів свідчать про існування глибокого коріння, що сприяло формуванню чітко вираженого вузла дегазації в цій області глибоководного басейну Чорного моря. Джерела виділення газу ймовірно пов'язані з потужними потоками вуглеводнів геофлюїдів глибинного генезису.

Вулканічні структури (точка сканування SP6) відносно молодого [Dimitrov, 2002] грязьового вулкану Страхова (вулкану другого типу) мають крутіші схили та менші розміри (рис. 21А), канали яких досягають глибини 12 км (нижній еоцен). Сигнали від газів були зафіксовані в інтервалах 945-1565 м та 2241-3167 м. Встановлені факти міграції газу у водну товщу та атмосферу.

Грязьовий вулкан Тредмар на глибині 2150 м (рис. 21Б, SP7) відносять до третього типу. Він має відносно слабо виражений рельєф (діаметр біля основи близько 2 км, висота не перевищує 40 м), форму усіченого конуса, на вершині якого знаходиться кратер, з потоками грязьової брекчії та відкладень різного віку. Цей грязьовий вулкан вважається

наймолодшим і найактивнішим на сьогодні. Газ складається переважно з метану (90–99 %) і має змішане біогенне та термогенне походження. Вважається, що «коріння» грязьових вулканів знаходиться в потужних відкладах зі значним вуглеводневим потенціалом майкопської формації [Dimitrov, 2002]. Зв'язок між корінням грязьового вулканізму та структурами не лише майкопських відкладень, а й мезозойських горизонтів, характерний для грязьових вулканів, що існують в Західно-Чорноморській западині на південь від Криму [Шнюков и др., 2013].

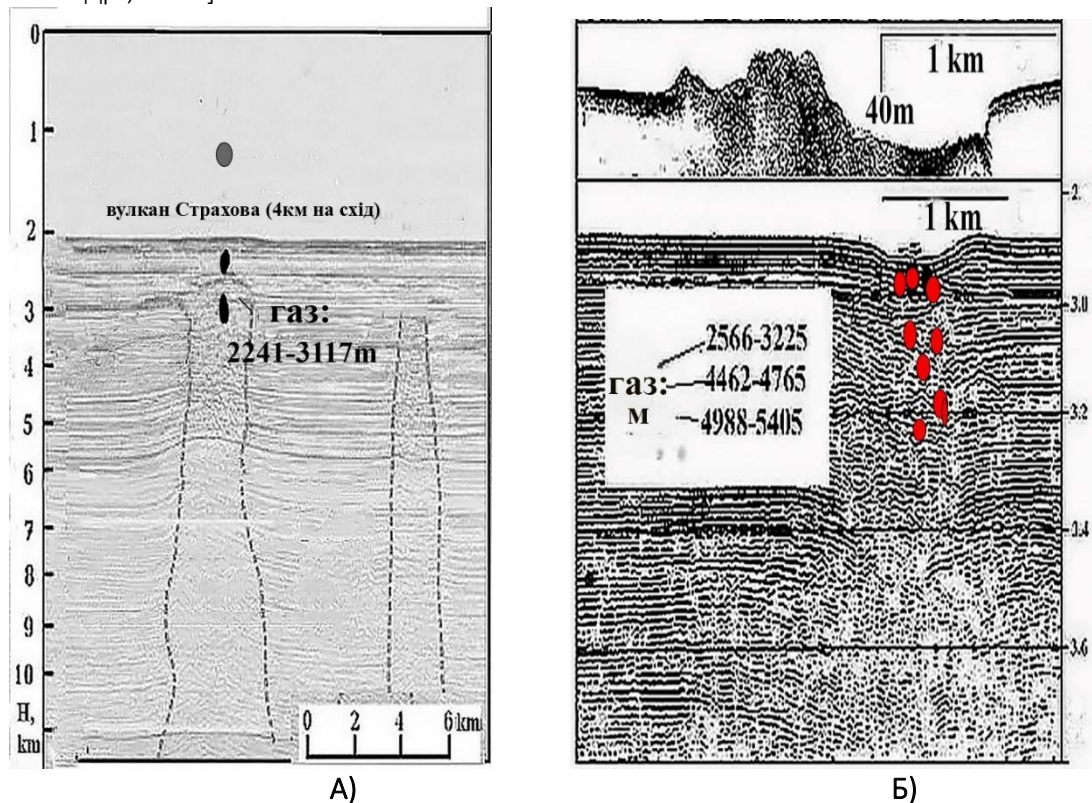


Рис. 21. А – Грязьовий вулкан Страхова та Б – вулкан Тредмар в центральній частині Чорного моря [Dimitrov, 2002; Кутас, 2020; Gonchar et al., 2004] за результатами сканування.

Структури континентальної окраїни Східної Антарктиди

На локальній ділянці в протоці Брансфілд було виявлено джерело викидів метану, можливо не пов'язаних з процесами віддаленого перенесення по латералі аномальних полів метану в товщі антарктичних вод. Ця локалізація може бути обумовлена ендегенними процесами та особливостями тектонічної будови дна протоки Брансфілд [Polonik, 2020].

З метою детальнішого вивчення аномалії виконано сканування в точці **SP1** (рис. 22Б). В процесі обробки фрагмента знімка зафіксовані сигнали на частотах нафти і газу. В інтервалі глибин до 3 км отримані відгуки на частотах осадових порід.

Встановлено факт міграції газу в атмосферу, зроблені припущення про глибину джерел метанових викидів, а також підтверджена наявність коренів вулканічних структур в протоці Брансфілд, яка може бути пов'язана з імпульсним функціонуванням глибинних газо-флюїдних каналів міграції.

У морі Уедделла зафіксовано вулканічний комплекс із коренем на глибині 218 км, заповнений магматичними породами. Із вулкану отримано сигнали на частотах алмазів, а сигнали від вуглеводнів (ВВ) (нафта та газ) із інтервалу глибин до 10 км були відсутні.

У пункті сканування SP5 (рис. 22А) зафіксовано сигнали на частотах вуглеводнів на поверхні і сигнали синтезу ВВ на глибині 57 км. Встановлено процес міграції газу в атмосферу. Виявлені інтервали глибин залягання пластів, насичених ВВ (від поверхні до 10 км): 1262-

1297 м, 2427-2531 м, 3061-3329 м, 3862-4177 м, 4772-5658 м, 7862-8872 м. Отримані також глибинні відгуки від магматичних (ультрамафічних) порід. У пункті сканування SP6 (рис. 22А). сигнали на частотах ВВ не зафіксовані. Отримані відгуки на частотах технічних мікроалмазів – лонсдейлітів та від магматичних (ультрамафічних) порід.

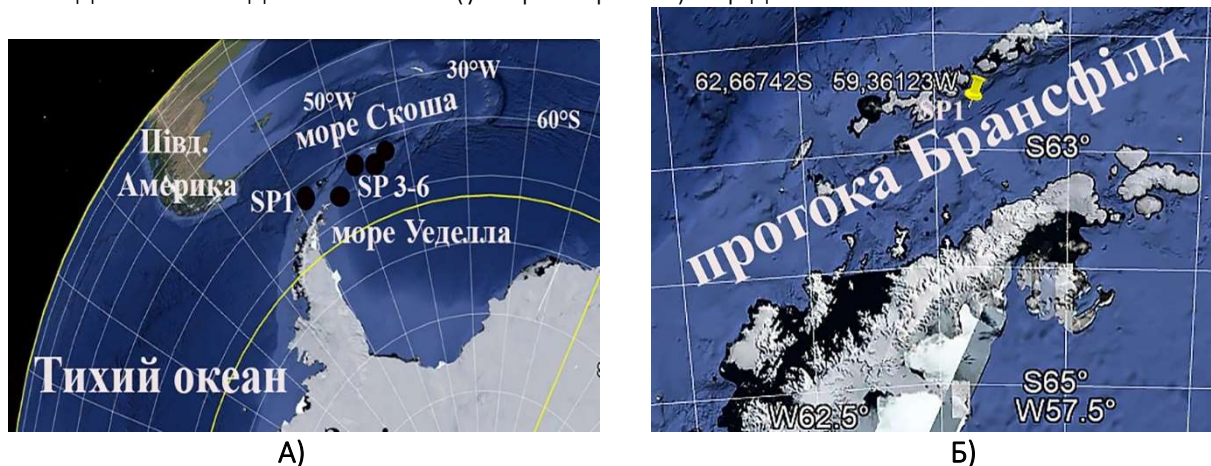


Рис. 22. Схема розташування (А) пунктів сканування (SP) в Західній Антарктиці, в морі Уедделла (SP3-SP6); супутниковий знімок (Б) локальної ділянки в протоці Брансфілд.

Результати локальних частотних зондувань в морі Уедделла можуть підтвердити перспективність на ВВ лише окремих ділянок, де існують сприятливі умови для їх формування. Багаторічний досвід застосування ЧР методів дослідження регіональних і локальних структур показав, що факт інструментальної реєстрації сигналів ВВ свідчить про їх реальну наявність у розрізі, а перспективність виявлених скупчень може бути уточнена при детальних дослідженнях. Відсутність таких сигналів з великою ймовірністю може свідчити про безперспективність даної ділянки на значні накопичення вуглеводнів.

Шельф і континентальний схил моря Рісер-Ларсена належать до індоокеанської пасивної окраїни Східної Антарктиди, яка досліджувалася комплексом геолого-геофізичних методів міжнародними експедиціями протягом багатьох років. Існують доволі детальні уявлення про структуру кори багатьох осадових басейнів регіону, в тому числі і осадової товщі (рис. 23) моря Рісер -Ларсена [Leitchenkov et al., 2008].

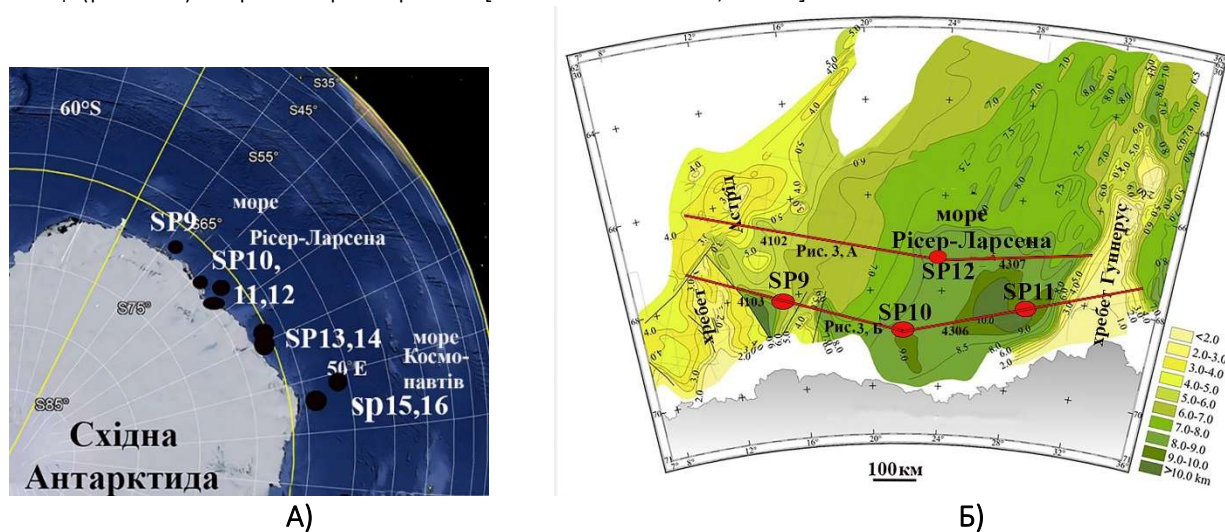


Рис. 23. А – Супутниковий знімок узбережжя Східної Антарктиди з пунктами сканування (SP9-SP16); Б – схематична карта товщі осадових порід (глибин до фундаменту) моря Рісер-Ларсена із пунктами сканування (SP9-SP12), ізобатами та положенням окремих сейсмічних профілів за даними [Leitchenkov et al., 2008].

Відомо, що ця територія має виразну морфологію структур дна: на заході море Рісер-Ларсена обмежене підводною вулканічною спорудою – хребтом Астрід, а на сході – хребтом Ганнерус, який є морським продовженням кристалічного фундаменту Східної Антарктиди. Дослідження показали, що осадова товща сягає тут 7 км (рис. 23, 24), її структура в значній мірі ускладнена наявністю чисельних розломів, особливо в прибережній частині моря, де активними були процеси рифтогенезу. Товщина земної кори змінюється від приблизно 35 км під шельфом моря Рісер-Ларсена, 26-28 км під хребтом Гуннерус, 12-17 км під хребтом Астрід і до 9,5-10 км під океанічною частиною басейну [Leitchenkov et al., 2008].

Пункти сканування (SP9-SP11) розташовані в крайовому рифті (рис. 23), в межах блоку шельфу (шириною 50 км) з корою підвищеної густини і намагніченості, викликаними, вірогідно, наявністю глибинних включень мафічних порід у південній континентальній окраїні моря Рісер-Ларсена [Leitchenkov et al., 2008].

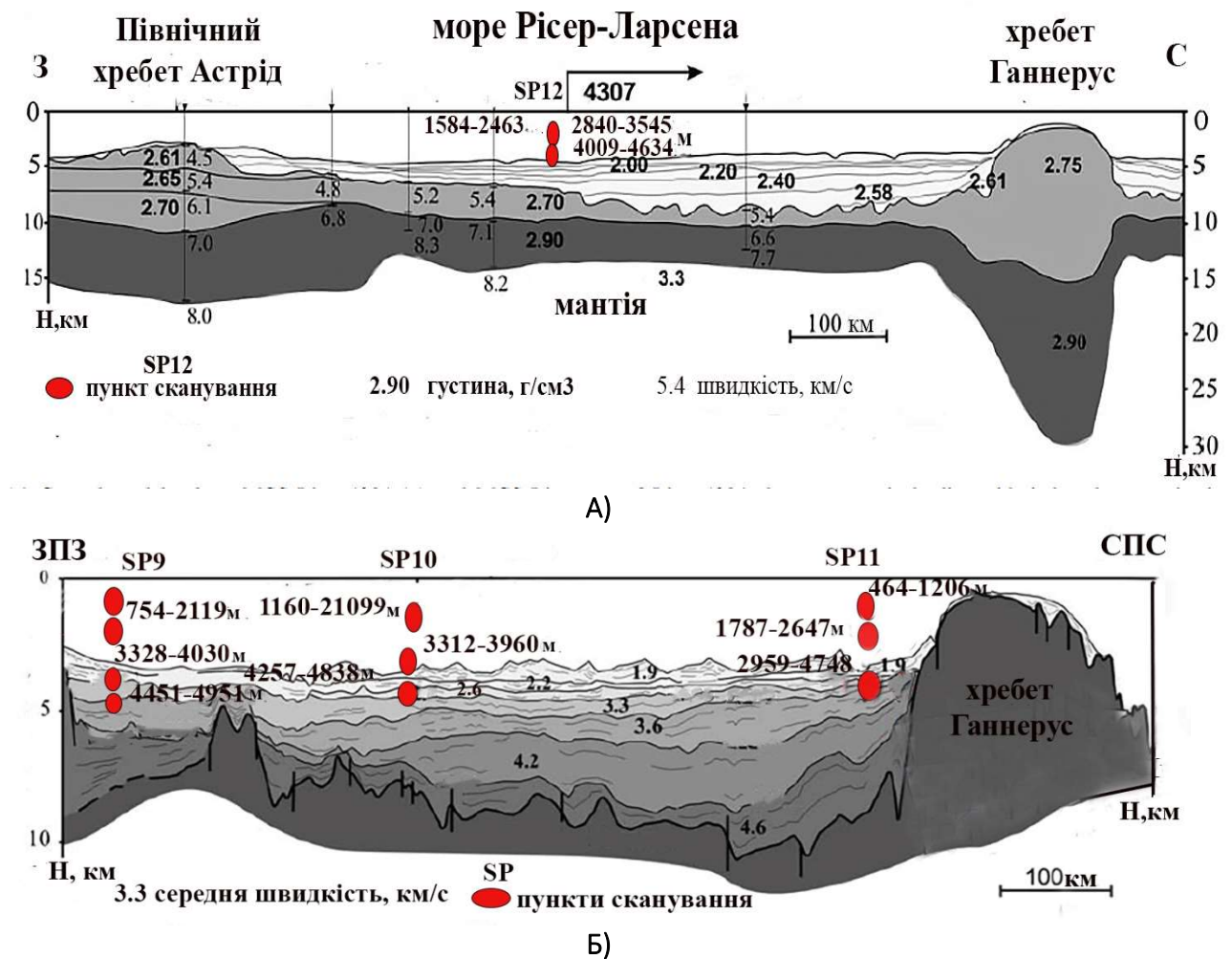


Рис. 24. Моделі земної кори вздовж профілів 4102-4307, 4103-4306 (Рис. 23) в морі Рісер-Ларсена за даними [Leitchenkov et al., 2008]. Показані результати ЧР сканування для пунктів SP9-SP12.

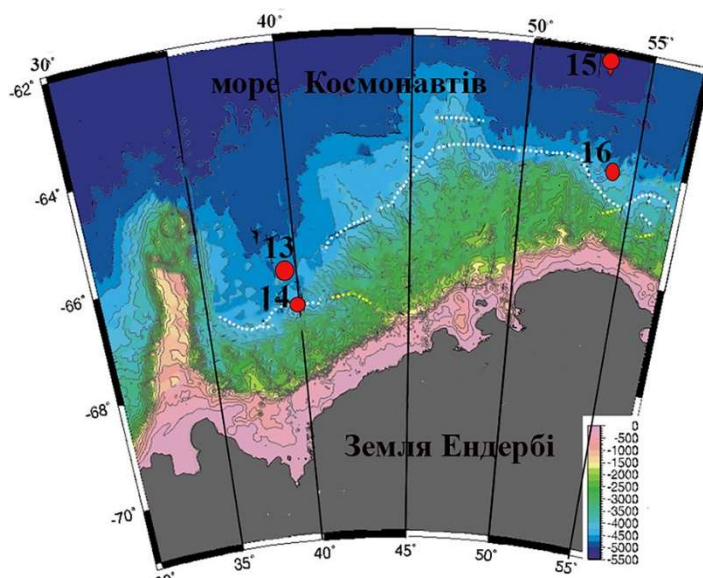
Окремі пункти сканування в морі Рісер-Ларсена, де зондування проводилося до глибини 5 км, розташовані в місцях накопичення значної кількості осаdkів для попередньої оцінки нафтогазоносності окремих ділянок.

В пункті SP9 фіксується спільний сигнал водню із базальтами, в інтервалах глибин: 754-2119 м, 3328-4030 м (сильний), 4451-4951 м. Цікаво, що сигнал водню фіксується на поверхні

та в інтервалі 0-57 км. Такий самий результат отримано і для пунктів сканування SP10-SP12 (рис. 23, 24). Тісний зв'язок базальтів з дегазацією водню був неодноразово відмічений раніше [Yakymchuk et al, 2024]. В пункті SP10 зафіксовано сигнал водню на поверхні, а також в інтервалах глибин: 1160-2109 м, 3312-3960 м, 4257-4838 м. В пункті SP11 зафіксовано сигнал водню на поверхні, а також в інтервалах глибин: 464-1206 м, 1787-2647 м, 2959-4748 м (сильний сигнал). В пункті SP12 зафіксовано сигнал водню на поверхні, а також в інтервалах глибин: 1584-2463 м, 2840-3545 м, 4009-4634 м. Пункт сканування розташований в океанічній частині моря Рісер-Ларсена, в частині із стандартною океанічною корою і значним осадовим покривом (рис. 23, 24).

Спільними характерними рисами частотних зондувань в локальних пунктах моря Рісер-Ларсена є наявність чітких сигналів від базальтів, а також водню на поверхні та в широкому діапазоні глибин від 0 до 57 км, що свідчить про глибинний генезис процесів дегазації в регіоні. Проведені дистанційні оціночні частотні зондування не дають чіткої незалежної відповіді на питання щодо прогнозу оцінки перспектив нафтогазоносності обстеженої ділянки моря Рісер-Ларсена і потребують додаткової деталізації.

Басейн морів Космонавтів, Співдружності та Дейвіса Східної Антарктиди був закладений на етапі рифтогенезу між Індією та Антарктидою [Stagg, 1985].



Примітка. Жовті пунктирні лінії позначають положення депоцентрів на заході і сході моря.

Рис. 25. Батиметрична карта моря Космонавтів, із розташуванням пунктів частотного сканування (13-16), та позначеним, за сейсмічними даними, північним краєм виявленого клину осадових порід (біла пунктирна лінія) довжиною понад 1000 км і шириною від 50 км до 250 км [Solli et al., 2007].

На шельфі сейсмічними дослідженнями виявлено продовження кристалічного фундаменту материка на глибину до 2 км. В окраїнному рифті спостерігається заглиблення порід фундаменту на зовнішньому шельфі по системі розломів до 6-8 км і далі у бік океану від 7 до 11 км [Leitchenkov et al., 2010]. На основі комплексної інтерпретації геофізичних даних було запропоновано схематичні моделі тектонічної будови земної кори, на яких показано положення границі континент – океан, а також райони океанічної кори з різною морфологією фундаменту та внутрішньої будови. Згідно з цими моделями, в морі Космонавтів границя континент-океан розташовується приблизно вздовж ізобати 4000 м.

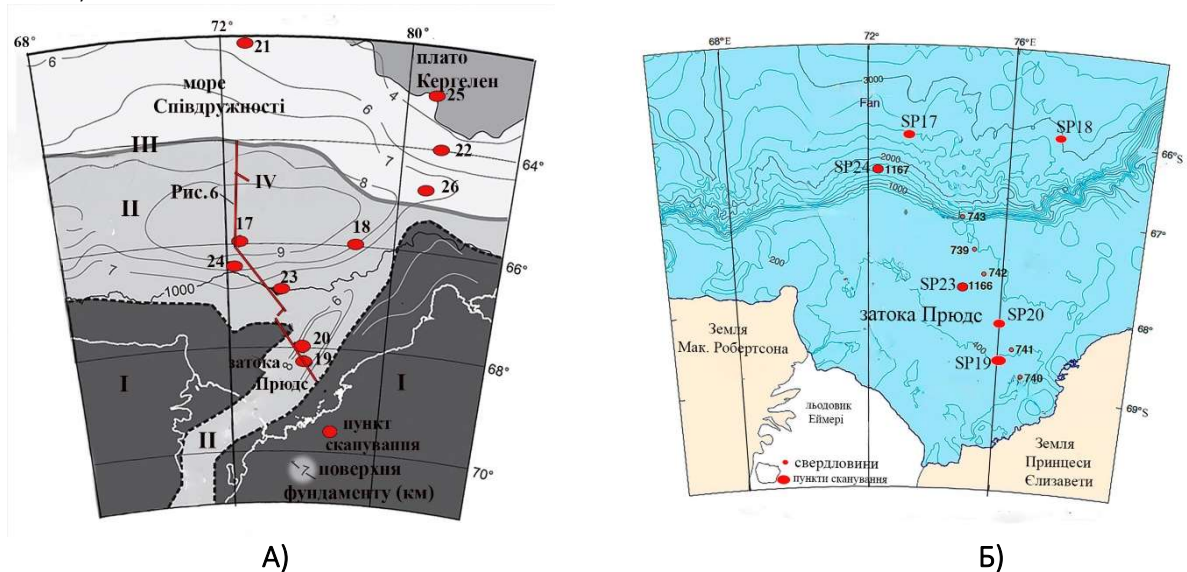
Виконані дослідження показують, що окраїнний рифтовий грабен басейну морів Космонавтів, Співдружності та Дейвіса має складну будову та різну ширину. У морі Космонавтів вона становить 200-240 км [Leitchenkov et al., 2010].

Результати частотного сканування мають рекогносцирувальний оціночний характер і можуть свідчити про наявність ВВ (SP13, SP15, SP16, рис. 25). Тут фіксується сигнал ВВ на поверхні і (спільно з карбонатами) на глибинах {до 6,5 км}.

Для SP13 характерні наступні інтервали сигналів ВВ: 601-958 м, 1472-2301 м, 3464-3882 м, 4489-5166 м, 5333-6400 м. Для SP14 фіксується сигнал водню на поверхні та в інтервалах глибин 546-1150 м, 1702-2602 м, 3100-3558 м. Пункт розташований в межах окраїнного рифтового грабену юрсько-крейдового віку [Leitchenkov et al., 2010], тому наявність сигналу водню може бути пов'язана з процесами розвитку цієї структури. Для SP15 фіксується сигнал ВВ з карбонатами в інтервалах глибин: 684-3394 м, 3460-5784 м, 5912-6512 м.

Для SP16 фіксуються сигнали ВВ на поверхні і в інтервалах глибин: 1161-1918 м, 2575-2925 м, 3108-4052 м, 4123-4738 м. Окремо слід зазначити, що тільки на цьому пункті (рис. 25) отримані відгуки від гранітів, які можуть бути пов'язані з північною границею континент-океан та серією розломів, відомих тут за сейсмічними даними.

Басейн моря Співдружності, розташований у південній частині Індійського океану на континентальній окраїні Антарктиди, включає в себе внутрішньоконтинентальний і окраїнний рифти [Cooper et al, 2004], які поєднуються в одну систему у районі затоки Прюдс (рис. 26).



Примітка. I – границя кристалічного щита і басейну осадків; II – внутрішньоконтинентальний та окраїнний рифти; III – границя континент-океан; IV – сейсмічний профіль [Leitchenkov et al, 2014].

Рис. 26. А – Схема тектонічної будови південно-східної частини моря Співдружності з нанесеними пунктами частотного сканування та ізогіпсами поверхні фундаменту; **Б** – карта рельєфу дна затоки Прюдс [Cooper et al, 2004] з пунктами частотного сканування і свердловинами.

В південно-східній частині моря Співдружності осадові товщі в значній мірі формувалися під впливом теригенного матеріалу з льодовика Ламберта. На південно-східному борту рифтового грабену затоки Прюдс поверхня фундаменту залягає на глибинах 1,0-2,0 км, а на північно-західному борту грабена на шельфі вона занурена [Leitchenkov et al, 2014] на глибину 1-3 км (рис. 26, 27). Для цієї частини моря Співдружності результати

рекогносцирувального дистанційного частотного обстеження космічних знімків отримані для серії пунктів, розташованих вздовж сейсмічного профілю (рис. 27).

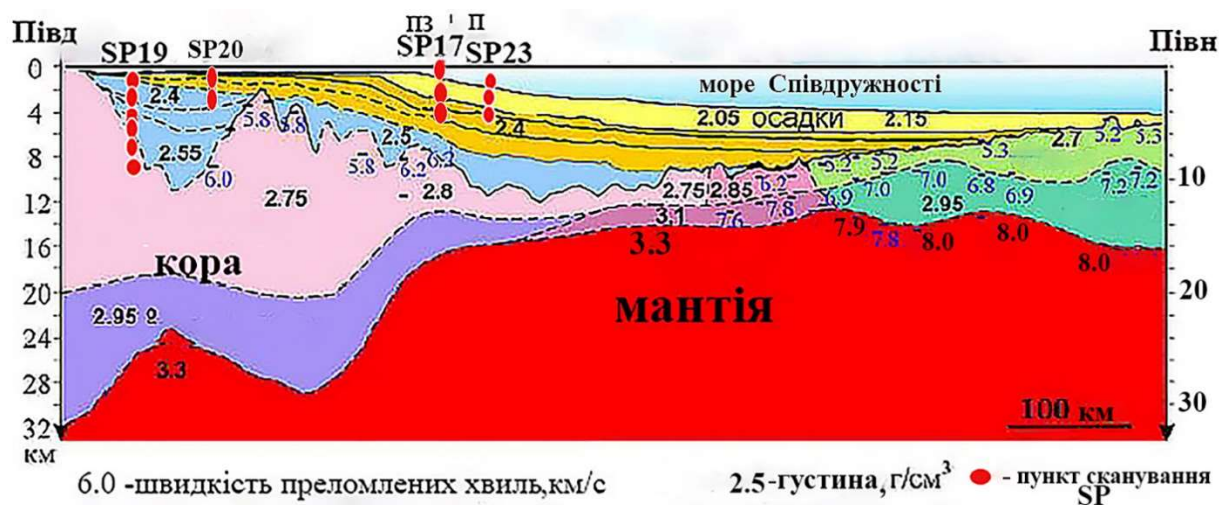


Рис. 27. Модель глибинної будови земної кори [Leitchenkov et al, 2014] вздовж профілю IV з результатами частотного сканування (SP17, 19, 20, 22, 23).

Для SP19, розташованому в борті рифтового грабену затоки Прюдс, фіксується спільний сигнал ВВ із сіллю в інтервалах глибин: 996-2595 м, 2743-3770 м, 4028-5448 м, 5903-7188 м. З глибини 7200 м фіксується спільний сигнал ВВ із магматичними (ультраосновними) породами в інтервалах: 7344-7994 м, 8105-8535 м, 8817-9277 м, 9374-9677 м, 9762-9906 м.

Для SP20, розташованому майже в центрі рифтового грабену затоки Прюдс, фіксується сильний спільний сигнал водню із базальтами в інтервалах глибин: 797-1744 м, 1999-2371 м, 2893-3403 м, 3505-3931 м, 4030-4381 м. Для SP17, розташованому в межах центральної частини затоки Прюдс, фіксуються сигнали водню та ВВ на поверхні і в інтервалах: 318-657 м, 1060-1644 м, 1896-2717 м, 2900-3334 м, 3440-3820 м, 4080-4341 м, 4529-4831. Для SP23 фіксується сигнал водню в інтервалах глибин: 920-1816 м, 1997-3220 м, 3949-4300 м, 4387-4955 м, зондування проведено, як і в багатьох інших випадках, до глибини 5 км. Є також глибинний сигнал базальтів. Для SP21 фіксується спільний сигнал ВВ із сіллю, в інтервалах: 578-1392 м, 2191-3580 м, 375-4464 м. Зондування проводили до глибини 5 км.

Отримані також результати частотного зондування для структур, розташованих вздовж сейсмічних профілів в східній частини моря Співдружності [Gohl et al, 2007], поблизу плато Кергелен (рис. 28, 29).

Результати частотного зондування отримані також для пунктів SP22, 25, 26 розташованих вздовж сейсмічних профілів у трозі Принцеси Єлизавети [Leitchenkov et al, 2019]. Для SP26, розташованому в південній частині трого, фіксується сильний сигнал ВВ в інтервалах глибин: 964-2193 м, 2832-3628 м, 4099-4648 м, 4862-5515 м. На глибині фіксуються сигнали від гранітів, базальтів та ультраосновних порід. Зондування проводили до глибини 5600 м. Для SP25, розташованому в центральній частині трого, фіксується сигнал водню в інтервалах глибин: 631-1274 м, 2437-3683 м, 4053-4964 м. Для SP22, розташованому на північному схилі трого Принцеси Єлизавети (рис. 29,Б), фіксуються сигнали ВВ на поверхні і в інтервалах: 1215-1938 м, 2641-3018 м, 4174-6035 м. На глибині фіксуються сигнали гранітів, базальтів та ультраосновних порід. Зондування проводили до глибини 6100 м.

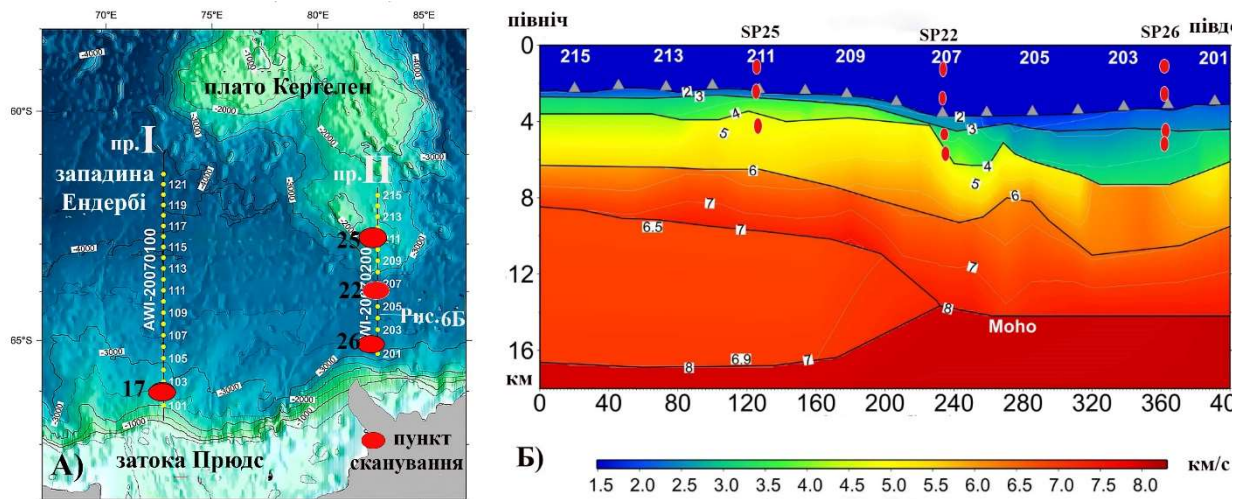


Рис. 28. А – Карта району досліджень з нанесеним положенням сейсмічних профілів I і II [Gohl et al, 2007] та пунктів частотного сканування (17, 22, 25, 26); Б – модель земної кори [Gohl et al, 2007] вздовж сейсмічного профілю II з результатами частотного сканування.

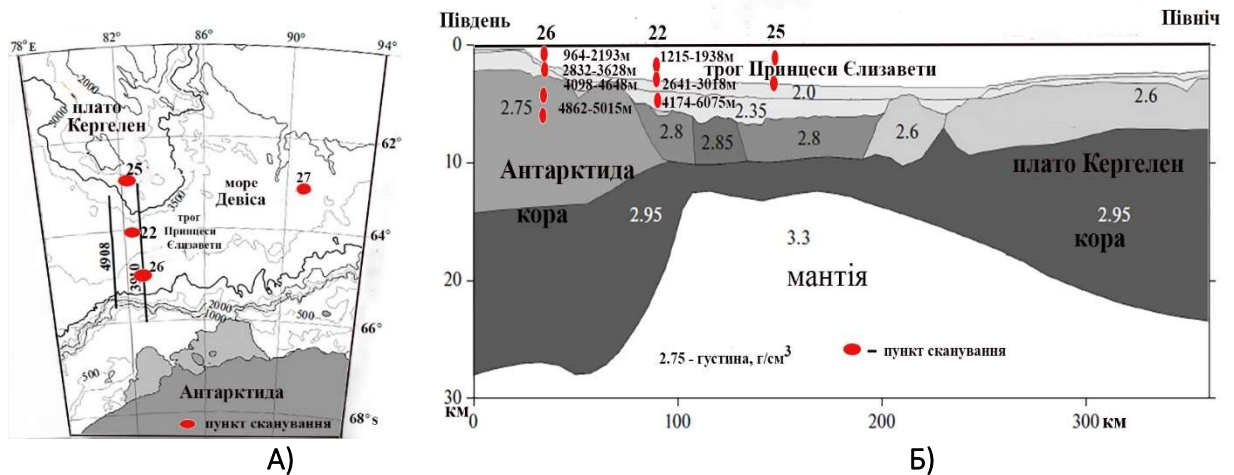


Рис. 29. А – Положення сейсмічних профілів, розташованих південніше плато Кергелен, дані яких були використані при моделюванні структури кори трого Принцеси Єлизавети; Б – густинна модель кори трого вздовж профілю 3910 [Leitchenkov et al, 2019] з нанесеними результатами частотного зондування для пунктів 22, 25, 26.

Ці пункти сканування фіксують сигнали від різних типів магматичних порід, що можна пояснити їх розташуванням в тій частині трого, яку, за даними густинного моделювання, вважають ділянкою, де змінюється тип кори із значним підйомом мантії порід [Leitchenkov et al, 2019].

Басейни морів Космонавтів, Співдружності та Дейвіса сформувалися в результаті послідовного відділення Африки, Індії та Австралії від Антарктиди та розташовані в межах рифтогенних невулканічних окраїн та океанічних улоговин [Leitchenkov et al, 2010].

Для локального пункту сканування (SP27, рис. 29), розташованому в межах океанічної ділянки із підйомом глибинних магматичних порід фіксуються сигнали водню в інтервалах глибин: 539-1317 м, 1457-2218 м, 2465-3238 м, 3322-3723 м, 4428-5019 м. На поверхні фіксуються сигнали ВВ, вуглекислого газу, водню, на глибині фіксуються сигнали від гранітів, базальтів та ультраосновних порід. Зондування виконано до глибини 5100 м.

Вже на протязі майже півстоліття відомі спроби оцінити потенціальні перспективи цього регіону, які базувалися, в основному, на загальних уявленнях про будову осадових

басейнів та на результатах нечисленних сейсмічних досліджень [Davey, 1985; Behrendt, 1991 та ін.].

Інтенсивні міжнародні геолого-геофізичні дослідження 2000-х років дозволили дати більш об'єктивну оцінку вуглеводневому потенціалу та скласти сучасні прогностичні карти для цього сегменту індоокеанської континентальної окраїни Антарктиди [Guseva et al, 2008; Leitchenkov et al, 2008, 2010, 2014, 2019, та ін.]. Автори підкреслюють, що багато необхідних для впевненого прогнозу фактичних даних про вік, літологічний склад, ймовірні шляхи міграції флюїдів з вуглеводнями, залишаються мало вивченими. Особливо це стосується глибоководних частин осадових басейнів, де важливим фактором нафтидогенезу є вплив глибинних флюїдів.

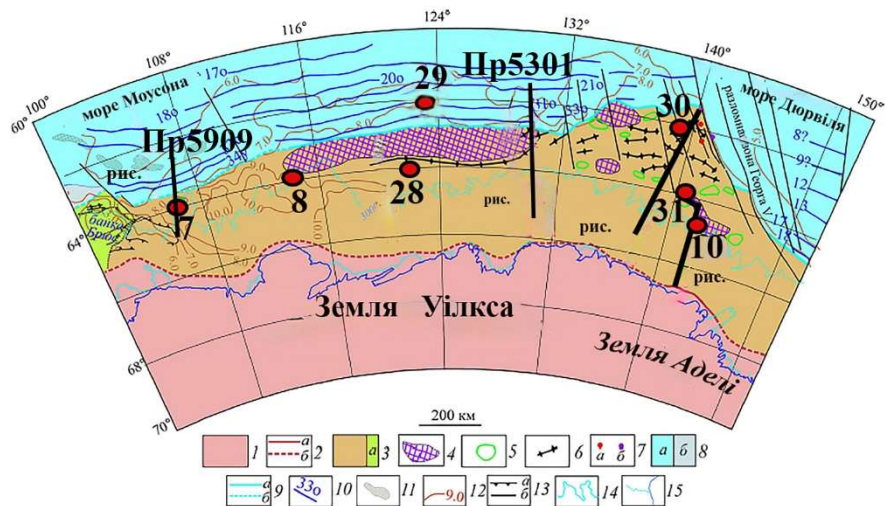
На рис. 30 показано розташування пунктів ЧР сканування для локальних структур осадових басейнів (від моря Дейвіса до моря Дюрвіля).



Рис. 30. Супутниковий знімок узбережжя Східної Антарктиди з пунктами частотного сканування (SP7-10, 27-31).

Басейн морів Моусона і Д'юрвіля має ускладнену будову земної кори за рахунок мантійного діяпіру в його центральній частині (рис. 31), який був виявлений за гравімагнітними даними [Leitchenkov et al, 2014, 2018]. Всього виконані сканування для семи (рис. 30) пунктів (SP7-10, 28-31), розташованим в морі Моусона (SP7, 8), центральній частині басейну морів Моусона-Дюрвіля (SP28, 29), а також в морі Дюрвіля (SP9, 10, 30, 31).

В центральній частині басейну морів Моусона-Дюрвіля (SP28) результати сканування показали, що на поверхні фіксуються сигнали ВВ, вуглекислого газу, водню та водневих бактерій. Фіксується спільний сигнал ВВ і гранітів фундаменту в інтервалах глибин: 3364-3661 м, а також сильний сигнал на глибині 4160-5556 м (зондування проведено також до глибини 5600 м). Зафіксовані також відгуки від шостої (габбро-базальти) та сьоомої ультрамафічні) груп магматичних порід, що може бути пов'язане з процесами підйому мантійних порід в суміжних структурах біля розділу континент-океан (рис. 32).



Примітка. 1 - докембрійсько-ранньопалеозойський кратон; 2 - межа кратону: а - встановлена, б - прогнозована; 3 - юрсько-крейдовий окраїнний рифтовий грабен (а - вулканічні комплекси, що перекривають древній фундамент); 4 - мантіїний підйом; 5 - мафічні інтрузії та вулканічні споруди; 6 - осі антикліналей, пов'язаних з підйомом мантії та (або) зсувними деформаціями; 7 - пункти драгування древніх гнейсів (а) та серпентинізованих перидотитів (б); 8 - океанічна плита: а - пізньокрейдова, б - ранньокрейдяна; 9 - розділ континент - океан: а - встановлений, б - прогнозований; 10 - лінійні магнітні аномалії з номерами хронів полярності геомагнітного поля; 11 - амагматичні спредінгові сегменти; 12 - ізоглибини поверхні фундаменту (км); 13 - розривні порушення: а - скиди, б - зрушення, трансферні розломи та палеотрансформні розломи; 14 - ізобата 3000 м; 15 - лінія налягання льоду (суцільний контур) та льодовий бар'єр (пунктирний контур).

Рис. 31. Схема тектонічної будови окраїнних басейнів Мусона-Дюрвіля (Східна Антарктика) з умовними позначеннями, за [Leitchenkov et al, 2018] і пунктами сканування.

Пункт сканування SP29 розташований в межах ділянки, яка пов'язується з місцями виходу на поверхню моря приповерхневих (з глибини біля 350 м) флюїдів, пов'язаних з розвантаженням селевих потоків [Donda et al, 2003]. Сканування для SP29 показало, що в цій частині моря (рис. 32) на поверхні фіксуються сигнали ВВ, вуглекислого газу, водню, а також фіксується спільний сильний сигнал водню і базальтів в інтервалах глибин: 3327-4262 м та 4695-5594 м (зондування проводилося до глибини 5600 м). Крім того, зафіксовані, також відгуки від магматичних порід, як і на пункті сканування SP28.

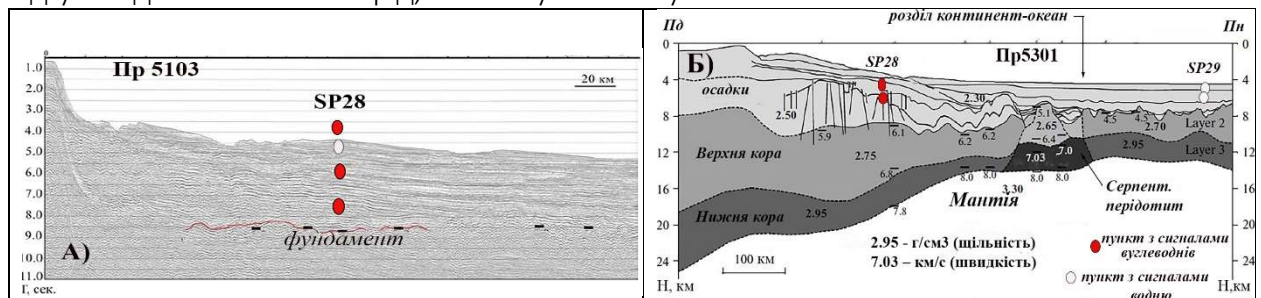
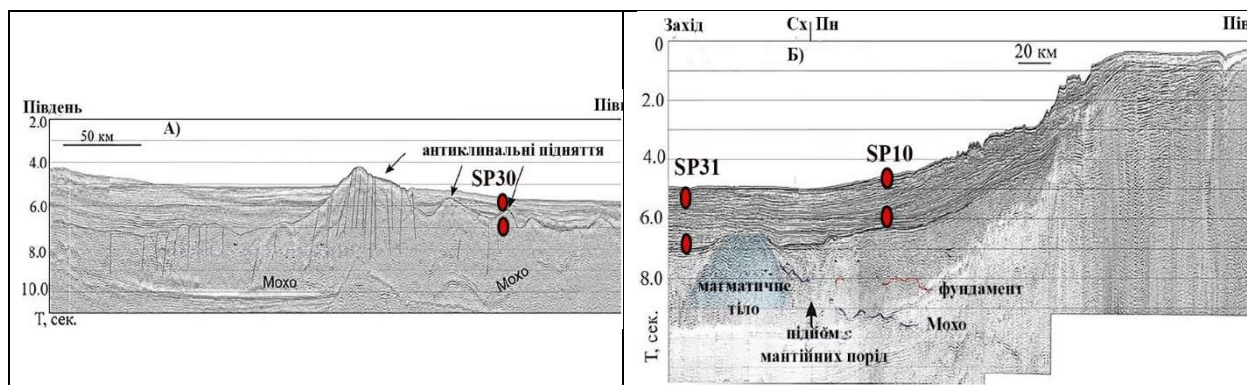


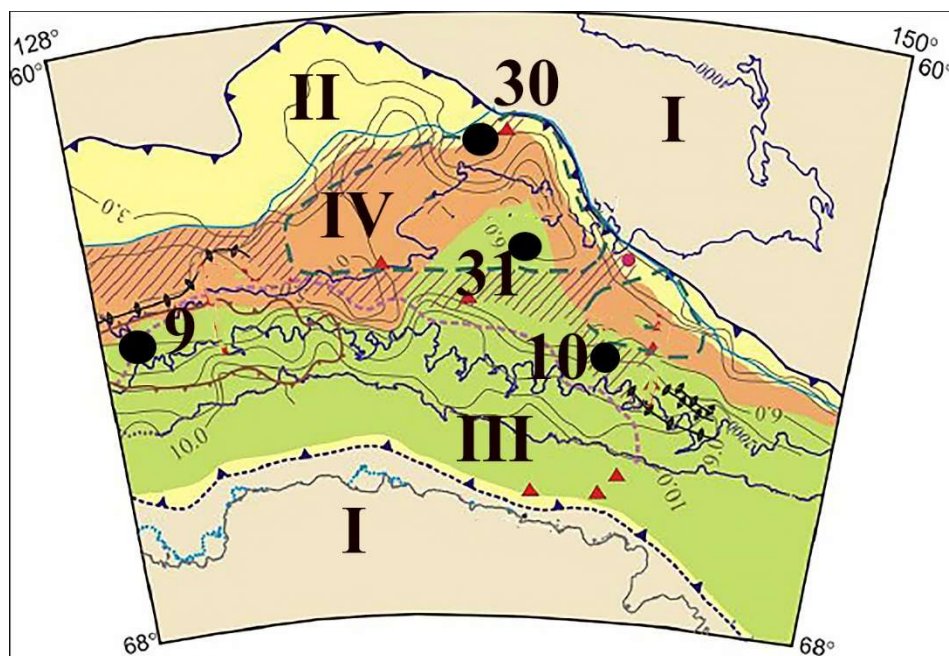
Рис. 32. Модель структури земної кори центральної частини басейну морів Мусона-Дюрвіля вздовж профілів 5103 (А) і 5301 (Б) [Leichenkov et al., 2014] з пунктами сканування SP28, 29.



Примітка. Нанесені узагальнені результати сканування в локальних пунктах SP10, 30, 31. Положення пунктів – на рис. 30, 31.

Рис. 33. А – Рельєф поверхні океанічного фундаменту в північній частині моря Моусона; Б – сейсмічний розріз у морі Дюрвіля [Leichenkov et al., 2014].

Будова континентальної окраїни у районі моря Дюрвіля (136° до 150° східної довготи) ускладнена континентальними блоками, відокремленими від Антарктиди зоною мантийного підйому, де серпентинізовані мантийні породи виділяють безпосередньо під осадовим чохлам загальною потужністю до 10 км [Leichenkov et al., 2014]. В морі Дюрвіля (рис. 34), в межах трансформного розлому Георга V (серії трансформних розломів), результати сканування фіксують сигнали ВВ, вуглекислого газу, гелію та ін. На глибинах 3029-4081 м, 4337-4709 м (SP30) фіксується сильний спільний сигнал ВВ і гранітів (зондування проводилося до глибини 5 км). Зондування для SP31 показало, що тут фіксується сильний спільний сигнал ВВ і вапняків на глибинах 3684-5190 м (зондування виконано до глибини 5200 м).



Примітка. Умовні позначення та перспективи ділянок на вуглеводні: I – відсутні; II – низькі; III – середні; IV – високі, за [Safonova et al., 2022].

Рис. 34. Схема перспектив на вуглеводні басейну моря Дюрвіля [Safonova et al., 2022], де показано положення пунктів сканування (SP9, 10, 30, 31).

Для пункту зондування SP10 фіксуються сигнали вуглеводнів, вуглекислого газу, сигнали дегазації газу та осадових порід до глибини 6 км. Інтервали глибин залягання пластів

насичених ВВ від поверхні до 6 км: 1722-2265 м, 5363-4741 м. Відгуки отримані для пунктів сканування SP32, 34, розташованих в північній частині суббасейну Седуна Австралійсько-Антарктичної улоговини. Цей суббасейн, який має високий вуглеводневий потенціал та наявність стійкої системи нафтогазогенерації, автори вважають аналогом осадового басейну Моусон-Дюрвіль на континентальній окраїні Австралії [Safonova et al., 2022]. Можливі інтервали глибин залягання пластів насичених ВВ від поверхні для SP32: 1201-1471 м, 2125-2289 м, 2757-3335 м, 3695-4426 м, 4890-5491 м. На глибині 5,7 км одержані відгуки від порід фундаменту (рис. 35).

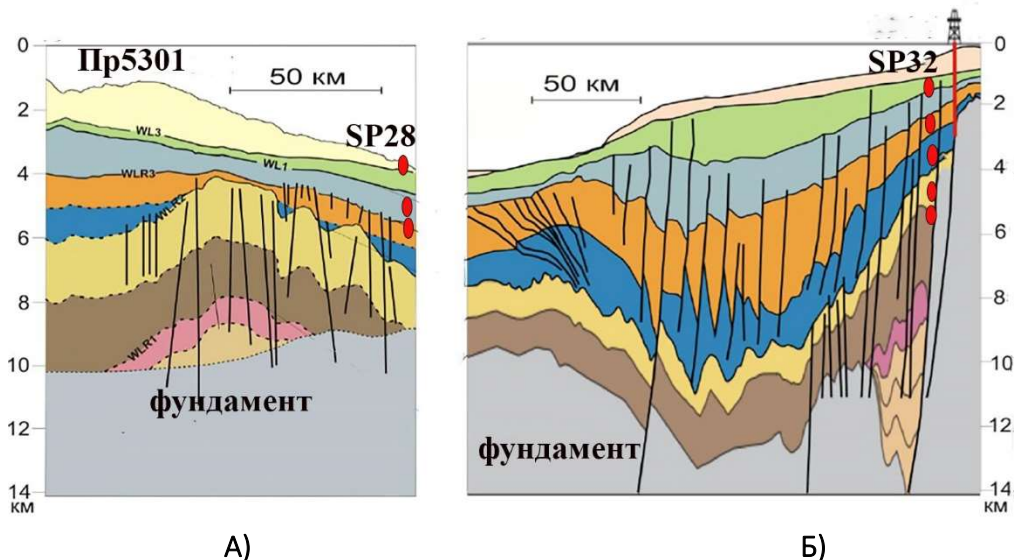


Рис. 35. Модельні сейсмічні розрізи осадових товщ в західній частині моря Дюрвіля (фрагмент профілю 5301, **А**) та в суббасейні Седуна на спряжених континентальних окраїнах Антарктиди і Австралії [Safonova et al., 2022, із спрощеннями, **Б**), де показані результати локального сканування в пунктах SP28, 32.

Сканування для пункту SP34, який теж розташований в межах суббасейну Седуна показало, що сигнали від вуглеводнів (та від гранітів) фіксуються на глибинах 666-2922 м, 3566-4407 м та 5317-6047 м. Сканування проведено до глибини 6200 м (рис. 35). Ці результати підтвердили наявність вуглеводнів в межах локальних пунктів сканування, розташованих в цій частині моря Моусона- Дюрвіля.

На схемі перспектив на вуглеводні (рис. 34) зони окраїнного рифту з осадовим чохлам потужністю 4-8 км, повним набором осадових комплексів та з прогріванням та генерацією метану при серпентинізації перидотитів у зоні підйому мантійних порід вважаються високо-перспективними. До зони низьких перспектив віднесено нижню частину підніжжя континентального схилу та океанічне ложе з осадовим чохлам потужністю 2-4 км [Safonova et al., 2022].

Проведені багаторічні експедиційні дослідження показали, що в осадовій товщі басейну моря Дюрваля є всі умови для утворення потенційних нафтоматеринських товщ, в тому числі існують локальні структури, які можуть бути пастками для скупчень нафти і газу. Такими перспективними нафтоматеринськими породами вважають рифтові осадки верхньої юри та нижньої крейди з високим вмістом органічної речовини. Важливою особливістю будови осадових товщ є наявність газових флюїдів, які свідчать про можливі скупчення глибинних вуглеводнів [Safonova et al., 2022].

Шельф Австралії

Пункти сканування (SP32, 34-40) розташовані в локальних структурах (рис. 36), континентальних окраїн півдня та заходу Австралії, в межах Великої Австралійської затоки

(западина Байт, суббасейн Седуна) і западини Броуз (шельфова зона Ямпі). Суббасейн Седуна вважається перспективним нафтогазоносним районом континентальної окраїни Австралії. [Totterdell et al., 2008; 2009; 2014].

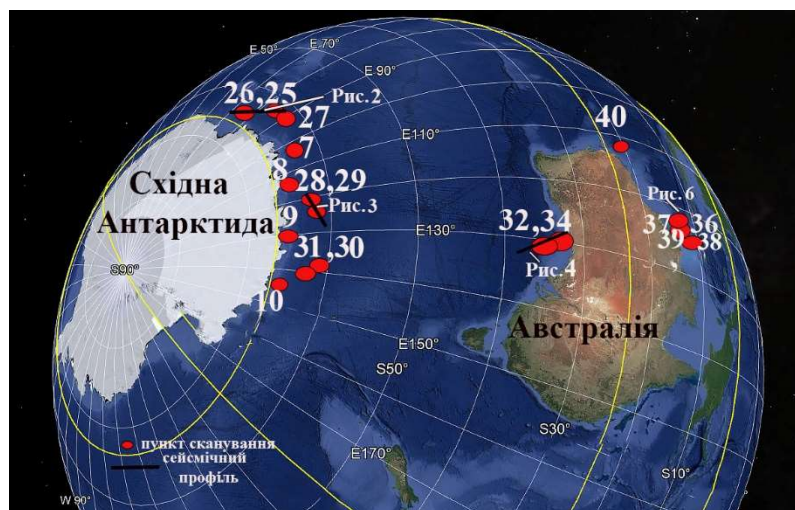


Рис. 36. Супутниковий знімок Східної Антарктиди із пунктами сканування та положенням окремих сейсмічних профілів за даними [Leitchenkov et al., 2019].

Для ділянки западини Байт (в межах суббасейну Седуна), яка містить понад 15 км відкладень середньоюрсько-верхньокрейдового періоду [O'Brien et al., 2005], створені модельні профілі, один з яких (рис. 37) показує можливі діапазони глибин розрізів ймовірного існування вуглеводнів (нафти і газу) в залежності від характеристик осадової товщі. Резервуарами і пастками можуть бути верхньокрейдові дельтові та мілководні морські відкладення з пористістю 15-25 %, а регіональними покришками – верхньокрейдяні морські сланці [Totterdell et al., 2014].

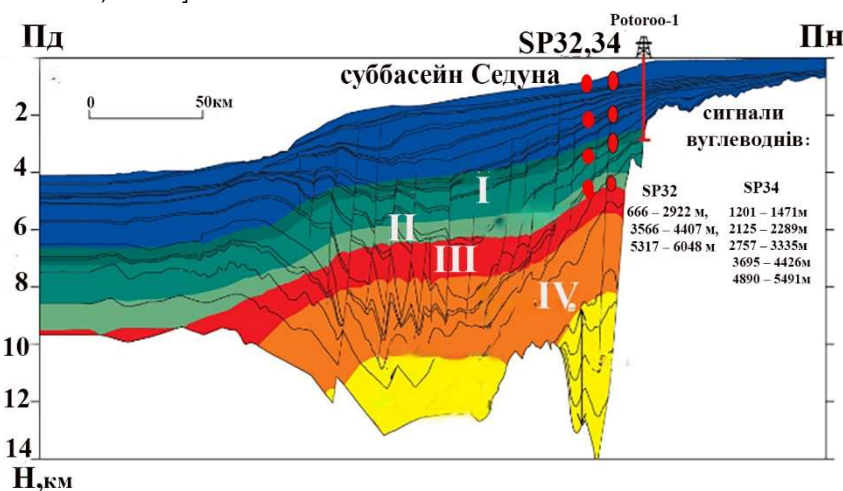


Рис. 37. Модельний профіль [Totterdell et al., 2014] в суббасейні Седуна через свердловину Potoroo-1, який показує розподіл глибин розрізу, сприятливих для формування накопичень нафти (горизонти I, II) і газу (горизонти III, IV). Наведені результати сканування в пунктах SP32, 34 (рис. 36).

Комплексне 3D-моделювання басейну та нафтогазових систем Великої Австралійської затоки показало, що навіть незначні зміни в системі розломів або в складі та структурі осадової товщі значно впливають на розташування скупчень вуглеводнів [Frery et al., 2017].

В умовах досить обмеженої кількості свердловин зростає роль додаткової інформації, що стосується особливостей формування вуглеводневих систем в осадових товщах регіону,

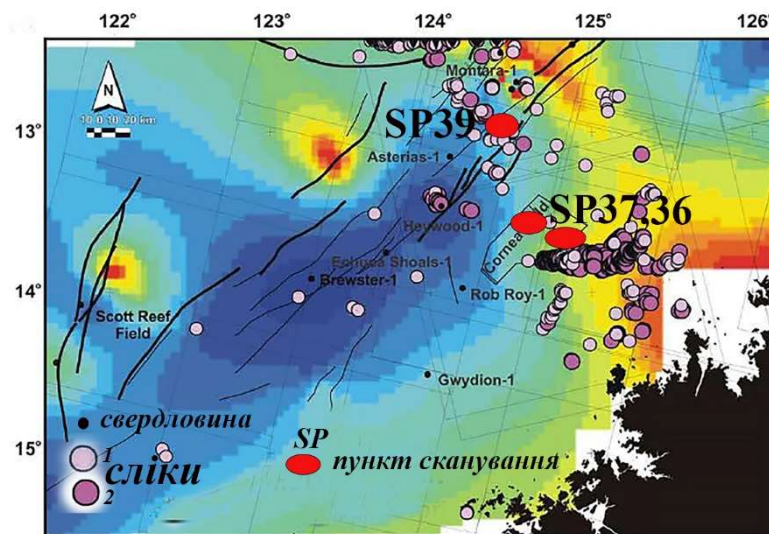
який за вуглеводневими перспективами поступається багатьом іншим структурам континентальних окраїн Австралії [Totterdell et al., 2014].

Пункти сканування (SP32, 34) розташовані поблизу свердловини Potoro-1 і можуть характеризувати особливості будови розрізу і наявність можливих проявів глибинних вуглеводнів. Для пункту сканування SP32 визначені ймовірні інтервали глибин залягання пластів, насичених ВВ (рис. 37). У пункті сканування SP34 (рис. 36) з поверхні зафіксовано сигнали на частотах водню, вуглекислого газу, червоного фосфору та водневих бактерій, а також встановлено факт міграції водню в атмосферу. Фіксується сигнал ВВ (рис. 37), зондування проведене до глибини 6200 м.

Басейн Броуз, розташований на шельфі північно-західної Австралії, займає площу біля 140000 км² і містить на багатьох стратиграфічних рівнях (від пермських до нижньокрейдяних), значні вуглеводневі горизонти відкладів, збагачених органікою. Найбільш перспективним вважається суббасейн Касуэлл, з потужністю осаdkів до 15000м, в межах якого виявлено багато комерційних вуглеводневих родовищ і пробурено більше 200 свердловин [Kempton et al., 2020; Totterdell et al., 2014].

В межах ділянки Корнеа дослідження ЧР методами проведені для його північно-східної та східної частини (рис. 38), де на півночі шельфу Ямпі спостерігалися витoki вуглеводнів [Logan et al., 2010].

При скануванні пункту SP36 фіксується спільний сигнал ВВ і вапняків в інтервалах глибин: 560-2099 м, 2551-4690 м. Просторово цей пункт розташований неподалік місця зафіксованих «газових труб» та інтенсивних сліків (рис. 38).



Примітка. Нанесені пункти сканування (SP36, 37, 39) та виявлені на поверхні моря сліки різної інтенсивності (2 - більш достовірні та інтенсивні) [O'Brien et al., 2005].

Рис. 38. Басейн Броуз біля північно-західного узбережжя Австралії.

Для пункту SP37 фіксується спільний сигнал ВВ і магматичних порід в наступних ймовірних інтервалах глибин: 1260-2080 м, 2851-3608 м, 4047-4682 м. Зондування проведено до глибини 5 км.

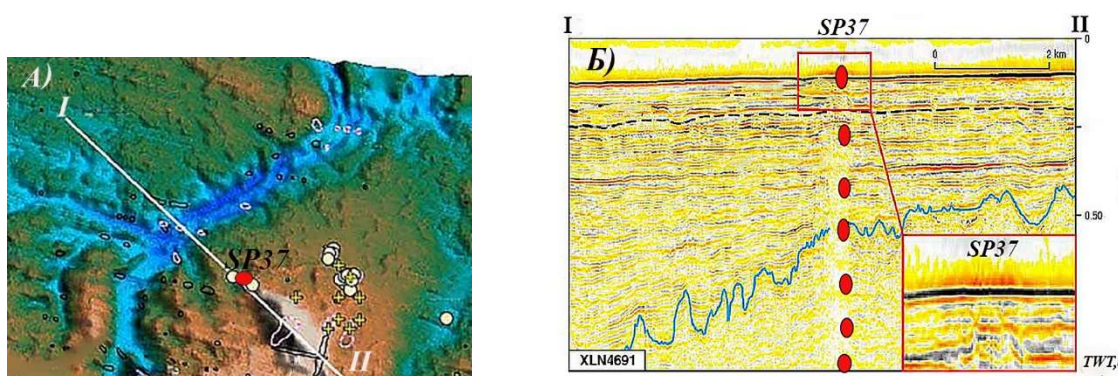


Рис. 39. А – Розташування [Logan et al., 2010] пункту сканування SP37 в межах ділянки Корнеа (шельф Ямпі); Б – результат інтерпретації даних для цього пункту дегазації.

На поверхні фіксуються сигнали ВВ, вуглекислого газу, водню, водневих бактерій та ін (рис. 38, 39). Для пункту сканування SP38, розташованому на ділянці активного газовиділення в Тиморському морі (рис. 40), на поверхні фіксуються сигнали вуглеводнів, гелію та ін. Фіксується спільний сигнал ВВ і солі в ймовірних інтервалах глибин: 1039-2217 м, 2454-3689 м, 3932-4363 м, 4568-5005 м.

Ці результати показали, що сліки в районі обстеження можуть бути пов'язані не лише з віддаленими витокami із Корнеа [O'Brien et al., 2001], а і з наявними вуглеводнями глибинного походження, про що свідчать результати локального ЧР сканування (SP38).

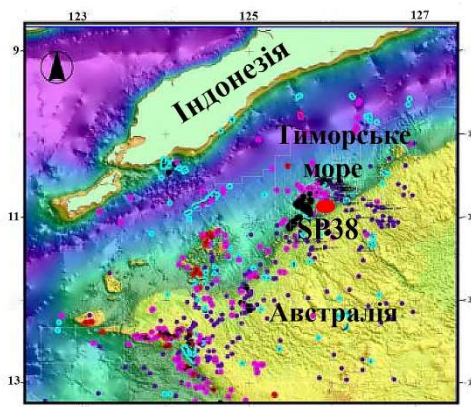


Рис. 40. Ділянки сліків в Тиморському морі [O'Brien et al., 2001], де показано розташування пункту сканування SP38.

Для пункту сканування SP39 (рис. 38) відгуки від газу зафіксовані з таких інтервалів розрізу: 1) 1830-2015 м; 2) 3400–3830 м; 3) 4585-5615 м; 4) 7550 – 8450 – 8570 м (простежено до 10 км). Під час обробки знімка більшої площі (біля пункту сканування) отримані сигнали на частотах нафти, конденсату, газу, сланцю, газогідратів, вугілля та інших речовин, відгуки від водню не отримані.

Оцінка перспективності досліджених локальних структур континентальних окраїн Антарктики та Австралії

На прикладі окремих структур показана практична можливість проведення дистанційних досліджень в Антарктиці та Австралії з метою виявлення особливостей формування глибинних флюїдних каналів та вуглеводневих систем регіону.

Дані ЧР сканування (рис. 36) охоплюють локальні структури окраїнних осадових басейнів Антарктики та Австралії. Вони надають просторові дані про ділянки, з високою вірогідністю перспектив на прояви глибинних вуглеводнів.

В морі Уедделла сканування показало вибірккову насиченість окремих ділянок системами вуглеводнів, а структури моря, вірогідно, мають локальну перспективність. Результати сканування (SP5) виявили тут можливі скупчення глибинних вуглеводнів. В морі Рісер-Ларсена для локальних пунктів сканування сигналів вуглеводнів не зафіксовано. На всіх пунктах сканування зафіксовані чіткі сигнали від “геологічного” водню на глибинах до 4,5-4,9 км. В морі Космонавтів зафіксовані відгуки від глибинних (6,4-6,5 км) ВВ в пунктах сканування SP13, 15, 16, а також сигнал від водню до глибини 3,5 км в пункті SP14. В морі Співдружності зафіксовані відгуки від надглибинних (до 9,9 км) ВВ в пункті SP19; сигнал від глибинних ВВ (до 4,5 км) отримано для SP21. Також отримані сигнали водню з глибин 4,3-5,0 км (SP23), спільно з ВВ і базальтами (SP17, 20). Для SP22 фіксуються сигнали ВВ на поверхні і до глибини 6 км, а для SP25, SP26 фіксується спільний сигнал водню і базальтів до глибини майже 5 км. На глибині фіксуються сигнали гранітів, базальтів та ультраосновних порід. В морі Дейвіса зафіксовані сильні сигнали водню (спільно з базальтами).

Для сегменту континентальної окраїни в межах морів Моусона-Дюрвіля фіксуються відгуки від вуглеводнів для багатьох пунктів сканування, що може свідчити про перспективність цього регіону (рис. 41).

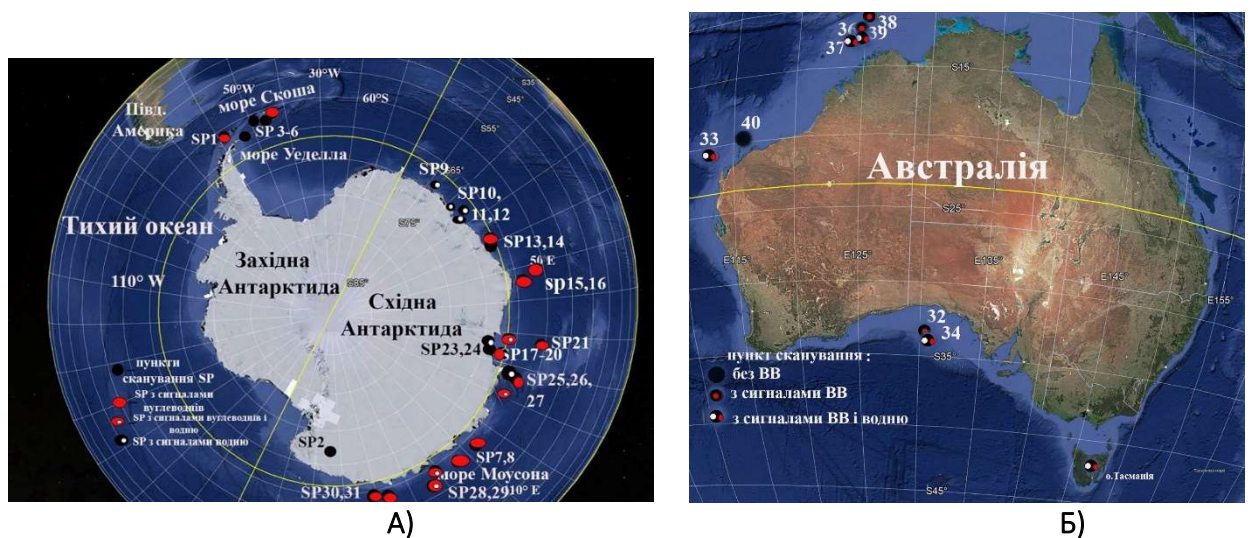


Рис. 41. Загальна схема положення пунктів сканування (SP) і пунктів із сигналами вуглеводнів для сегменту морів континентальної окраїни Східної Антарктиди (А) та Австралії (Б).

Отримані нові незалежні дані принципово підтверджують існування нафтових та газових накопичень в межах цих локальних структур і можуть бути використані як додаткові аргументи при оцінці перспектив нафтогазоносності структур континентальних окраїн регіону.

Загальні висновки. Розглянуті результати дослідження частотно-резонансним методом (ЧР) в місцях газових викидів різного генезису та сучасних газовиділень у структурах шельфу та континентальних окраїн.

Застосовані технології ЧР-зондування дозволяють дистанційно визначити ймовірну глибину геологічних джерел активної міграції, дають додаткову (і незалежну) інформацію про можливе розташування джерел дегазації і скупчень вуглеводнів. Існує багато прикладів, коли за даними ЧР сканування виправдовувались попередні (до буріння) прогнозні оцінки локальних структур на перспективність виявлення скупчень вуглеводнів або їх відсутність. Впевненість у реальності отриманих результатів можуть підтвердити нові матеріали застосування цих методик для досліджень матеріалів з прогностичним характером та

однозначною інтерпретацією. Вивчення характеру електромагнітних аномалій з використанням технології ЧР-обробки супутникових знімків проводилося в районах активного вулканізму (Флегрейські поля (Італія); Мауна-Лоа (Гавайські острови); вулкани Авачинський та Безіменний (півострів Камчатка) та ін. Ці експерименти показали, що оперативна обробка супутникових знімків діючих вулканів дозволяє виявити аномальні зони, які можуть бути провісниками вивержень [Levashov et al, 2018].

Прикладом застосування таких досліджень є спроба зробити прогноз поведінки локального резервуару розплавленої магми в земній корі структур вулканів Єллоустоуна (США) за результатами ЧР обробки серії супутникових (Landsat-8) знімків за 13.09.2013, 12.02.2017 та 10.10.2017р. з використанням методики сканування розрізу [Levashov et al, 2018].

За матеріалами досліджень в одній із ділянок була виявлена значна кількість аномальних геоелектричних зон (всього 13 зон), пов'язаних з структурами активної вулканічної діяльності (рис. 42Б). Всі ці зони були виділені в процесі ЧР-обробки знімків шляхом реєстрації аномального підвищення напруженості природного електричного поля Землі (ПЕПЗ) та аномального підвищення концентрації позитивних зарядів у приземному атмосферному шарі. Такі ж особливості (закономірності) у поведінці поля ПЕПЗ та розподіли зарядів фіксувалися також під час проведення досліджень на діючих вулканах раніше. За даними ЧР обробки цієї серії супутникових знімків з використанням методики сканування розрізу для цих пунктів сканування була оцінена приблизна швидкість підйому продуктів вулканічних вивержень до поверхні в контурах виявлених аномальних зон високочастотного електромагнітного випромінювання, аномальних значень напруженості природного електричного поля Землі. Підйом розплавлених порід (у тому числі і розплавлених частково) здійснюється по боковим локальним каналам, розташованим уздовж виділених зон тектонічних порушень (рис. 42).

Аналіз даних за період з 2013 по 2017 роки показав [Levashov et al, 2018], що найбільш активною є ділянка № 2б, розташована в районі діючих гейзерів Morning Glory, Old Faithful та інших (рис. 44).

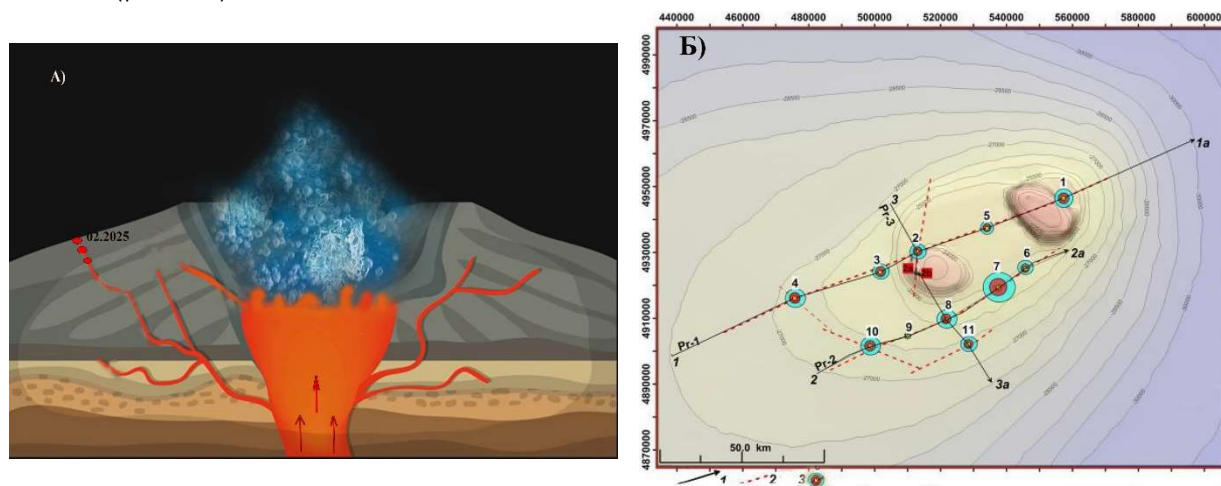


Рис. 42. Узагальнена схема (А) будови глибинного резервуару магми в районі вулканів Єллоустоуна [Levashov et al, 2018]; карта глибин (Б) до верхньої кромки локальної зони плавлення порід (за даними частотно-резонансної обробки супутникового знімку за 10.10.2017); 1 – лінія вертикального розрізу; 2 – тектонічні порушення; 3 – пункт сканування.

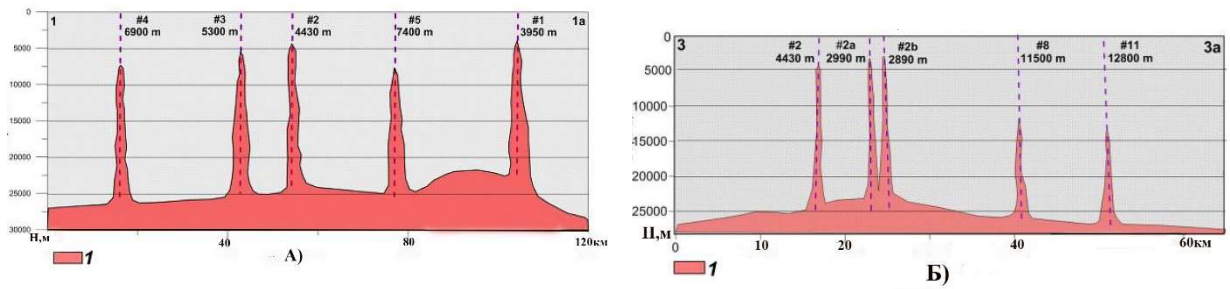


Рис. 43. Вертикальний розріз [Levashov et al, 2018] вулканів (Рис. 42): **А** – профіль 1-1а; **Б** – профіль 3-3а, станом на період 10.10.2017. 1 – глибини розташування прогнозованої зони плавлення (в тому числі і часткового) порід.

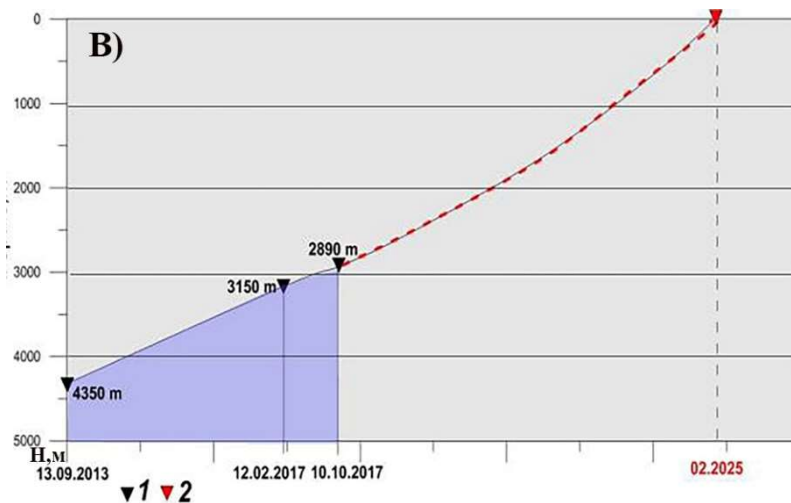


Рис. 44. Загальний вигляд діючих гейзерів Morning Glory Pool (**А**) і Old Faithful (**Б**); **В**-графік швидкості підйому розплавленої магми [Levashov et al, 2018] в зоні вулкана № 2b. 1 – дати визначення глибини зони підйому магми; 2 – прогнозна дата виверження.

Якщо оцінена швидкість підйому магми буде приблизно постійною, виверження вулкана в цьому місці можна очікувати у лютому 2025 р. Отримана оцінка дати виверження може бути скоригована у бік збільшення чи зменшення за умови проведення регулярного моніторингу за вулканічною активністю на території парку.

Ці дослідження мали прогностичний характер, адже дата виверження була конкретною. Підтвердженням прогнозу стало повідомлення із США (<https://www.msn.com/en-us/weather/topstories/yellowstone-is-waking-up-after-160-000-years/ss-AA1zdIDG?ocid=msedgntp&pc=LCTS&cvid=92fead216cf44e6fd10a4932d76103ce&ei=16#image>

)=1) про значно підвищену вулканічну активність на території Єллоустоунського парку саме в лютому 2025 року. Наведені дані показали, що виявлений підйом розплавів в пунктах сканування (2а, 2б) може бути прямо пов'язаним із вулканічною активністю основного магматичного резервуару, розташованого на глибинах 20-25 км (Рис. 43).

Результати експериментальних досліджень показали, що метод вертикального сканування геологічного розрізу дозволяє оцінювати приблизно швидкість підйому продуктів вулканічних вивержень до поверхні в контурах виявлених аномальних зон височастотного електромагнітного випромінювання, аномальних значень напруженості природного електричного поля Землі та аномального підвищення концентрації позитивних зарядів у приземному атмосферному шарі [Levashov et al, 2018].

Результати детального вивчення характеру зміни електромагнітних параметрів випромінювання (максимальної частоти та площі аномальної зони) у часі можуть бути використані надалі для моніторингу за активними вулканами та районами підготовки сильних землетрусів.

Матеріали експериментальних досліджень у різних регіонах земної кулі і зонах дегазації структур континентальних окраїн Арктики, Антарктики, Австралії, Північного, Середземного та Чорного морів є важливими аргументами на користь «вулканічної» моделі формування різних структурних елементів Землі. Витоки метану та нафтові плями служать індикаторами активності вулканів, в яких можуть синтезуватися вуглеводні. У контурах таких вулканів є глибокі канали, через які нафта, конденсат та газ ймовірно мігрують до верхніх горизонтів літосфери і поповнюють скупчення та родовища вуглеводнів.

Дані сканування показали, що інтенсивність та динаміка їх формування частково залежать від притоку газових флюїдів з глибоких джерел через активні процеси дегазації, що дає змогу отримати додаткову (і незалежну) інформацію про взаємозв'язок процесів дегазації надр з природними явищами в локальних структурах Світового океану (сипи, грязьові вулкани, газогідрати) та про їх важливу роль у формуванні накопичень вуглеводнів у верхніх частинах земної кори і в широкому діапазоні глибин літосфери.

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Medical Sciences

Балалардағы Крон ауруы

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Аннотация. Мақалада Крон ауруы күрделі патогенез болып негізделген, яғни қабыну әсерінен өршу мен ремиссия кезеңдерінің ауысуымен анықталады. Крон ауруының дамуы қабыну реакциясының күрделі өзгеруімен негізделген, ол ішектің шырышты қабығының тосқауылының туа біткен иммунитетінің өзгеруімен және жасушадан тыс матрицаның қайта құрылуымен сипатталады. Бұл өзгертілген микроорта IL-12 және TNF- α сияқты цитокиндерді өндіру арқылы қабыну ошақтарындағы лейкоциттердің миграциясын күшейтеді. Авторлар, симптомдарға көбінесе іштің ауыруы, диарея, тік ішектен қан жоғалту және жалпы әлсіздік жатады, ал ауру көбінесе салмақ жоғалтуға және дұрыс тамақтанбауға әкеледі деп талқыланады.

Кілт сөздер: Крон ауруы, балалар, биологиялық терапия, стероидтар, ішектің қабыну ауруы, инфликсимаб, адлимумаб.

Крон ауруы - бұл асқазан-ішек жолдарының әртүрлі бөліктерінің үзілісті (сегменттік) зақымдалуымен сипатталатын ішек қабырғасының барлық қабаттарын қамтитын спецификалық емес біріншілік созылмалы, гранулематозды қабыну ауруы. Трансмуральды қабынудың салдары - фистулалар мен абсцесс түзілуі [1]. Балалық шақтағы Крон ауруы жиілігінің өсуі бүкіл әлемде батыс диетасына қарай ауысуларымен тығыз байланысты, нәтижесінде ішек микробиотасы өзгереді және ішек иммунитеті мен метаболизмі бұзылады. Ішектің қабыну аурулары эпидемиологиясы туралы деректер, популяциялық зерттеулер нәтижесінде соңғы 50 жылда батыста аурушандық мен таралудың өсуін көрсетеді [2].

АҚШ, Канада, Норвегия, Швеция, Финляндия, Франция, Чехия, Хорватия және Венгрияда Крон ауруы айтарлықтай өсуі байқалды - 100000 тұрғынға шаққанда 1-2 жағдайдан. Крон ауруы бүкіл әлемде өсуде және аурудың басталуы кез келген жаста болуы мүмкін. Крон ауруымен ауыратын науқастардың 15% - на дейін 20 жасқа дейін анықталып жатыр [3].

Бұл аурудың этиологиясы мен патогенезі белгісіз. Крон ауруы генетикалық бейімділігі бар адамдарда, әлі анықталмаған қоршаған орта факторларына, ішек микробиомасының өзгеруіне және иммундық жауаптың бұзылуынан болуы мүмкін деген болжам жасалды.

«Ерте өмір» деп сипатталған 5 жасқа дейінгі пренаталды кезең ұрық үшін ерекше сезімтал болып табылады, сондықтан осы кезеңде сыртқы ортадан немесе эндогенді факторлар Крон ауруы қаупін арттырады деп болжайтын көптеген гипотезалар бар. Агравал мен авторлардың жүйелі шолуы өмірдің бірінші жылында антибиотиктердің пренатальды әсері (OR 1,8; 95% ДИ: 1,2-2,5), темекі шегу (OR 1,5; 95% ДИ: 1,2-1,9) және ерте жастағы ортаңғы құлақтың отиті (антибиотиктерді қолданудың жанама көрсеткіші болуы мүмкін) (OR 2,1; 95% ДИ: 1,2-3,6) ішектің қабыну ауруы қаупінің жоғарылауымен байланысты болды [4].

Желшешек инфекциясы (OR 3,89; 95% ДИ: 1,61-9,4) Крон ауру қаупінің жоғарылауымен байланысты болды [5]. Екінші жағынан, Агравал және басқалар ішектің қабыну аурулары босану әдісімен, анасының жасымен, перинаталдық факторлармен,

вакцинациямен, әлеуметтік-экономикалық немесе гигиенамен байланысты факторлармен байланысын таппады.

Вакцинация мен ішектің қабыну ауру қаупін зерттейтін мета-талдау балаларға арналған жеті вакцинаның (БЦЖ, дифтерия, сіреспе, шешек, полиомиелит, қызылша) ішектің қабынуының дамуымен байланысы жоқ екенін анықтады. Бірақ, кіші топтық талдау полиомиелитке қарсы вакцинаның Крон ауруы (RR 2,28, 95% ДИ: 1,12-4,63) даму қаупін анықтады, бірақ зерттеудің гетерогенділігіне байланысты сақтықпен қарау керек. Сондай-ақ H1N1 (RR 1,13; 95% ДИ: 0,97-1,32) вакцинациясында ішектің қабынуының даму қаупінің тенденциясы байқалды, бірақ авторлар балаларға арналған вакциналар немесе H1N1 вакцинасы ішектің қабыну ауруы даму қаупін арттырады деген идеяны қолдамайтынын атап өтті [6].

Крон ауруы кезінде қабыну бүкіл ішекті қамтиды, көбінесе дистальды мықын ішекті зақымдайды. Крон ауру диагнозы қойылған науқастар аурудың өршу кезеңдерін және ремиссия кезеңдерін бастан кешіреді. Патогенез қоршаған орта факторларының, иммундық жүйенің, сезімталдық гендерінің өзара әрекеттесуінің және ішектің шырышты қабығының бұзылуына әкелетін микробиомасының өзгеруінің нәтижесі болып табылады. Қазіргі таңда бұл аурудың дамуының нақты механизмі белгісіз болып қалады.

1998 жылы гастроэнтерологтардың Дүниежүзілік съезінде Крон ауруының Вена классификациясы ұсынылды. 2005 жылы келесі конвенцияда классификация өзгертіліп, Монреаль деп аталды және осы уақытқа дейін қолданылады [7].

Жіктеудің негізгі категориялары жас, локализация, аурудың ағымы және зақымданудың таралуы болып табылады:

1. Диагноз қойылған кездегі жас (17 жастан аз, 17-40 жас, 40 жастан асқан).
2. Зақымданудың локализациясы (терминалды илеит, колит, илеоколит және кез-келген форманы толықтыра алатын жоғарғы асқазан-ішек жолдарының зақымдануы).
3. Фенотиптік нұсқа (немесе аурудың ағымы) - стриктураланатын, пенетрациялық, стриктураланбайтын / пенетрацияланбайтын типтер және кез-келген типті толықтыра алатын перианальды зақымданулар.
4. Зақымданудың таралуы бойынша - локализацияланған (мықын ішектің 30 см-ден аз және тоқ ішектің кішкене бөлігі зақымдануы) және кең таралған (барлық зақымдалған аймақтардың қосындысы 100 см-ден асады).

Алайда, ұсынылған жіктемелер балалық шақтағы Крон ауруының ерекшеліктерін ескермеді. 2010 жылы педиатриялық Еуропалық консилиумда дәлелді медицина қағидаттарына негізделген жаңа, балалардағы ішектің қабыну аурулары - Париж классификациясы, Монреаль модификациясы қабылданды [8]. Бұл жіктеу критерийлері педиатриялық фенотипті ескереді және қазіргі уақытта көптеген Еуропа елдеріндегідей Крон ауруы бар балаларда қолданылады.

Париж классификациясында келесі топтарға жіктеледі:

- 1) диагноз қойылған кездегі жас: 0 жастан 10 жасқа дейін (A1a), 10 жастан 17 жасқа дейін (A1b), 17-40 жас (A2), 40 жастан асқан (A3);
- 2) зақымдануды локализациялау: терминалды илеит (L1), оқшауланған колит (L2), илеит және колит (L3), Трейц байламына дейін зақымдануы бар жоғарғы бөліктер (L4a), Трейц байламынан төмен, бірақ мықын ішектің дистальды 1/3 бөлігінен жоғары зақымдануы бар жоғарғы бөліктер (L4b);
- 3) формасы бойынша: стриктураланбайтын және пенетрацияланбайтын (B1), стриктураланатын (B2), пенетрацияланатын (B3) және стриктураланатын және пенетрацияланатын (B2B3), р-перианальды көріністер;
- 4) өсу - өсудің тежелуі жоқ (G0), өсудің тежелуі (G1).

Алайда, жоғарыда көрсетілген критерийлерден басқа, аурудың ауырлығын (немесе

қазіргі өршуін) бағалау қажет, ол үшін іс жүзінде Крон ауруының педиатрлық белсенділік индексі (Pediatric Crohn' s Disease Activity Index - PCDAI) қолданылады [9]. Бұл индекс консервативті терапияның тиімділігін объективтендіру, гормоналды тәуелділік пен төзімділіктің дамуын анықтау үшін қажет, бұл пациенттің ары қарай емдеу тактикасын анықтау үшін қажет.

Балалардағы Крон ауруының жалпы белгілеріне қызба, іштің ауыруы, қанды немесе шырышты іріңді созылмалы диарея, анемия, нашар жетілу және ішек өтімсіздігінің белгілері жатады. Басқа белгілерге абсцесс немесе фистула сияқты перианалды ауытқулар, артрит, түйіндік эритема және увеит сияқты ішектен тыс көріністер жатады. Аурудың үдемелі қабыну процесін төмендету үшін қол жетімді емдеу стратегияларына қарамастан, Крон ауруы бар балалардың шамамен 25% - ында стриктуралық типі дамиды [10,11]. Диагноз қойылған науқастардың шамамен 10% -да ауру асқынған.

Диагноз анамнез, клиникалық көрініс, зертханалық өзгерістер, эндоскопиялық, сәулелік және гистологиялық зерттеу әдістерінің нәтижелері негізінде қойылады.

Эндоскопия - балалардағы ішектің қабыну ауруларын диагностикалау мен бақылаудың алтын стандарты. Бұл инвазивті процедура, седация мен ішекті дайындау қажеттікті талап етеді.

Балалардағы ультрадыбыстық зерттеу(УДЗ) трансабдоминалды түрде қолдана отырып жасалады және бастапқы диагностиканың қол жетімді инвазивті емес әдісі болып табылады. Ультрадыбыстың артықшылықтары жақсы төзімділікті, сәулеленудің болмауын және арзан бағаны қамтиды. Сонымен қатар, ультрадыбыстық зерттеу Крон ауруының аш ішектің, әсіресе белсенді мықын ішектің қабынуын анықтаған кезде жоғары сезімталдықты көрсетті [12]. Соңғы жылдары жаңа әдіс дамыды -жіңішке ішектің модификацияланған контрнспен ультрадыбыстық зерттеуі (small intestinal contrast ultrasound - SICUS) [13].

Эндоскопия мен трансабдоминальды УДЗ кейін аурудың таралуы мен белсенділігін анықтау үшін магнитті-резонанстық энтерографияны қарастырған жөн. Қазіргі уақытта МРТ педиатриялық тәжірибеде динамикалық бақылаудың алтын стандарты болып табылады және Крон ауруының әртүрлі фенотиптік формаларында, соның ішінде перианалды локализацияда қолданылады. Жамбас МРТ мәліметтері бойынша, тік ішектің күйін бағалай отырып, жамбас аралық бұлшықеттер мен параректалды кеңістікке қатысты патологиялық процестің анатомиялық проекциясын анықтай отырып, күрделі фистулалар мен абсцесстерді табуға болады. Бастапқы диагностика үшін КТ энтерографиясын қолдануға болады.

Крон ауруын емдеу диеталық әдістерден бастап, фармацевтикалық препараттарға дейін спектрі таралған, олар қабынуға қарсы препараттар, иммуносупрессанттар және биологиялық препараттар. Бірақ кейбір жағдайларда аурудың ерте стадияларында биологиялық препаратты агрессивті тәсіл ретінде қолдану көрсетілген. Бұл тәсілдің негіздеме ретінде, шырышты қабықтың толық емделуіне қол жеткізу аурудың табиғи ағымына әсер етуі мүмкін деген дәлелдерге негізделген. Хирургиялық араласулар асқинуларды, соның ішінде фистулаларды, стриктураларды, абсцесстерді емдеуге және дәрі-дәрмекпен емдеуге жауап бермейтін науқастарға арналған.

Энтеральды тамақтануды 2014 жылы жарияланған Еуропалық Крон ауруы және колит ұйымының нұсқауларында (ECCO)/Еуропалық балалар гастроэнтерологиясы, гепатологиясы және тамақтану қоғамы (ESPGHAN) емдеудің бірінші бағыты ретінде ұсынады [14]. Еуропалық зерттеулердің ұсыныстары тиімді емдеу 100% энтеральды тамақтануды қажет етеді деп болжайды.

Стероидтар емдеудің негізі болды. Стероидтер 1-5 мг/кг преднизолонмен дозалаңады және 8-12 апта ішінде азайтып отырып, ремиссия қол жеткізу. Өкінішке орай, стероидтардың жанама әсерлерінің профилі балалық шақтағы пациенттер үшін ерекше қауіпті болып табылады, өйткені олар өсуге айтарлықтай әсер етуі мүмкін. Тиопуриндер мен

метотрексат көбінесе стероидтерге тәуелділікті азайту мақсатында демеуші терапия ретінде қолданылады. Тиопуриндер әсер ету үшін бірнеше апта қажет және индукциялық терапия үшін қолданылмайды. Олар ремиссияны сақтауда тиімді [15], бірақ айтарлықтай иммуносупрессивті жанама әсерлері, гепатоуыттылығы бар. Метотрексат тиімді, бірақ миелосупрессиямен, жүрек айнуымен, құсумен және бауыр ауруымен байланысты болуы мүмкін [16].

Ісікке қарсы некроз факторы (TNF) терапиясы стероидқа төзімділік кезінде ремиссияны индукциялау және қолдау үшін тиімді ем ретінде дамыды. Инфликсимаб және адалимумаб тиімді препараттардың бірі болып табылғанмен, тұрақты және дұрыс дозалауды қажет етеді.

Крон ауруына арналған хирургиялық көрсеткіштер әртүрлі және балалардағы ауру ағымының әртүрлі кезеңдерінде пайда болады. Педиатриялық популяциядағы хирургия принциптері ұқсас, хирургиялық араласудан өткен науқастардың 50% - ы болашақта қайта операцияны қажет етеді. Осылайша, ішектің ұзындығын сақтау және тыртықтарды азайту стратегиялары маңызды болып табылады. Хирургиялық араласуға әкелетін ең көп таралған асқынулар - бұл обструкция, абсцесс, фистулалар және фармакологиялық емдеудің тиімсіздігі немесе төзімсіздігі.

Хирургиялық емдеу дәрі-дәрмек терапиясымен бірге дамыды және қазіргі хирургиялық процедуралар бұрынғыға қарағанда қауіпсіз және аз инвазивті болды. Хирургия өмірге қауіп төндіретін асқынулар үшін соңғы шара, өмір сүру сапасын арттыру үшін медициналық араласулармен бірге қолдануға арналған терапияға көшті. Қысқа ішек синдромының спектрін есте ұстаған жөн, бірақ Крон ауруының асқынуын емдеудің жоспарлы процедураларын қауіпсіз және тиімді орындауға болады. Дәрі-дәрмек терапиясы бір күні хирургиялық терапияны қажетсіз етуі мүмкін болса да, хирургия қазіргі уақытта Крон ауруы бар пациенттердің емдеу тобының ажырамас бөлігі болып қала береді.

Сонымен, балалардағы Крон ауруын диагностикалау мен емдеудің жаңа тәсілдеріне қарамастан, бұл ауру пациенттердің өмір сапасына айтарлықтай әсер етеді және этиопатогенезді әрі қарай зерттеуді және емдеудің қолданыстағы тәсілдерін жетілдіруді қажет етеді.

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METHODOLOGICAL BASIS AND ANALYTICAL EVALUATION OF CANCER SCREENING IN KAZAKHSTAN

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Annotation: In this scientific and analytical work, the indicators of incidence and mortality from cervical cancer, breast cancer and colorectal cancer in the regions of our country are considered. The screening methods currently used and the results of this preventive survey of the population are described in detail. Detailed step-by-step algorithms are presented, and the principles of organization and diagnostic capabilities of the screening program for the active detection of these nosological forms of malignant neoplasms in clinically asymptomatic individuals are reflected.

Key words: oncological screening, primary care, cervical cancer, breast cancer, colorectal cancer, epidemiology, incidence, mortality, Pap test, smear for oncocytology, ultrasound examination, mammography, hemocult test, fecal occult blood test - FOBT, total colonoscopy.

Today, one of the most important postulates of the oncology service continues to be the early diagnosis of malignant tumors. The purpose of screening is to identify asymptomatic

(preclinical) cancer or precancerous conditions in an otherwise healthy target population. In this case, screening plays a leading role in secondary cancer prevention. The key concept of cancer screening is to identify pathology at a stage of development when the effectiveness of treatment is maximum and the prognosis is most favorable. When precancerous diseases are detected during screening, secondary prevention methods allow to prevent the transition of the initial pathological state to cancer. In this case, the main conditions for screening are the presence of trained personnel and a standard approach to identifying the trait being studied and evaluating the results. The methods used must be sufficiently simple, reliable and reproducible, as well as have sufficient sensitivity and high specificity [1-3].

Screening plays an important role in improving early diagnosis and treatment outcomes. According to the Guide to Cancer Early Diagnosis by Ilbawi A. et al. [4], screening aims to detect unrecognized cancer or its prior lesions in a typically healthy, asymptomatic population through tests or other procedures that can be applied quickly and are widely available to the target population. In screening, the target population is assessed for unrecognized cancer or precancer, and most people tested will not be diagnosed with the disease. Screening should be seen as a process and not as the performance of a specific test, examination, or procedure. The screening process includes a system of informing and inviting the target population to participate; administering the screening test; following-up with test results and referral for further testing among those with abnormal test results; ensuring timely pathologic diagnosis, staging and access to effective treatment with routine evaluation to improve the process. A screening program encompasses the process from invitation to treatment and requires planning, coordination and monitoring and evaluation.

To date, the republican oncological screening program includes three nosological forms of malignant neoplasms - cervical cancer (CC), breast cancer (BC), colorectal cancer (CRC). Let's consider the current epidemiological indicators, methodology and results of cancer screening in our country.

CC in the structure of all malignant tumors of both sexes of the population in 2022 took 6th place with a share of 5.51% (2021 - 4th place, 5.54%), in women - stable 2nd place - 9.7% (9.7%) [5].

The incidence rate per 100 thousand population increased from 9.4 to 9.92. In 10 regions of the republic, the incidence rate is higher than the national average: Pavlodar - 17.2 per 100 thousand people (2021 – 16.7) – the highest level, East Kazakhstan – 14.3 (10.8), North Kazakhstan – 14.3 (10.2), Atyrau – 13.2 (13.8), Zhetysu - 11.7, Karaganda - 11.7 (12.0), Abay - 11.1, Akmola - 11.1 (11.9), Mangistau - 11.1 (9.7), Kostanay - 10.8 (10.6) regions.

Low incidence rates in Zhambyl region - 5.8 per 100 thousand population (5.7), Turkestan region - 6.1 (5.2), Aktobe region - 8.3 (11.6), Kyzylorda region - 8.5 (8.2) areas.

CC in the structure of causes of death from malignant tumors of the population of both sexes in 2022 rose from 9th to 8th position, with a share of 4.6% (2021 - 4.3%), mortality from CC is stable at 3.1 per 100 thousand population (3.1).

The mortality rate from CC in 10 regions is higher than the national average: Akmola - 4.2 per 100 thousand population (2021 - 3.1) - maximum level, West Kazakhstan - 4.1 (4.8), Pavlodar - 3.8 (5.6), Almaty – 3.7 (2.5), Zhetysu – 3.7, Atyrau – 3.4 (4.0), East Kazakhstan – 3.3 (3.8), Karaganda - 3.2 (4.7), Kostanay - 3.2 (2.4) regions and Almaty city - 3.4 (2.9).

Below the national average, mortality was recorded in Abay region, cities Astana, Shymkent - 2.9 per 100 thousand population, Mangistau - 2.8 (3.0), Turkestan - 2.3 (2.2), Aktobe - 2.2 (3.0), North - Kazakhstan - 2.0 (2.6), Kyzylorda regions - 1.7 (3.5) - the best result [5].

In 12 regions, a 100% level of morphological verification of the diagnosis was ensured, the lowest or worst indicator for the third year was in the Kyzylorda region - 94.3%, below the national average indicators in Akmola - 98.8%, Atyrau - 98.9%, Kostanay - 98, 9%, Mangistau - 97.6%,

Pavlodar - 96.6%, regions and Almaty city - 98.5%;

In a number of regions, the frequency of diagnosis of stage I-II CC was below the national average (88.1%) - in Akmola - 76.2% (2021 - 73.6%) - the worst result in the country, in Karaganda - 77, 2%, Zhetysu - 82.9%, Abay - 83.8%, Kostanay - 84.3%, Aktobe - 85.5%, West Kazakhstan - 85.7%, Pavlodar - 81.3%, while that in the Atyrau region - 100.0% result.

The proportion of stage IV CC is higher than the national average (2.7%) in the following regions: the worst result is in Zhetysu (6.1%), above the national average in Karaganda - 5.1% (2021 - 5.6%), Akmola - 4.8% (2.3%), Kostanay - 4.5% (4.4%), North Kazakhstan - 3.9% (7.4%), Almaty - 3.7 % (5.1%), Zhambyl - 2.9% (0.0) regions, cities Almaty – 3.6% (1.8%) and Shymkent – 3.8% (5.9%). The lowest neglect is in the East Kazakhstan region - 1.0% (0.7%).

Late diagnosis rates (III-IV stages) for CC are above the national average - 11.9% (15.4% in 2021) were noted in Akmola - 23.8% (2021 - 26.4%) - worst result, Karaganda - 22.8% (35.2%), Pavlodar - 18.8% (20.8%), Zhetysu - 17.1% (24.2%), Abay - 16.2% (12.8%), Kostanay - 14.6% (15.6%), Aktobe - 14.5% (9.6%), West Kazakhstan - 14.3% (32.4%) regions. The lowest neglect is in the Mangistau region - 6.0% (20.8%).

Across the country, the five-year survival rate of patients with CC registered in 2018 was 59.9% in 2022, with a decrease from the level of 2021 (67.5% for those registered in 2017), and with a significant range in by region, from the maximum – 72.9% (2021 – 70.7%) in the North Kazakhstan region, to the minimum – 34.9% (64.4%) in the Atyrau region [5].

CC screening is a periodic, comprehensive examination of women of a certain age group as part of a special medical program to prevent and reduce incidence and mortality from CC.

Type of screening - population. The purpose of screening is to identify pre-invasive diseases of the cervix with subsequent recovery. The screening method is a cytological examination of a smear for oncocytology from the cervix (traditional and liquid cytology). Coloring according to the "Papanicolaou test" (Pap test). Interval - 1 time in 4 years. Target group: women aged 30-70 years who are not registered in the dispensary for CC. The expected results are a decrease in incidence and mortality from CC.

Screening steps:

1) Preparatory - formation of target groups, information support and invitation to screening. The preparatory stage is carried out by the nurses of the primary health care organization responsible for preventive measures and includes: annual compilation of a list of women subject to screening in the coming year by November 15 of the current year, followed by monthly correction; informing target groups of the female population about the need for screening; screening invitation; ensure timely screening.

2) Screening - filling out a statistical card of a preventive medical examination (screening) of an outpatient (form 025-08/y), a register of patients subject to cytological screening and taking material for cytological examination from the cervix. The screening examination of the target groups of the female population is carried out by a specially trained midwife of the primary health care organization.

3) The final one is obtaining the results of cytology, informing the woman and developing further management tactics, fill out accounting and reporting statistical documentation. Responsible for the final stage of screening is the obstetrician-gynecologist of primary health care [6].

Cytological screening of CC is a complex of organizational and medical measures aimed at early detection of precancerous and neoplastic diseases of this localization and at reducing the mortality of this cohort of patients. For traditional cytology, a smear containing 8-12 thousand cells of stratified squamous epithelium (including cells of metaplastic epithelium) is considered adequate; for liquid cytology - 5 thousand cells. For both methods, the number of cells of endocervical epithelium and/or metaplastic epithelium (from the transformation zone) must be

at least 10 (single or in clusters). If more than 75% of the cells of the stratified squamous epithelium are covered with erythrocytes, leukocytes, etc., then the quality of the smear is considered unsatisfactory.

Interpretation of the results of a cytological study is carried out according to the Bethesda-terminology cytological system:

Intraepithelial changes and malignant processes are absent (NILM). This group includes cytological conclusions about the normal state of the epithelium, as well as the presence of various non-neoplastic diseases. Normally, squamous epithelial cells, groups of cells of columnar epithelium and metaplastic epithelium, a small number of leukocytes, and rod/mixed microflora are found in preparations. In the presence of non-neoplastic processes, their nature and, if possible, the cause are specified: atrophic changes, reactive changes associated with inflammation, including typical regeneration. In addition, the presence of microorganisms is indicated: *Trichomonas vaginalis*, fungi, morphologically corresponding to *Candida* spp., bacterial vaginosis, cellular changes corresponding to the defeat of Herpes simplex virus, squamous epithelial cells with atypia of unknown significance (ASC-US), squamous epithelial cells with atypia of unclear significance, not excluding the presence of a high degree of intraepithelial changes (ASC-H). Low-grade squamous intraepithelial changes (LSIL) include lesions associated with HPV and CIN I, high-grade squamous intraepithelial changes (HSIL) include CIN II, CIN III, carcinoma in situ and cases suspected of invasion, squamous cell carcinoma, cervical (glandular) epithelium with atypia of unknown significance, cells of the cervical (glandular) epithelium, possibly neoplasia, endocervical adenocarcinoma in situ, endocervical adenocarcinoma, endometrial adenocarcinoma, secondary adenocarcinoma, unclassified carcinoma, other malignant tumors.

There are certain features when taking material for oncocytology: firstly, the examined woman should be informed about the exclusion of sexual intercourse, vaginal manipulations, including douching, baths, tampons, etc. 2 days prior to sampling. Taking material for cytological examination is carried out by the midwife of the examination room of the department of medical examinations of the primary health care organization: the traditional method (2 glasses - with obligatory fixation in 96% alcohol, it is preferable to use glass slides with a polished edge, which are easily marked) or the liquid cytology method (one container with stabilizing liquid); the code or surname of the patient, identical to the code and surname in the form for sending material for cytological examination, should be clearly marked on the glasses or container [6].

At the same time, when using the traditional method, the biomaterial is delivered to the cytological laboratory as soon as possible after its collection in specialized containers for glass slides with 96% alcohol. If there are visible visual changes in the cervix, then the material is taken from the woman and, without waiting for the results, she is referred for an examination by an obstetrician-gynecologist.

A cytological study is carried out in centralized cytological laboratories at oncological institutions, where an archive of cytological preparations of patients involved in the screening examination is formed, regardless of the result, for a period of at least 10 years with the formation of a computer database.

What material and technical equipment is required to take material for a Pap test? It is as follows: soap and water for washing hands, a light source for cervical examination, a gynecological chair, a disinfected speculum and gloves, an Eyre spatula, a glass slide and a marking pen, a container with a stabilizing solution for liquid cytology, a fixative solution (96% alcohol), a container with warm water for lubricating and warming the vaginal mirrors, a 0.5% chlorine solution for disinfecting gloves and instruments, or another approved for this purpose. And, of course, the registration form itself.

For carrying out liquid cytology, you additionally need: a disposable cervix brush, a container with a stabilizing solution for liquid cytology, and a fixing solution.

At the same time, a smear for oncocytology cannot be taken: during menstruation, earlier than 48 hours after sexual contact or after using lubricants, vinegar or Lugol solution, tampons or spermicides, after vaginal examination or douching, and also during the treatment of genital infection.

Now, regarding the results of CC screening. In 2022, 771,282 women of the target group aged 30 to 70 years were examined during cytological screening (in 2021 - 757,454).

During cytological screening in 2022, 392 cases of cervical cancer were identified (319 in 2021). The detection rate increased from 0.42 to 0.51 per 1000 women examined

High detection of CC during screening is ensured in Aktobe, Almaty, Atyrau, East Kazakhstan, Kyzylorda, Pavlodar, North Kazakhstan, Turkestan regions and Shymkent city. The detection rate in these regions ranges from 0.55 to 1.59 per 1000 women examined. The best indicator is in Atyrau region - 1.59. Compared to 2021, there is an increase in detection in 10 regions, with the exception of Akmola, Aktobe, Zhambyl, Kostanay, Mangistau, North Kazakhstan regions and Shymkent city. The worst result in Astana is 0.15 per 1000 women examined [5].

Cytologically, cervical precancer was detected in 1.16% of those examined (2021 – 0.99%). The detection rate of precancer below 0.6% (the planned indicator for 2022, according to the Comprehensive Plan) was noted in Aktobe, Karaganda and Kostanay regions.

A high proportion of stage I CC (70% or more) was detected in 6 regions of the country (in 8 in 2021): Kostanay, Mangistau (94.7% - best result), North Kazakhstan, Turkestan regions, cities Almaty and Astana. Low levels of early detection of CC (below 50%) were not observed in any region.

Localized processes (stages I-II) were identified in 99.2% of all cases of detected cancer (96.5%). In the Akmola and Karaganda regions, cases of CC were identified not only in localized, but also in widespread stages of the process. A total of 3 cases of CC in stage III and no cases in stage IV were identified (11 and 0, respectively) [5].

BC ranks first in the structure of the frequency of malignant tumors of both sexes in the population with a share of 14.7% (2021 - 15.4%). This situation has been stable since 2004; in addition, BC ranks first and remains consistently in this position in the structure of female oncopathology. The incidence of BC in 2022 in the country as a whole increased to 26.5 per 100 thousand (2021 – 26.3). In the structure of cases, BC occupies the 1st ranking place in the vast majority of regions and cities of the country, except for three: Akmola, Kyzylorda and North Kazakhstan regions, where lung cancer takes the 1st ranking place [4].

Above the national average - 26.5 per 100 thousand of us. – incidence of BC in 10 regions of the country: Abay – 33.3, Akmola – 32.7 (2021 – 29.8), East Kazakhstan – 44.7 (39.9) – the highest level, West Kazakhstan – 31.2 (28.4), Karaganda – 40.2 (40.1), Kostanay – 37.5 (35.8), Pavlodar – 43.2 (47.4), North Kazakhstan – 34.7 (38.2) regions and Almaty city – 35.4 (34.5), Astana city – 31.5 (28.4). Below average indicators per 100 thousand of us. in Aktobe - 21.6 (24.3), Almaty - 21.9 (17.7), Atyrau - 22.8 (15.7), Zhambyl - 14.2 (15.1), Zhetysu - 22.8, Kyzylorda - 14.6 (14.4), Mangistau - 14.7 (17.3), Turkestan - 11.3 (11.7) regions and Shymkent city - 14.9 (21.9) [5].

BC ranks third in the structure of causes of death from malignant tumors in the population of both sexes for the thirteenth year in a row, amounting to 8.1% in 2022 (2021 – 8.7%). In the republic as a whole, mortality from BC decreased by 13.0%, from 6.2 to 5.4 per 100 thousand people.

The regions where mortality from BC is higher than the national average include: Abay - 10.1 per 100 thousand people (maximum level), East Kazakhstan - 8.0 (2021 - 8.5), Pavlodar - 7.1 (10.0), North Kazakhstan - 7.0 (11.4), Kostanay - 6.9 (7.5), Akmola - 6.5 (8.2), West Kazakhstan - 5.7 (6.9), Zhambyl - 5.5 (4.8) and Astana city – 6.3 (6.6), Almaty city – 6.6 (9.5). The indicators are significantly lower in Aktobe - 4.5 (3.5), Almaty - 4.5 (5.8), Zhetysu - 4.0, Atyrau - 3.7 (3.0), Kyzylorda - 4.4 (4.1), Turkestan - 3.6 (3.6), Mangystau regions - 2.7 (3.6) - the lowest level [5].

Mass screening to identify BC patients should mainly involve healthy women without any signs of the disease or symptoms. Screening not only helps to detect hidden forms of cancer that can be treated, but also has psychological value for women. As a result of screening, women are convinced that they do not have BC, and this is the most important potential success of such programs. While the ultimate goal of screening is to reduce BC mortality, its immediate goal is to detect cancer before clinical manifestation. However, BC is a heterogeneous disease, which can significantly affect the effectiveness of screening. Screening models for BC are usually based on the fact that the majority of detected tumors are invasive cancers in the early stage of progression. In addition, it must be taken into account that the detection of cancer (or its precursors) before clinical manifestation increases the risk of false positive diagnosis [7,8].

Mammography has a sensitivity of 95% and a specificity of 97%. These indicators decrease when examining women with denser mammary glands (young age, use of hormone therapy), with low quality mammography, and also with insufficient qualifications of the radiologist. Detection of high-grade invasive cancer by screening, when the tumor is not yet detected by clinical examination (palpation), means the possibility of reducing mortality from BC [9].

Preventive screening for early detection of BC in the Republic of Kazakhstan includes [10]:

1) mammography of both mammary glands in two projections - direct and oblique in the mammography room of the city, district polyclinic (mobile medical complex). All digital mammograms in the presence of a system for archiving and transferring medical images are copied to CDs and other electronic media and transferred to the server of the mammography room of the Cancer Center using specialized licensed software integrated between medical organizations; in case of impossibility of digital transmission - they are printed on X-ray film at a scale of 1:1 - 100% (1 patient - 1 set - 2 or 4 mammograms) with subsequent transfer to the mammography room of the Cancer Center;

2) interpretation of mammograms according to the BI-RADS classification (M0t, M0d, M1, M2, M3, M4, M5) by two or more independent radiologists of the same medical organization - double reading or different medical organizations: a radiologist of the mammography room city, district polyclinic (mobile medical complex) - the first reading, and the radiologist of the mammography room of the Cancer Center - the second reading;

3) in-depth diagnostics - targeted mammography, ultrasound examination (hereinafter - ultrasound) of the mammary glands, trepanobiopsy, including under ultrasound or stereotaxic control for histological examination, which is carried out in case of detection of pathological changes on mammograms (M0d) in the mammography room of the Cancer Center.

√ An average medical worker or a responsible person of the organization of outpatient care sends the patient for mammography to the district, city polyclinic.

√ The X-ray laboratory assistant of the mammography room of the city, district polyclinic (mobile medical complex) performs mammography, fills out a referral for double reading of mammograms and transmits the referral through information interaction.

Radiologist of the mammography office of the city, district polyclinic (mobile medical complex): fulfills the requirements for the safety and quality of mammographic examinations; evaluates the quality of the images provided and the correctness of the installation; performs repeated mammography in the M0t category (technical errors of mammography); determines the radiological density of the mammary glands on the ACR scale (A, B, C, D) indicating this parameter in the study protocol; conducts the first reading of mammograms with interpretation of the BI-RADS classification results. In the M0d category (undetermined or suspicious radiological changes requiring additional examination), the study protocol indicates the predominant pathology: education, asymmetry, violation of architectonics, microcalcifications; sends mammograms, electronic copies of mammograms through the archiving system and transfer of medical images to the workplace of the mammography office of the Cancer Center together with directions for

double reading of mammograms; directs low-dose computed tomographic images through the system of archiving and transferring medical images to the workplace of the computer tomography office of the Cancer Center together with copies of images recorded on CD-ROMs or other electronic media and directions for double reading.

◆ The radiologist of the mammography room of the Cancer Center: evaluates the quality of the provided images and the correctness of the styling. Viewing digital x-ray images transferred to the server or on digital media (CD, DVD) is carried out on a monitor for interpreting digital x-ray images with a resolution of at least 5 megapixels, which has a certified grayscale transmission in accordance with the DICOM standard; conducts a double (second) reading of mammograms with the interpretation of the results according to the BI-RADS classification, using, if necessary, archival images. Organizes the third reading according to indications. With double reading, an independent interpretation of the images is carried out (blinding method - the second radiologist does not know the results of the first reading); in the M0m category (technical errors in mammography), recommends repeat mammography; in the M0d category (uncertain or suspicious radiographic changes requiring additional examination), the study protocol indicates the predominant pathology: education; asymmetry, violation of architectonics, microcalcifications; recommends that the outpatient care organization, according to indications, invite the patient for in-depth diagnostics (targeted mammography, ultrasound of the mammary glands, trephine biopsy, including under ultrasound or stereotaxic control, followed by histological examination of the material); collects and archives all mammograms (films and electronic media) made as part of the examination. The shelf life of mammograms is at least 3 years after leaving the age subject to a screening study; the results of the double (second) reading are transferred to the outpatient care organizations through information exchange.

◆ Indications for in-depth diagnostics are the conclusions of double reading mammograms M0d (uncertain or suspicious X-ray changes requiring additional examination).

◆ In-depth diagnostics is carried out in two stages. At the first stage, ultrasound is performed, according to indications, targeted mammography, possibly with an increase (with asymmetry, violation of architectonics and the presence of microcalcifications). When visualizing a suspicious pathology (M4 and M5), the second stage is performed - trepanbiopsy, including under ultrasound control and stereotaxic control for histological examination.

◆ Histological examination is carried out in the laboratory of pathomorphology or pathological bureau. Morphological interpretation of the biopsy is carried out in accordance with the recommendations of the World Health Organization.

◆ Physician or responsible person of the outpatient care organization:

- 1) upon receipt of a mammography result according to the BI-RADS classification:
 - in case of M0t (technical errors in mammography) - sends the patient for a second X-ray examination to the mammography room of the city, district polyclinic (mobile medical complex);
 - with M0d (undefined or suspicious X-ray changes requiring additional examination) - sends the patient for in-depth diagnostics to the mammography room of the Cancer Center;
 - with M1 (no changes detected) - recommends that the patient undergo a follow-up mammography examination after 2 years. With radiological density of the mammary glands, C and D are sent for ultrasound of the mammary glands to exclude a false-negative result of mammography;
 - with M2 (benign changes), refer the patient for a consultation with an oncologist (mammologist) of the clinical diagnostic department, followed by a screening mammography examination after 2 years;
 - with M3 (probable benign changes) - sends the patient for short-term dynamic radiation observation to the local doctor with the recommendation of control mammography or ultrasound in 6 months;

- with M4 (signs that cause suspicion of malignancy), M5 (practically reliable signs of malignancy) and if it is technically impossible to perform a trepanbiopsy or a biopsy is refused, a referral to an oncologist (mammologist) of the clinical diagnostic department for dynamic observation and decision on the verification of the identified pathology;

2) upon receipt of the result of a histological examination:

- benign education - refers the patient to an oncologist (mammologist) of the clinical diagnostic department for dynamic monitoring, followed by a screening mammography examination after 2 years;

- formation with an indeterminate malignant potential or carcinoma in situ - refers the patient to the Cancer Center for consultation and treatment, followed by dynamic observation by an oncologist (mammologist) of the clinical diagnostic department at the place of her attachment;

- malignant neoplasm - refers the patient to the Cancer Center for treatment and follow-up;

3) communicates the results of the screening examination to the patient in any available way (by telephone, in writing, through electronic means of communication);

4) enters the results of double reading, in-depth diagnostics, histological examination, recommendations of the radiologist of the Cancer Center mammography room into the information system.

Establishing the size of the primary tumor is especially important in screening. Tumor size is an important criterion for evaluating the quality of screening and determining the ability of X-ray mammography to detect non-palpable tumors. Therefore, it is extremely important that pathologists measure tumor diameter as accurately as possible. The smaller the size of the primary tumor, the greater the likelihood of error in determining its size.

Let's analyze the results of BC screening. Mammography screening identified 1,570 cases of BC in 2022 (1,402 in 2021). The cancer detection rate increased from 1.78 to 1.94 per 1000 examined. The best result is in the Karaganda region – 2.63 per 1000 women examined. Low detection rate per 1000 examined, compared to the republican average, in Atyrau (1.72), Zhambyl (0.58), Kyzylorda (1.68), Mangistau (0.42 - worst result), Turkestan (1.22) regions and cities Astana (1.5) and Shymkent (1.58). Compared to 2021, there was an increase in the detection of BC in 9 regions, with the exception of Aktobe (decrease from 2.87 to 2.19 per 1000 women examined), Karaganda (from 2.73 to 2.63), Mangistau (from 1.10 to 0.42), North Kazakhstan (from 3.27 to 2.31), Turkestan (from 1.36 to 1.22) regions and cities Astana (from 1.54 to 1.50), Almaty (from 2.24 to 2.18) and Shymkent (from 2.35 to 1.58) [5].

In 2022, the proportion of patients identified during screening studies with early stages of BC (stage 0-I) was 50.2% during screening (in 2021 - 47.9%). A high proportion of stages 0-I BC (over 50%) was recorded in 8 regions (in 8 in 2021): Akmola, West Kazakhstan, Karaganda (70.8% - best result), Pavlodar, North Kazakhstan, Turkestan regions, cities Astana and Shymkent. Low levels of early detection of BC (below 40%) were noted in Aktobe (19.3% - worst result), Zhambyl (34.8%), Kostanay (39.5%), Mangistau (27.3%) regions and Almaty city (37.3%). Localized cancer (0-I and II stages) amounted to 96.2% (2021 - 95.5%), while not a single case was detected in stages III-IV in Atyrau, West Kazakhstan, Zhambyl, Kyzylorda, Mangistau, Pavlodar regions, cities Astana and Shymkent. A total of 46 cases of breast cancer in stage III and 14 in stage IV were identified (52 and 11, respectively) [5].

Epidemiological indicators of CRC in the form of colon cancer and colorectal cancer are considered separately for objective reasons.

Colon cancer with a specific gravity of 5.53% (2021 - 5.2%) in the structure of oncopathology of both sexes of the population has risen to 5th place, in men it remains in 6th place - 5.8% (5.5 %), for women - in the 5th - 5.3% (4.91%) The incidence rate of cancer of this localization in the country in the reporting year increased from 8.8 to 9.95 per 100 thousand

population.

The incidence of colon cancer in 10 regions is higher than the national average - 9.95 per 100 thousand population: Kostanay - 20.7 (2021 - 15.9), Pavlodar - 18.8 (15.3), North Kazakhstan - 18, 0 (12.7), East Kazakhstan - 16.9 (13.4), Karaganda - 15.4 (15.0), Akmola - 14.6 (10.2), West Kazakhstan - 11.0 (10.1), Abay - 10.0 (9.0) regions and cities Almaty – 12.8 (12.1) and Astana – 10.5 (9.0). As in 2021, colon cancer was detected much less frequently in Turkestan - 3.1 per 100 thousand population (2.7), Kyzylorda - 4.1 (4.6), Zhambyl - 5.5 (5.8), Almaty - 6.3 (4.7), Zhetysu - 6.4, Mangistau - 6.8 (4.9) regions and Shymkent city - 5.0 (4.0) [5].

Rectal cancer in the structure of malignant neoplasms of both sexes retains 7th place in rank with a specific gravity of 4.9% (2021 - 4.92%), but in men it dropped from 4th to 5th place - 6.1%, for women – from 9th to 10th – 4.0%. The incidence rate per 100 thousand population increased from 8.4 to 8.8.

A high incidence rate was recorded in Kostanay - 17.8 per 100 thousand population (2021 - 16.2), East Kazakhstan - 17.7 (13.9), North Kazakhstan - 15.6 (15.1), Pavlodar – 14.9 (18.1), Karaganda – 13.3 (11.7), Abay – 12.9, West Kazakhstan – 12.9 (9.8), Akmola – 10.3 (13.1) regions and Astana city – 10.3 (9.0). Traditionally, a low incidence of rectal cancer is observed in Mangistau - 3.1 (2.8), Turkestan - 3.3 per 100 thousand population (2.7), Zhambyl - 3.7 (5.1), Kyzylorda - 4, 1 (5.3), Almaty – 5.3 (5.6) regions and in Shymkent city – 5.5 (5.0) [5].

Rectal cancer in the structure of causes of death from malignant neoplasms of the population of both sexes in 2022 remained in 5th place with a share of 5.41% (2021 – 5.41%). In the republic as a whole, the mortality rate from this form of cancer was 3.6 per 100 thousand population (3.87).

The mortality rate per 100 thousand population was higher than the national average in East Kazakhstan - 7.8 (2021 - 8.6) - the maximum level, Pavlodar - 7.5 (7.6), Abay - 5.9, North Kazakhstan - 5.8 (4.3), Kostanay - 4.9 (4.9), West Kazakhstan - 4.8 (4.2), Karaganda - 3.8 (5.2) regions. Below the national average - 3.8 per 100 thousand population, mortality in Aktobe - 3.2 (4.1), Almaty - 2.6 (2.6), Atyrau - 2.5 (3.4), Zhetysu - 2, 6, Zhambyl - 3.3 (2.7), Turkestan - 2.1 (1.6), Mangistau - 1.9 (1.2), Kyzylorda regions - 1.8 (2.1) - the lowest figure , and cities Almaty – 3.7 (4.3), Shymkent – 2.6 (2.1).

Colon cancer in the structure of causes of death from malignant neoplasms of the population of both sexes in 2022, as in 2021, ranks 6th, with a share of 5.2% (2021 – 5.0%). At the same time, the mortality rate in the country decreased by 5.6%, from 3.6 to 3.4 per 100 thousand population.

Mortality rates in 10 regions are higher than the national average: East Kazakhstan - 7.1 per 100 thousand population (2021 - 5.1) - maximum level, Pavlodar - 5.6 (6.0), Kostanay - 5.3 (5.6), Akmola – 5.2 (3.8), Abay – 5.1, Karaganda – 5.1 (5.6), West Kazakhstan – 4.8 (4.4), North Kazakhstan – 4.8 (5.0) regions and cities Astana – 3.6 (2.7), Almaty – 4.5 (5.3). Low mortality rates from colon cancer were noted in Kyzylorda - 1.2 per 100 thousand population (2.7) - the best result, Turkestan - 1.3 (1.7), Mangistau - 1.6 (2.6), Aktobe – 2.0 (2.5), Zhetysu – 2.4, Zhambyl – 2.5 (3.7), Atyrau – 2.5 (1.8), Almaty – 2.6 (1.8) regions and cities Astana – (2.7), Shymkent – (2.4).

For colon cancer (94.0%) - 100% verification level was achieved in 3 regions (Abay, Almaty and Turkestan regions), high rates in the Astana city (98.5%), Shymkent city (98.0%), Zhambyl (98.4%), Atyrau (98.2%) regions, low – in Akmola region (86.7%), Almaty city (84.3%), in the Kyzylorda region (61.8%) – the worst result since 2017.

For rectal cancer (97.4%) - in 6 regions there is a 100% verification level, the worst level is still in the Kyzylorda region - 85.3%, lower than the republican average in the Akmola region - 92.6%, Aktobe region - 96 .8%, Mangystau region - 87.0%, Pavlodar region - 95.3%, Almaty city - 93.2% [5].

The frequency of diagnosis of stage I-II rectal cancer, as a visually accessible localization

(68.9% - national average) in the regions, was: in Akmola - 34.6% - the worst result, as in 2021, in the country (2021 - 44.1%), Mangistau - 47.8%, Abay - 53.9%, West Kazakhstan - 59.1%, Almaty - 66.2%, Zhetysu - 68.6%, Karaganda - 65, 7% regions and Shymkent city - 62.9%.

For colon cancer (52.4%), early diagnosis rates are higher in Pavlodar (65.9% - best result), Abay, Aktobe, Atyrau, East Kazakhstan, Zhambyl, Zhetysu, Karaganda, Kostanay, Pavlodar, North Kazakhstan, Turkestan regions and Shymkent. The lowest figure (23.5%) is in the Kyzylorda region.

For colon cancer (17.3%), the rates of neglect at stage IV are higher - in Akmola - 31.0% - the worst result (2021 - 20.3%), Zhetysu - 27.3%, Abay - 23.1% , Turkestan - 22.2% (29.1%), Karaganda - 28.1% (28.6%), West Kazakhstan - 18.8% (8.2%), Mangistau - 17.6% (19 .4%) regions and cities Astana - 18.0% (22.9%), Shymkent - 20.0% (22.7%). The lowest level of neglect is 2.9% in the Kyzylorda region (7.9%).

The proportion of stage IV in rectal cancer (13.1%) is higher in Akmola - 29.6% - the worst result (2021 - 19.4%), Abay - 19.7%, Kyzylorda - 17.6% (9.1%), Karaganda - 16.9% (28.4%), Almaty - 15.6% (17.0%), Kostanay - 14.8% (11.1%), Zhambyl - 13.3 % (13.6%) regions and Shymkent city - 14.5% (12.5%). The lowest level of neglect - 6.0% - is in the Atyrau region (12.5%).

Late diagnosis of rectal cancer as a visually accessible localization (stages III-IV) in 2022 amounted to 31.1% (in 2021 - 33.5%).

For rectal cancer, the level of neglect is higher than the national average - 31.1%, the indicators in Akmola - 65.4% (2021 - 55.9%) - the worst result in the country, Mangistau - 52.2% (38.1%), Abay – 46.1% (30.6%), West Kazakhstan – 40.9% (25.4%), Karaganda – 34.3% (46.5%), Almaty – 33.8% (35.7 %), Zhetysu - 31.4% (34.1%) regions and Shymkent city - 37.1% (42.9%). The lowest neglect is in the Atyrau region - 12.0% (17.5%).

In the country as a whole in 2022, the five-year survival rate of patients with CRC registered in 2018 decreased to 40.4% (2021 - 52.9% for those registered in 2017); there is a significant dispersion of indicators by region, from maximum – 56.1% (47.5%) in the Kyzylorda region, to minimum – 24.3% (51.5%) in the Aktobe region [5].

Screening of CRC screening is the systematic use of screening studies in an asymptomatic population. The purpose of screening is to identify people with abnormalities suggestive of CRC. These persons in the future need additional examination to clarify the diagnosis. Opportunistic screening is the non-systematic use of screening tests in routine medical practice. A screening program is much more challenging than an early detection program. At the same time, the success of the screening program is largely determined by the awareness of the population and medical workers about the possibilities of early diagnosis of CRC. The feasibility of a screening program is determined by several factors that relate to the disease being screened, the screening test, the characteristics of the population, and the characteristics of the healthcare system.

The first factor is that the disease must be well understood, common enough in the target population to justify screening, have a recognizable early stage; treatment of the disease at an early stage should be more effective than at a later stage.

The second is that the test should be characterized by sufficient sensitivity, i.e. the ability to detect cancer among people with the disease; sufficient specificity - the probability that among people who do not have a disease, the test result will be negative; have a high positive predictive value (positive predictive value) or, in other words, the likelihood that people with a positive test result have the disease; have a high predictive value of a negative result (negative predictive value), i.e. the likelihood that people with a negative test result do not have the disease; security; low cost; and acceptability - the likelihood that people for whom this test is intended will agree to the examination (which to some extent depends on the awareness of the population about the possibilities and importance of early diagnosis).

The third factor is that the healthcare system should be ready for maximum screening test coverage of the target group, have the resources to confirm the diagnosis, appropriate treatment

and follow-up of people with positive test results, and regularly conduct screening tests at regular intervals. At the same time, the benefits of screening must outweigh the potential physical and psychological harm and justify the financial costs of its implementation [11].

The factors most significant for the development of CRC are:

- the presence of chronic inflammatory bowel diseases, adenomatous polyps, cancer of other localization, etc.;
- family history (presence of one or two first-degree relatives with CRC or familial diffuse intestinal polyposis);
- the age of men and women over 50 years old, taking into account the fact that more than 90% of patients with colorectal cancer are people of this age (medium risk).

Age, regardless of gender, is an important risk factor for CRC. After the age of 50, the incidence of CRC increases from 8 to 160 per 100,000 population. Thus, people who have reached the age of 50, even in the absence of symptoms, constitute a moderate risk group for CRC.

The second category of increased risk of CRC (20%) is made up of persons with a genetic and family predisposition, suffering from chronic inflammatory bowel diseases, diffuse familial polyposis.

The high-risk CRC group is determined by the so-called Amsterdam criteria (the presence of malignant tumors in two generations, the presence of cancer in a first-line relative under the age of 50 years), in this case, CRC screening should be carried out after the age of 30 years [12].

The degree of individual risk of developing CRC is determined before screening to select the scope of studies and the frequency of their conduct.

The interval for oncological colorectal screening is 1 time in 2 years, target group: men and women aged 50-70 years, with the exception of persons registered at the dispensary for CRC and colon polyposis. At the same time, when forming the target group, one should take into account the absence of severe concomitant diseases, such as the presence of a common malignant neoplasm, cerebrovascular diseases in the stage of decompensation, chronic obstructive pulmonary disease with respiratory failure, cirrhosis of the liver, myocardial infarction with congestive heart failure, diabetes mellitus with vascular complications. and others, which are highly likely to lead to death in the next 10 years.

The first step in screening for CRC is the fecal occult blood test (FOBT). Traditionally, such methods include a benzidine test for occult blood in the feces. This is a biochemical method based on the assessment of pseudoperoxidase activity of hemoglobin. There is ample evidence that invitation to guaiac FOBT screening (gFOBT) reduces CRC mortality by approximately 15% in age-matched average-risk populations.

To ensure the effectiveness of screening with gFOBT, the interval for screening under the national screening program should not exceed two years. To date, there is an immunochemical FOBT method - iFOBT, which is superior in efficiency to gFOBT in terms of the probability of detecting adenoma and cancer. iFOBT has improved analysis performance compared to gFOBT.

Immunochemical (immunochromatographic) examination of feces for occult blood - iFOBT or hemocult test is carried out for all men and women of the target group using an express method, which allows you to get a result within 3-5 minutes, without the participation of a medical worker. However, the evaluation of the test is carried out only by a medical worker in the PHC preventive department.

With a positive analysis of feces for occult blood, the second stage of colorectal screening is performed, which consists in endoscopic examination of the colon - total colonoscopy [6]. At the same time, in this case, this medical manipulation is of a therapeutic and diagnostic nature, since it allows one-stage removal of adenomatous polyps, which, according to various authors, occur in every third subject after 50 years of age. At the same time, women have 20% fewer polyps than men, but they have more right-sided lesions, which are more difficult to detect using fecal

blood tests, because they are less traumatic [13,14].

What results were obtained from screening for CRC? In 2022, 937,859 men and women of the target group aged 50 to 70 years were examined during colorectal screening (in 2021 - 920,640) [5].

Colorectal screening revealed 325 cases of colorectal cancer in the reporting year, which is 114 cases more than in the previous year (211 cases). The detection rate increased from 0.23 to 0.35 per 1000 patients examined. Low detection of colorectal cancer was noted in Zhambyl, Karaganda, Kostanay, Kyzylorda, Mangistau, Turkestan - the worst result, East Kazakhstan regions, Astana city - from 0.07 to 0.30 per 1000 examined. The best result is in the North Kazakhstan region – 0.81 per 1000 examined. Compared to 2021, there was a decrease in the detection of colorectal cancer per 1000 people examined during screening in Karaganda (from 0.22 to 0.21), Kostanay (from 0.29 to 0.28), Mangistau (from 0.20 to 0.12) regions and Astana city (from 0.20 to 0.19).

Colon precancer (adenoma detection rate) was detected in 27.5% of patients who underwent colonoscopy (2021 – 22.8%). The detection rate of precancer in Akmola, Aktobe, Almaty (8.5% is the worst result), West Kazakhstan, Zhambyl, Kostanay, Kyzylorda, Mangistau, Pavlodar, North Kazakhstan, Turkestan regions and cities is lower than the national average Astana and Shymkent. The best result is 36.2% in Almaty city. It should be noted that the planned indicator for the detection of precancer of the colon and rectum in the country for 2022, according to the Comprehensive Plan, was 23.0% and was achieved.

In 2022, the proportion of patients identified during screening studies with early stages of malignant neoplasms (stages 0-I) was 26.2% during colorectal screening (in 2021 - 27.5%).

High early detection of colorectal cancer (above 30%) was noted in Akmola, West Kazakhstan, Karaganda, Kostanay, Kyzylorda, Turkestan regions and Astana city (57.1% - the best result). Not a single case of early cancer has been identified in the Mangistau region. Cases of cancer in stages III-IV detected during screening were registered in Akmola, Aktobe, Almaty, West Kazakhstan, Zhambyl, Karaganda, Kostanay, Mangistau regions and Almaty city. A total of 21 cases of colorectal cancer in stage III and 3 in stage IV were identified (in 2021 - 18 and 5, respectively) [5].

The complex analysis carried out allows us to conclude that satisfactory results of cancer screening can be achieved only with its proper organization, high quality of implementation, active participation in population screening, the use of highly sensitive tests and instrumental methods of preventive examination, as well as subsequent accurate diagnosis of identified tumors and timely treatment. High-quality screening leads to early diagnosis of pedological diseases and malignant pathology in the early stages, which, in turn, increases the effectiveness of treatment and improves the prognosis of the disease. Target groups that, for one reason or another, do not participate in screening should be informed that there are no other methods other than screening that would reduce mortality from malignant neoplasms. Incidence and mortality rates from cervical cancer, breast cancer and colorectal cancer clearly reflect the epidemiological situation with this pathology in the regions of our country.

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Literature

PROMOTION OF HUMANISM IDEAS IN THE CREATIVE WORK OF NIZAMI GANDJAVI

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Abstract. Nizami Gandjavi, one of the brightest figures of Azerbaijani and Eastern culture, is one of the geniuses who had an unparalleled impact on the development of world literary and philosophical thought. The great poet, thinker and humanist artist, who was formed in the city of Ganja in the 12th century, had a strong impact not only on the literary and social environment of his time, but also on the literary and social environment of subsequent centuries. His rich heritage is considered one of the beacons of Azerbaijani literature and occupies a special place in the formation of our national and cultural identity.

Nizami's creativity acts not only as an example of artistic creativity in the history of Azerbaijani cultural thought, but also as a deep spiritual and philosophical source. In his works, concepts such as man, society, justice, freedom, morality, spirituality are widely covered. The poet accepts the spiritual perfection and moral exaltation of man as the main criterion, and values him as a supreme being. The ideas put forward by Nizami in this direction have had a strong influence on the formation of Azerbaijani enlightenment, the national awakening movement, and modern humanist thought.

The poet also played an exceptional role in the worldwide promotion of Azerbaijani culture. Nizami's works have spread throughout the widest geographical space of the East, have been translated into Persian, Turkish, Arabic, Urdu, Armenian, Georgian, Russian, and European languages, and many artists have created poems, operas, paintings, and musical pieces based on his motifs. The poetic direction known as the "Nizami tradition" in world literature has given a serious impetus to the rise of the international prestige of Azerbaijani culture.

The article extensively examines the artistic presentation of the images of ordinary people, hard workers, and heroes of labor in Nizami Ganjavi's work, and how humanist ideas are propagated through these images. At the same time, the socio-philosophical burden of his works, the relevance of humanist ideals for the modern era are also analyzed with a scientific approach.

Keywords: *Nizami Ganjavi, Khamsa, poetry, artistic creativity, humanist ideas, philanthropy, love of labor, simple hardworking people, etc.*

Nizami Ganjavi brought high artistic and aesthetic criteria to Azerbaijani poetry, enriched poetry in terms of both content and form. For the first time in classical Eastern literature, he raised the epic-lyric poem genre to a perfect level, and laid the foundation for a new poetic school with the "Khamsa" series. Nizami's language, poetic imagery systems, world of images, and philosophical depth had a strong influence on the subsequent development of Azerbaijani literature, and poets and thinkers benefited from his artistry. In particular, it is possible to clearly observe the traces of Nizami's poetics in the work of artists such as Fuzuli, Vagif, Vidadi, Zakir, Sabir.

Nizami Ganjavi, one of the greatest figures in the history of Azerbaijani literary and philosophical thought, is one of the leading representatives of the Eastern Renaissance. His rich creativity, especially "Khamsa", is imbued with a spirit of deep respect for man, his spiritual values, labor, justice and equality. Nizami's humanism takes its roots from the life of the people, the

difficulties of simple working people, their dignity and humanistic worldview. In the poet's poetry, man - regardless of the class he belongs to - is valued as a supreme being.

Nizami's humanism is not just a literary motif, but a whole philosophical system. The basis of this system is the moral value and dignity of man, the sanctity of labor, the principles of justice and equality, intransigence against oppression and the idea of serving the people.

For Nizami, the value of man does not come from his nature, birth, but from his labor, morality and sincere role in society.

Azerbaijani folk art, the socio-political environment of the Atabey state, Islamic culture, humanist ideas of antiquity and Iranian-Turanian mythology played an important role in the formation of the poet's humanism.

Nizami's first poem "The Treasury of Secrets" is a didactic work rich in humanist ideas. Here the poet especially emphasizes labor, lawful labor, honesty, justice and the difficult life of simple peasants.

The images of ordinary people found in the work strengthen the poet's ideal of social justice.

In the work "The Story of the Prophet Solomon and the Old Farmer", the poet brings to mind the moral perfection of a noble hardworking man. Here, the old man who worked tirelessly day and night, was told by the prophet Solomon:

...Where is your waist in your hand? With a little digging, the desert,
There is no water, no ditch. Do not waste the barley.

Think: how much grain have we sown on the watery soil,
What have we seen from this sowing except your labor?

In these thirsty deserts that turn grain to ashes,
What can you gain even if you burn your soul?

The authority replied: - Come, do not be offended by my words,
I do not expect anything from the bounty of the earth, from the water.

I do not know whether the field has water or not?
Sowing is my job, and growing is God's

Look, this is my water - the sweat that drips from my forehead,
My ling, my waist, my ashes - these nails, these hands.

I do not suffer from a kingdom or a property like you,
This plantation will be enough for me for the rest of my life. (1, p.106-107)

Here it is impossible not to see the image of a person exalted by his own labor. The peasant who stands before the Shah and takes refuge in his lawful labor and the glory that this labor gives, becomes even more exalted before our eyes.

Nizami Ganjavi wrote the image of a simple hard worker with the same love in "The Story of the Old Bricklayer". He presents the bricklayer not only as a professional, but also as a support for the country, a symbol of labor. One day, while the bricklayer was cutting bricks as usual, he suddenly came across a handsome young man. He was worried that the old man earned his bread with a thousand and one hard labors and told him to give up this hard work.

What kind of work is this, do you see? What kind of humiliation is this, old man,
Only slaves, slaves endure such humiliation!

Get up, don't throw ashes on the ground so much,
Who will spare you a loaf of bread?!

...The old man said, "Oh son, don't be arrogant!
Mind your own business, don't teach me wisdom!
Although it is painful, I learned this art
So that no one's gratitude would remain on my neck.

I do not accumulate treasures to be ridiculed,
I live by the labor of my hands, oh son!

I earn my bread, don't take it from me, my father,
I will not exchange my one-day halal for a thousand haram" (1, p.117)

Hearing these wise words of the old man, the young man is ashamed of his own words and sheds tears. In the poet's description, the moral perfection of this hardworking man is preferred over many magnificent palaces.

In N. Ganjavi's poem "Khosrov and Shirin", the moral purity of ordinary people stands out more prominently. In this work, the humanistic attitude of ordinary people, Shirin's more comfortable being among the people than in the palace environment, and the characters such as Arif, shepherd, and subject who rise from among the people strengthen Nizami's vision of social justice. While Shirin is among the shepherds, Nizami praises the sincerity, honesty, and dedication to labor of ordinary people in a highly poetic language.

In almost all of N. Ganjavi's works, humanistic thought plays a leading role. In his poem "Leyli and Majnun", the description of the peasants and the poor in the desert is an artistic expression of the poet's respect for ordinary hardworking people. Although the general content of the poem is love, Nizami here shows his sympathy for the poor class with the images of a well-digger and a countryman. They are spiritually pure, morally high, and loyal people.

In the poet's work "Iskendername", we also witness humanist ideas against the backdrop of ruler-people relations. This work is the most complete embodiment of humanist ideas. Nizami repeatedly advises Iskender not to hurt the people, but to respect the hardworking man. Because the basis of rule is justice.

The dialogue between the shepherd and Iskender in the work is the pinnacle of humanist thought. The shepherd says that I have little, but I have earned it through my lawful labor. In this dialogue, Nizami prefers the simple hardworking man to the ruler.

According to Nizami, the perfection of a person is measured by his labor. Labor elevates a person, a hardworking person is spiritually purer, and bread earned through hard work is sacred. This idea stands at the center of all his poems.

The call for social equality is strong in Nizami's work. He notes that the ruler should be a servant of the people, the rich should not oppress the poor, and society should be built on moral justice. The poet evaluates injustice as a "disease of society."

For Nizami, hardworking people among the people are sincere, honest, and humble. The poet often criticizes the hypocrisy of courtiers.

The poet believed that the country's progress rests on ordinary people. According to Nizami, every person has a seed of goodness in their hearts and everyone is responsible for society.

In terms of worldview, Nizami was a person who was as religious as he was, no matter how modern his thinking was. In his teachings on religion and belief, people should not be stratified based on whether they are rich or poor, but should be considered superior or inferior based on their actions.

We have equal wealth for everyone,
We will divide all our goods equally.

We have no excess over anyone,
No one laughs when someone cries...
If we see someone angry or bitter,
We will help them with advice.

No one is deceived by gold and silver,
They are worthless in our world.

We do not know stinginess in this world,
We do not buy anything by force, even a grain of barley (2, p.13).

The ideas of humanism have always occupied an important place in the cultural and historical development of mankind and have been one of the main ideological pillars ensuring the spiritual progress of society. Nizami Ganjavi, who is considered one of the most prominent representatives of the Eastern Renaissance, expressed humanistic thought in his work in a unique way for his time, making the moral value of man and his assessment as a supreme being, regardless of his social status, the main principle. These ideas are not limited to the socio-cultural realities of the 12th century, but are also of particular relevance against the background of the global challenges of the modern era.

The human factor is at the center of Nizami's humanism. The poet considers the spiritual perfection of man, fair thinking, kindness and justice to be the highest moral criteria. Today, in an era when world social relations are becoming more complex, social inequalities are deepening, and conflicts are increasing, Nizami's ideas such as the protection of human dignity, the exaltation of working people and the promotion of a just social model come to the fore. In the modern world, the ideas that Nizami's legacy has eternally preserved play a serious moral support role in the struggle for human rights, gender equality, social justice and moral and legal values (3, p.52).

In the era of globalization, when the flow of information is accelerating and material values are overshadowing spiritual values, Nizami's humanist philosophy calls for bringing man back to the center of values. In his works, human spiritual perfection, moral integrity and purity of thought are shown as the main conditions for the happiness of society. This approach is especially important in the 21st century, because against the background of psychological, social and moral pressures created by modern life, man's need for moral support and a high moral example is even greater. The principles set forth by Nizami - justice, mercy, respect for labor, moral purity - play a universal guiding role for modern man both at the level of personal life and public relations.

Another important aspect of Nizami's humanism for the modern era is his ideas on social justice and the model of governance. In his works such as "The Treasury of Secrets" and "Iskandername", the poet, who explains the relationship between the ruler and the people on the basis of moral responsibility, conscience and justice, speaks from a position that is in harmony with the principles of modern state administration. Today, the strengthening of democratic institutions, transparent governance, fair social policy and the philosophy of serving citizens are a continuation of the ideas that Nizami promoted centuries ago. His assessment of human well-being as the main task of the state is also a relevant concept for modern societies.

One of the important factors that increases the importance of Nizami's humanism for our time is his thoughts on multiculturalism and tolerance. The poet does not distinguish people based on their language, religion or social affiliation, but accepts all people as bearers of the same moral value. This approach is of particular importance in a global environment where ethnic and cultural diversity is rapidly increasing and the necessity of interreligious and intercultural dialogue is coming to the fore. Nizami's philosophy of tolerance creates an important ideological basis for the development of harmony, cultural mutual understanding and peace in modern societies (4, p.75).

Nizami Ganjavi's humanist ideas are not only of historical or aesthetic importance in the modern era, but also form a system of human values that are relevant in moral, social, political and cultural aspects. His legacy still has a profound impact today in terms of protecting the spiritual elevation of man, creating a just society, understanding cultural diversity and strengthening social solidarity. Nizami's humanism remains an inexhaustible source of inspiration for modern man and a spiritual guide for society, and will also seriously influence the thinking of future generations.

Nizami Ganjavi's creativity is based on the glorification of human values, as one of the highest peaks not only of Azerbaijani literature, but also of Eastern culture. At the center of his poetic world is a person - especially a simple hard worker. For the poet, a person who works hard, working to earn a halal livelihood, is the true support, spiritual pillar and true owner of society. Nizami evaluates hard workers as carriers of high spiritual qualities and shows in their example the purest, most pure face of humanity. From this perspective, the artistic representation of ordinary people in his work is not only a depiction of social classes, but also one of the main directions of the philosophy of humanism.

In Nizami's works, when describing the lives of ordinary people, their hard work, daily struggle, but despite this, their spiritual elevation are especially emphasized. The poet treats labor and hard work with great respect, determining the value of a person not by his social position, but by his labor, morality and sense of loyalty. The images of the blacksmith, shepherd, woodcutter, poor traveler, and peasant found in works such as "The Treasury of Secrets", "Khosrov and Shirin", "Leyli and Majnun", and "Iskandername" are the artistic embodiment of this humanistic thought. Through these images, Nizami conveys to the reader that values such as hard work, simplicity, humility, honesty, and humanity are extremely important in society (5, p.38).

When considering the philosophical essence of the works, it becomes clear that the poet's humanism is not limited to the glorification of individual moral qualities. He also considers justice, equality and the protection of human rights to be important in socio-political relations. In particular, the dialogue between the ruler and the simple shepherd in "Iskandername" is one of the most effective artistic expressions of humanist ideas. In this dialogue, the shepherd - as a symbol of the people, a hard worker - is presented as morally superior to the ruler. This is the most vivid expression of Nizami's ideal of social justice, the moral exaltation of simple people.

For Nizami Ganjavi, humanism is not only a theoretical idea, but also a system of practical moral principles necessary for the development of society. It demands that rulers be just, care for the poor and hard workers, and the establishment of justice and equality in society. The poet presents these ideas in his works in unity from an artistic and philosophical point of view, emphasizing the importance of humanist values penetrating all spheres of human life. In his opinion, the progress of society is possible precisely with respect for the labor of simple people and with governance based on the principles of justice.

One of the most important aspects of the role of Nizami Ganjavi's heritage in the history of Azerbaijani cultural thought is its strengthening of national self-awareness. In his works, the poet devoted a special place to Azerbaijani culture, the history of Ganja, local customs and traditions, and the way of life of the people, raising the spiritual world of the people to the level of high ideals. In this sense, Nizami is a leading figure in the formation of not only literature, but also national cultural thought (6, p.25).

Within the framework of this topic, it becomes clear that love for ordinary people in Nizami's work is not just an expression of an emotional attitude, but also the basis of a socio-philosophical worldview. For him, people of hard work are the embodiment of spiritual perfection, moral exaltation, and the health of society. Nizami raises them to the highest artistic pedestal and presents them as the main driving force of society. This was a very innovative and progressive approach for the poet's time.

Thus, Nizami Ganjavi is a genius who played a magnificent role in the evolution of Azerbaijani literature and culture, representing the pinnacle of our national-spiritual heritage. His work has shaped the literary environment of Azerbaijan for centuries, strengthened the artistic and philosophical foundations of our national identity, and remains relevant today as an inexhaustible source of ideas.

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Journalism

Роль и влияние медиа в освещении этнических конфликтов на постсоветском пространстве: казахстанский и международный опыт

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Аннотация. Данная статья является анализом роли медиа в освещении различных этнических конфликтов на территории бывшего Советского Союза с наиболее большим акцентом на казахстанский опыт. Рассматриваются все особенности диктовки и подачи информации, а также влияние журналистов, журналистики и медиа на восприятие обществом этнических конфликтов и вызовы цифровой эпохи в рассмотрении этнических конфликтов. Данная статья берет особенный акцент на опыт Казахстана, так как рассматриваются теоретические подходы к изучению воздействия медиа в ситуациях межэтнических конфликтов, напряженности, а также различные практические модели освещения этнических конфликтов в медиа, которые являются традиционными или новыми. На основе сравнения ситуации в Казахстане и опыта других стран, в том числе постсоветских государств, в статье показывается, каким образом структуризация, выбор тем, интерпретация этнических конфликтов, а также лексика, источники информации — как это все влияет на общественную оценку этнических конфликтов, а также может способствовать обострению либо снижению градуса конфронтации и конфликтов в обществе. Обозначаются риски использования языка враждебного в журналистике, а также стереотипных клише в освещении этнических конфликтов. Обсуждается миротворческий, гуманистический потенциал журналистики, а также конфликтологический потенциал медиа, и формируются предложения для совершенствования гуманистической роли журналистов, а также улучшения профессиональных стандартов в этнической тематике журналистики Казахстана и других стран.

Ключевые слова: медиа, этнические конфликты, постсоветское пространство, Казахстан, медиадискурс, язык вражды, миротворческая журналистика.

1. Введение

Этнические конфликты продолжают оставаться одной из наиболее сложных и чувствительных форм социальной напряженности в странах постсоветского пространства, поскольку они затрагивают фундаментальные вопросы коллективной идентичности, исторической памяти, доступа к экономическим и символическим ресурсам. Многонациональный состав населения, сформировавшийся в результате длительных исторических процессов, включая имперский и советский периоды, в сочетании с социально экономическими диспропорциями между регионами создает условия, при которых локальные инциденты могут быстро приобретать этническую интерпретацию и выходить за рамки конкретного сообщества. В подобных условиях средства массовой информации

становятся ключевым посредником между событиями и общественным сознанием, поскольку именно через медиапространство формируются доминирующие интерпретации конфликтов.

Освещение этнических конфликтов в медиа носит противоречивый характер. С одной стороны, профессиональная журналистика способна выполнять стабилизирующую функцию, предоставляя проверенную информацию, снижая уровень социальной тревожности и предлагая контекстуальные объяснения происходящего. С другой стороны, ориентация на сенсационность, использование эмоционально окрашенной лексики, акцентирование этнической принадлежности участников конфликтов и распространение непроверенных сведений могут усиливать стереотипы и предубеждения, формируя устойчивые образы «чужих» в общественном сознании. Динамичное развитие цифровых медиа и социальных сетей усиливает данные риски, поскольку информационные потоки ускоряются, а профессиональные стандарты журналистской ответственности часто оказываются ослабленными.

Казахстан представляет собой значимый кейс для анализа медийного освещения этнических конфликтов на постсоветском пространстве. Официальная государственная риторика последовательно акцентирует модель межэтнического согласия и социальной стабильности, поддерживаемую институциональными механизмами, такими как Ассамблея народа Казахстана. Вместе с тем наличие периодических локальных конфликтов и инцидентов с этнической составляющей свидетельствует о сложности и многослойности межэтнических отношений в стране. То, каким образом данные события репрезентируются в медиа, оказывает непосредственное влияние на общественное восприятие и уровень доверия к официальным интерпретациям.

Цель настоящей статьи заключается в анализе роли и влияния медиа в освещении этнических конфликтов на постсоветском пространстве с фокусом на казахстанский и международный опыт. Для достижения данной цели предполагается обобщить основные теоретические подходы к анализу медиавоздействия, рассмотреть особенности казахстанской медиасистемы, сопоставить их с практиками других постсоветских стран и выявить ключевые модели медиарепрезентации этнических конфликтов.

2. Теоретическая рамка исследования

Анализ роли средств массовой информации в освещении этнических конфликтов опирается на совокупность теоретических подходов, позволяющих выявить механизмы медиавоздействия на общественное сознание. Теория повестко формирования исходит из предположения, что медиа определяют круг тем, воспринимаемых аудиторией как социально значимые, влияя на приоритеты общественного внимания. Частота и контекст упоминаний этнической проблематики формируют представления о масштабах и значимости конфликтов.

Теория фрейминга дополняет данный подход, акцентируя внимание на способах интерпретации событий. Посредством выбора источников, лексики и структуры материала медиа формируют смысловые рамки, в которых конфликт предстает либо как частный инцидент, либо как проявление системных социальных проблем. В случае этнических конфликтов такие рамки оказывают прямое влияние на распределение ответственности и формирование общественных ожиданий относительно возможных решений.

Концепция миротворческой журналистики предлагает альтернативу конфликт ориентированным моделям освещения, ориентируя журналистов на анализ структурных причин противоречий, демонстрацию многообразия позиций и поиск ненасильственных форм взаимодействия. В условиях многонациональных обществ данный подход приобретает особую значимость, поскольку позволяет снизить риски эскалации и поляризации.

Исследования языка вражды подчеркивают долгосрочное воздействие дискриминационных и стигматизирующих высказываний в медиадискурсе. Даже косвенные формы связывания этничности с негативными характеристиками способствуют нормализации исключаящих практик и укреплению межгрупповых границ. Постколониальный подход, в свою очередь, позволяет рассматривать этнические конфликты в контексте исторически сложившихся иерархий и борьбы за символическое пространство в постсоветских обществах.

3. Методология исследования

В статье используется качественный аналитический подход, основанный на теоретическом обзоре и сравнительном анализе. Эмпирической базой исследования служат академические публикации по проблематике медиа и этнических конфликтов, а также аналитические интерпретации медиапрактик в Казахстане и ряде других постсоветских стран. Целью исследования не является количественный контент анализ, основное внимание уделяется выявлению доминирующих дискурсивных паттернов и фрейминговых стратегий, применяемых при освещении этнических конфликтов.

4. Освещение этнических конфликтов в медиа Казахстана

Медиасистема Казахстана формировалась в условиях одновременной политической и экономической трансформации, что обусловило сочетание рыночных механизмов и существенного государственного влияния. В традиционных медиа доминирует официальный дискурс, ориентированный на поддержание образа межэтнического согласия и социальной стабильности. В сообщениях о конфликтах с этнической составляющей основной акцент делается на правовых аспектах и действиях государственных институтов, тогда как этнический компонент часто минимизируется или остается имплицитным.

Подобная стратегия позволяет снизить вероятность немедленной эскалации, однако одновременно ограничивает возможности публичного обсуждения структурных причин напряженности, включая социально экономическое неравенство и локальные формы дискриминации. Альтернативные интерпретации чаще возникают в цифровых медиа и социальных сетях, где отсутствуют устойчивые редакционные фильтры, а этническая проблематика нередко становится объектом эмоционально окрашенных и поляризующих обсуждений.

5. Международный и постсоветский опыт

Сравнительный анализ медиапрактик в других постсоветских странах показывает значительное разнообразие моделей освещения этнических конфликтов. В ряде государств этническая проблематика активно используется в политически мобилизационных целях, что усиливает конфронтационные нарративы и способствует радикализации общественного дискурса. В странах Южного Кавказа и Молдове медиaprостранство во многом структурировано вокруг затяжных территориальных конфликтов, что приводит к сегментации аудитории по этническому и языковому принципу.

Опыт стран Балтии и Украины демонстрирует сочетание стремления к европейским стандартам журналистики с высокой степенью политической поляризации, в результате чего этническая тематика становится предметом постоянных дискуссий и конкурирующих интерпретаций. Эти примеры подчеркивают, что роль медиа в этнических конфликтах определяется не только профессиональными стандартами, но и более широким политическим и институциональным контекстом.

6. Обсуждение результатов

Сопоставление казахстанского и международного опыта позволяет сделать вывод о том, что медийное освещение этнических конфликтов находится в прямой зависимости от уровня политизации медиасистемы, степени плюрализма и устойчивости профессиональных норм. Казахстанская модель ориентирована на стабилизацию и предотвращение открытой эскалации, однако чрезмерная деполитизация может приводить к вытеснению важных

социальных проблем из публичного обсуждения. В более поляризованных медиасистемах, напротив, возрастает риск усиления конфронтационных нарративов и легитимации исключающих практик.

7. Заключение

Проведенный анализ подтверждает, что средства массовой информации играют ключевую роль в формировании общественного восприятия этнических конфликтов на постсоветском пространстве. Казахстанский опыт демонстрирует преимущества стабилизирующего медиадискурса, но одновременно выявляет его ограничения в части обсуждения структурных причин межэтнической напряженности. В этой связи развитие конфликт чувствительной журналистики, укрепление профессиональных стандартов и повышение уровня медиаграмотности населения представляются важнейшими условиями профилактики эскалации этнических конфликтов в многонациональных обществах.

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Physical and Mathematical Sciences

НЕКОТОРЫЕ ВОПРОСЫ ПРИМЕНЕНИЯ ДИФфуЗНО-ОТРАЖАТЕЛЬНОГО МЕТОДА ДЛЯ ДИАГНОСТИКИ СОСТОЯНИЯ ПЛОДООВОЩНОЙ ПРОДУКЦИИ В ВИДИМОЙ ОБЛАСТИ СПЕКТРА

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Введение

Как отмечается в работе [1] диффузно-отражательная спектроскопия непрозрачных материалов позволяет проводить их исследование без необходимости их предварительной подготовки.

Для идеального диффузного рассеятеля, при гомогенном распределении абсорбера и при достаточно толстом образце материала для выбранной длины волны уравнение Кубелки–Мунка имеет вид

$$F(R) = \frac{(1 - R)^2}{2R} = \frac{k}{s}$$

где R – диффузное отражение от исследуемого материала;

k – коэффициент абсорбции материала;

s – коэффициент рассеяния;

$F(R)$ – функция ремиссии Кубелки–Мунка.

Как отмечается в работе [2] классический метод диагностики плодоовощной продукции в видимой и близкой инфракрасной областях электромагнитного спектра обладают таким недостатком, что не позволяют определить химический состав диагностируемого объекта. Преимущества и недостатки метода использования видимого и ближнего инфракрасного частей спектра (далее VIS – NIR метода) подробно обсужден в обзорных работах [3-4].

Следует отметить, что видимый диапазон спектра охватывает длины волн 400-750 нм, а ближний инфракрасный (NIR) диапазон 756-2500 нм.

В плодоовощной продукции применимость закона Бугере-Бера невозможно из-за удлинения эффективной длины диагностирующей электромагнитной волны, проходящей

через диагностируемый образец. Дело в том, что диагностирующий свет взаимодействуя с клетками материала подвергается рассеянию, что эквивалентно увеличению эффективного пути прохождения света.

Диагностика плодоовощной продукции часто осуществляется в видимой (VIS) области для исследования состояния цветковых пигментов, таких как хлорофилл, каротины, ксантофиллы, антоцианины и другие фенолы. Цвет является важной характеристикой качества сельхозпродукции. Указанные пигменты имеют специфические спектральные признаки поглощения в области 400-700 нм [5].

Удлинение эффективной длины хода диагностирующего светового пучка из-за взаимодействия с клетками материала схематически иллюстрируется на рис. 1 [2].

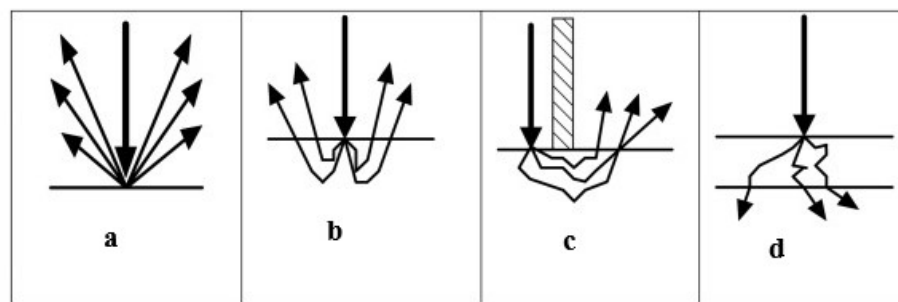


Рис. 1. Схематическое представление типов отражения диагностирующего светового пучка от диагностируемого материала [2] принятые обозначения: а) отражение с поверхности; б) диффузное отражение; в) частичное прохождение и ремиссия; д) полное прохождение через объект.

Следует отметить, что при отражательной геометрии (рис.1) применительно к диагностике сельхозпродуктов измерительный прибор будет измерять сумму сигналов как отраженных с поверхности объекта, так и диффузно-отраженный сигнал. Однако отраженный от поверхности сигнал не содержит информацию о состоянии внутренней части диагностируемого объекта.

В спектроскопии плодоовощной продукции развиваются два направления:

1. Метод неразрушающего пигментного анализа [5].
2. Метод использования спектральных индексов [6].

В работе [6] был предложен простой индекс спелости яблок (MI) в виде

$$MI = \frac{f \cdot (R_{720} - R_{680})}{SI} \quad (1)$$

где f – показатель твердости;

R_{720} R_{680} – коэффициенты отражения на длинах волн 720 нм и 680 нм, соответственно;

SI – индекс крахмала.

Как отмечается в работе [7], повреждения плода (ушибы) отражается на спектральных характеристиках.

Так, например, уменьшение коэффициента отражения происходит по экспоненциальному закону

$$R = a \cdot \exp(-b \cdot t) \quad (2)$$

где a , b – постоянные характеризующие тип плода;

t – время, прошедшее после ушиба.

На рис. 2 приведен график сезонного изменения коэффициента спелости фруктов [7]. Как видно из приведенного графика при переходе от летнего сезона в осенний сезон индекс спелости резко падает, что можно объяснить уменьшением f .

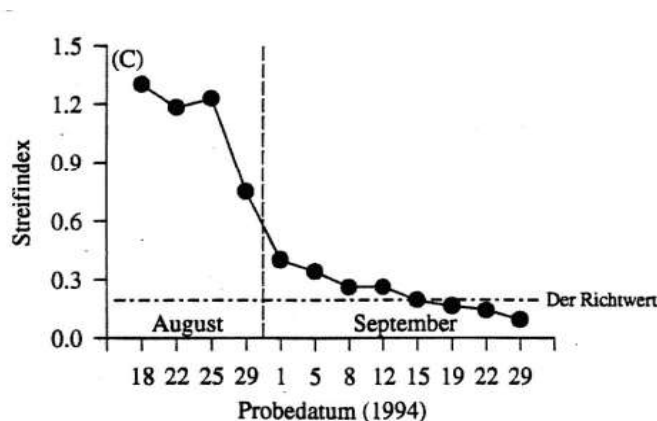


Рис.2. График сезонного уменьшения индекса спелости при переходе от летнего сезона в осенний сезон [7-9]. График вычислен по формуле (1).

Целью настоящего исследования является оптимизация модельного представления диагностики яблочной продукции по критерию (1) с учетом сезонного уменьшения показателя f .

Материалы и методы

Примем наличие двух множеств показателей f и SI яблочной продукции:

$$F = \{f_i\}; i = \overline{1, n} \quad (3)$$

$$SI = \{SI_j\}; j = \overline{1, n} \quad (4)$$

Допустим, что осуществляется поточная диагностика яблочной продукции в межсезонный период (переход от лета к осени) и вероятности появления яблок с показателем f_i одинаковы, т.е. указанное событие равно вероятное. Аналогичное свойство, как предполагается также принадлежит показателю SI .

С учетом вышеуказанных модельных представлений введем на рассмотрение дискретную функцию связи в виде

$$SI_j = \varphi(f_i) \quad (5)$$

С учетом выражений (1) и (5) построим следующий целевой функционал оптимизации F_g :

$$F_g = \sum_{i=1}^n \frac{f_i(R_{720} - R_{680})}{\varphi(f_i)} \quad (6)$$

Очередным модельным допущением является следующее условие

$$\sum_{j=1}^n \varphi(f_i) = c; \quad c = const \quad (7)$$

С учетом выражений (6) и (7) построим дискретный функционал вариационной оптимизации $F_{o.g.}$:

$$F_{o.g.} = \sum_{i=1}^n \frac{f_i(R_{720} - R_{680})}{\varphi(f_i)} + \lambda \left[\sum_{i=1}^n \varphi(f_i) - c \right] \quad (8)$$

где λ – множитель Лагранжа.

Дискретные модели (6) и (7) условно заменим на непрерывные модели. Имеем следующие непрерывные модели

$$F_H = \int_0^{f_{max}} \frac{f \cdot (R_{720} - R_{680})}{\varphi(f)} df \quad (9)$$

$$\int_0^{f_{max}} \varphi(f) df = c_1; \quad c_1 = const \quad (10)$$

С учетом выражений (9) и (10) целевой функционал (8) в непрерывном виде может быть выражен следующим образом:

$$F_{o.H} = \int_0^{f_{max}} f \cdot \frac{(R_{720} - R_{680})}{\varphi(f)} df + \lambda \left[\int_0^{f_{max}} \varphi(f) df - c_1 \right] \quad (11)$$

Решение оптимизационной задачи (11) согласно [8] должно удовлетворять условию

$$\frac{d \left\{ \frac{f(R_{720} - R_{680})}{\varphi(f)} + \lambda \cdot \varphi(f) \right\}}{d\varphi(f)} \quad (12)$$

Из условия (12) получаем

$$\frac{-f(R_{720} - R_{680})}{\varphi^2(f)} + \lambda = 0 \quad (13)$$

Из условия (13) находим

$$\varphi(f) = \sqrt{\frac{f(R_{720} - R_{680})}{\lambda}} \quad (14)$$

При решении (14) функционал $F_{o.H}$ достигает минимума. Это можно проверить по критерию Лагранжа, согласно которому если вторая производная под интегрального выражения целевого функционала по искомой функции оказывается положительной величиной, то целевой функционал при этом достигает минимума.

Для вычисления λ можно воспользоваться выражениями (10) и (14).

Обсуждение

Таким образом сформулирована задача исследования экспериментальных свойств измерительного сигнала при проведении диагностики яблок поточным способом, используя диффузно-отражательный метод. При этом использован индекс спелости яблок, известный из литературы. На базе этого индекса сформулирован целевой функционал, характеризующий суммарный сигнал, формируемый диагностической аппаратурой. Было введено на рассмотрение оптимизационная функция зависимости между индексом крахмала и показателем твердости. Показано, что при наложении определенного ограничительного условия на оптимизируемую функцию может быть вычислен такой вид указанной функции, при которой целевой функционал достигает минимума. Дана рекомендация по недопущению на практике такой зависимости между индексом крахмала и показателем твердости диагностируемых яблок во избежание появления минимального сигнала на входе измерительно- вычислительного блока диагностической установки.

Заключение

Разработана методика для исследования экспериментальных свойств устройства поточной диагностики яблок по методу диффузного отражения. С применением метода вариационной оптимизации установлено, что суммарный сигнал поточного диагностического устройства может быть охарактеризован единым целевым функционалом, содержащем в себе оптимизируемую функцию связи между показателем твердости и индексом крахмала. Определен такой вид указанной функции, при котором целевой функционал, характеризующий суммарный сигнал на входе измерительного канала аппарата достигает минимума. Дана рекомендация по избежанию такой зависимости на практике.

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Механика бөлімін оқытуда оқушылардың өзіндік жұмыстарын ұйымдастыру әдістері

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1 курс магистранты

Аңдатпа. Механика - мектеп физикасының іргелі бөлігі, алайда ұғымдық қиындықтар (күш, үдеу, инерция, энергия түрленуі) оқушының тек сабақ үстіндегі әрекетімен ғана толық меңгерілмейді. Осы мақалада механика бөлімінде оқушылардың өзіндік жұмысын ғылыми дәлелдерге сүйеніп ұйымдастырудың тәсілдері жүйеленеді және оқу-әрекетті басқаруға арналған авторлық протокол ұсынылады. Негізгі идея - өзіндік жұмысты тек «үй тапсырмасы» ретінде емес, мақсат қою, жоспарлау, мониторинг, қателерді талдау және дәлелді кері байланыс арқылы жүретін өзін-өзі реттеу циклі ретінде құрастыру. Теориялық негіз ретінде өзін-өзі реттейтін оқу тұжырымдамасы және интервенциялық зерттеулердің мета-талдаулары алынады. Әдістемелік әзірleme механикадағы деңгейлік есептер, үлгі есептерді талдау, аралық өзін-өзі тексеру, уақыт бойынша бөлінген қайталау және жүйелі рефлексия сияқты компоненттерді біріктіреді. Нәтиже ретінде механикаға арналған өзіндік жұмыс типологиясы, 4 кезеңді ұйымдастыру протоколы, бағалау рубрикалары мен қателер журналының құрылымы ұсынылады. Ұсыныстар мұғалімнің басқарушы рөлін сақтай отырып, оқушының автономды оқу құзыретін арттыруға бағытталған.

Кілт сөздер: механика, өзіндік жұмыс, өзін-өзі реттеу, кері байланыс, деңгейлік есептер, метатаным, үй тапсырмасы, бөлінген қайталау, оқу күнделігі

Кіріспе

Қазіргі заманғы білім беру үрдісінде оқушылардың оқу материалын белсенді меңгеруі мен оны дербес зерттеу қабілеттерін дамыту маңызды педагогикалық міндеттердің бірі болып табылады. Механикадағы оқу табысының «әлсіз буыны» көбіне формуланы жаттап шығару емес, ұғымдық аппаратты орнықтыру: күш пен үдеудің байланысын сапалы түсіндіру, есеп шартын модельдеу, шешімнің физикалық мағынасын тексеру. Осы жерде өзіндік жұмыс шешуші орын алады, өйткені ол оқушыға уақыт, қадам, қате және түзету циклін өз қолына алуға мүмкіндік береді. Өзін-өзі реттейтін оқу парадигмасы бойынша тиімді оқу - жоспарлау, өзіндік бақылау және нәтижені бағалау үдерістерінің жүйелі іске қосылуы [1]. Сонымен бірге өзіндік жұмыстың өнімділігі оны қалай ұйымдастырғанға тәуелді: жай ғана көп есеп беріп қою нәтиже бермейді, ал мақсатты, құрылымды, кері байланыспен сүйемелденген өзіндік жұмыс тұрақты ілгерілеуге әкеледі. Оқу психологиясындағы интервенциялық деректер өзін-өзі реттеу стратегияларын үйрету, әсіресе метатанымдық компоненттерді енгізу, мектеп деңгейінде өлшенетін әсер беретінін көрсетеді [4].

Механика бөлімі физика ғылымының негізін құрайтындықтан, оқушылардан тек формулаларды жаттау ғана емес, олардың физикалық маңызын түсіну және практикалық есептерді шешу дағдыларын меңгеру талап етіледі. Сол себепті механика курсын оқытуда оқушылардың өзіндік жұмысы — теория мен практиканы терең меңгеруге бағытталған оқу қызметі ретінде педагогикалық зерттеулерде кеңінен қарастырылған.

Өзіндік жұмыс оқушының оқу мазмұнын өз бетінше меңгеруі, оқу мақсаттарына жету үшін ақпаратты талдау мен қолдану қабілетін қалыптастыруды көздейді. Бұл оқу қызметі оқушының танымдық белсенділігін арттырып, өз-өзін реттеу дағдыларын дамытады, нәтижесінде оқушы білім алған материалды терең түсініп, оны практикалық есептерге қолдана алады.

Әдеби шолу

Физика саласында өзіндік оқыту оқушылардың жеке танымдық белсенділігін дамытуға бағытталған оқу қызметі ретінде қарастырылады. Бұл оқу қызметін ұйымдастыру оқушыны ақпаратты белсенді түрде іздеуге, талдауға және өз нәтижесін бағалауға ынталандырады. Ғылыми зерттеулер көрсеткендей, өзіндік оқу физика пәнінде оқушының концептуалды түсінігін арттыруда маңызды рөл атқарады, себебі оқушы оқу материалын өздігінен меңгеруге және нақты физикалық заңдылықтарды түсіне білуге бағытталады [1].

Өзіндік жұмысты механикада «тапсырма көлемі» ретінде түсіну - әдістемелік редукция. Негізгі өлшем - оқушының оқу-әрекетін басқару сапасы. Zimmerman тұжырымдамасында оқушының өзіндік жұмысы 3 блокқа жинақталады: алдын ала кезең (мақсат қою, жоспарлау), орындау кезеңі (өзіндік бақылау, стратегия таңдау), рефлексия кезеңі (қателерді талдау, түзету шешімдері) [1].

Екінші маңызды тірек - уақыт бойынша бөлінген қайталау. Cepeda және әріптестері кең ауқымды деректерге сүйенген мета-талдауда (317 эксперимент, 839 бағалау) материалды аралықпен қайталау ұзақ мерзімді есте сақтауды жүйелі түрде күшейтетіні көрсетілген, бұл механикадағы формальды амалдарды емес, тұрақты ұғымдық бекітуді қолдайды [2].

Үшіншіден, үй тапсырмасының тиімділігі туралы мәселе. Cooper және әріптестері 1987-2003 жылдардағы зерттеулерді синтездеп, жалпы тенденция ретінде үй тапсырмасының үлгеріммен оң байланысы бар екенін, алайда әсер деңгейі жас ерекшелігіне және тапсырманың сапасына тәуелді екенін нақтылайды [3]. Демек, механикадағы өзіндік жұмыс «көп беру» емес, «дұрыс құрастыру» проблемасы.

Өзіндік жұмыс - бұл оқушының оқу материалын өз бетінше меңгеру процесі, онда оқушы мақсатты түрде оқу тапсырмаларын орындайды, ақпаратты талдайды, теориялық білімді практикалық есептерге қолданады және нәтижелерін бағалайды. Бұл оқу қызметінің мазмұны оқу бағдарламасының нақты тақырыптары мен оқыту мақсаттарына сәйкес құрылуы тиіс.

Мысалы, механикадағы концептуалды түсінік тапсырмалары оқушыны физикалық ұғымдар мен заңдылықтардың мәнін терең түсінуге бағыттайды, ал есептік тапсырмалар оқушының математикалық құралдарды қолдануын және физикалық процедураларды жүзеге асыру қабілетін дамытады.

Механика бөлімі бойынша оқытуда оқушылар жиі теориялақ және есептік тапсырмалармен кездеседі, алайда олардың концептуалды түсінігі жеткіліксіз болуы мүмкін. Осыған байланысты физика білім беру зерттеулері белсенді оқыту әдістерін қолданудың маңыздылығын көрсеткен, олар оқушылардың өздік оқуына негізделген тапсырмаларды тиімді орындауға септігін тигізеді.

Белсенді оқыту стратегиясы — студент-центрленген оқытудың бір бөлігі ретінде физикада өзіндік оқуды қолдайды. Осы әдістің ішінде Peer-Instruction (тәлімдас оқыту) кеңінен зерттелген. Бұл әдістің мәні — оқушылардың бір-бірімен концептуалды сұрақтарды талқылауы және физикалық ұғымдарды өзара түсіндіруі арқылы түсінік деңгейін арттыру. Zhang зерттеуі көрсеткендей, Peer-Instruction физика пәніне қатынасты позитивті пікірлер мен ұғымдарды қалыптастыруда тиімді, ол оқушының өзіндік оқу белсенділігін арттыруға ықпал етеді [2].

Peer-Instruction әдісі интерактивті талқылаулар мен топтық жұмысты қамтиды, бұл оқушылардың кәсіби тілдік және концептуалды дағдыларын жетілдіреді. Аталған әдіс дәстүрлі дәрістік оқытудан айырмашылығы — студент белсенді ойлау және өзара әрекеттесу арқылы білім алу процесіне тартылған [2].

Зерттеулер көрсеткендей, зерттеуге бағытталған оқу (research-based learning) және STEM-бағдарлы стратегиялар физика білімінде оқушының дербес оқу дағдыларын қалыптастыруда маңызды рөл атқарады. Бұл тәсілдер оқушыны күрделі проблемалармен жұмыс істеуге, жеке жобаларды орындауға және ақпараттық-коммуникациялық технологияларды пайдалана отырып білім алуға ынталандырады [3]. Сонымен қатар STEM-бағдарлы әдістер өздік зерттеу дағдыларын, сыни ойлауды және практикалық проблемаларды шешу қабілеттерін дамытуға жағдай жасайды [3].

Зерттеуге бағытталған оқу оқушыларға физикалық процестерді түсіну үшін теория мен тәжірибені интеграциялауға мүмкіндік береді. Digital оқыту құралдары, мысалы виртуалды лабораториялар және симуляциялар, оқушыларға физикалық заңдылықтарды практикалық контексте зерттеуге жағдай жасайды, бұл өздік түсінікті тереңдетеді және мотивацияны көтереді [3].

Материалдар мен әдістер

Мақала механика бөлімін оқытуға арналған әдістемелік протоколдың жобасы ретінде құрастырылды. Нысаналы аудитория - 9-11 сынып оқушылары (механика тақырыптары бар деңгей). Әзірлеме мектеп жағдайында, сыныптық-үйлік өзіндік жұмыс үйлесімінде қолдануға лайықталған.

Құралдар:

- Өзіндік жұмыс картасы (мақсат, ресурс, уақыт, бақылау сұрақтары).
- Қателер журналы (error log): қате түрі, себеп, түзету, қайта тексеру уақыты.
- Өзін-өзі бағалау рубрикасы (модельдеу, есептеу, физикалық түсіндірме, тексеру).
- Бөлінген қайталау кестесі (интервалды жоспарлау қағидаты) [2].
- Үй тапсырмасын «сапалық стандарттармен» жобалау принциптері [3].

Деректерді жинау

1. Механика тақырыптары бойынша мақсаттар Bloom таксономиясының деңгейлеріне сәйкестендіріліп, әр тақырыпқа 2-3 өзіндік жұмыс форматы бекітіледі (үлгі есеп, деңгейлік есеп, қысқа өзіндік тест, қате талдауы).

2. Әр аптада 1 рет «қателерді қайта өңдеу сессиясы» енгізіледі: оқушы 3 типтік қателікті таңдап, түзету логикасын қысқа мәтінмен рәсімдейді.

3. Әр тақырыптың соңында өзіндік рефлексия парағы толтырылады: «қай жерде қиналдым, не көмектесті, келесі аптада қандай стратегия өзгертемін»

Деректерді талдау

Бағалау логикасы сандық «балл қуалау» емес, оқушының стратегия тұрақтануын бақылауға негізделеді: рубрика бойынша сапалық деңгей, қате құрылымының өзгеруі, уақыт менеджменті. Әдістеменің тиімділігі мектепте апробацияланған кезде, бастапқы-аралық-қорытынды диагностиканы (мысалы, қысқа концептуал сұрақтар банкі) қолдануға болады, бірақ бұл мақалада нақты эксперименттік нәтижелер талап етілмейді.

Нәтижелер мен талқылау

Механика бөлімінде өзіндік жұмысты ұйымдастырудың басты қиындығы - оқушыға «көбірек есеп шығар» деуден гөрі күрделірек: өзіндік жұмыстың мақсаты, форматы және құралы бір-бірімен логикалық сәйкестікте болуы қажет. Егер мақсат ұғымдық түсіну болса, құрал тек жаттығу емес, түсіндіру мәтіні немесе ұғым картасы болуы тиіс; ал егер мақсат күштерді ажырату болса, онда негізгі артефакт формула емес, еркін дене диаграммасы

болуы заңды. Осы логиканы нақтылау үшін нәтижелердің бірінші компоненті ретінде өзіндік жұмыстың типологиясы жасалды. Типологияның жаңалығы - ол тапсырманы «түр» ретінде емес, оқу әрекетінің когнитивтік функциясы ретінде қарап, әр функцияға өлшенетін артефакт бекітеді: мәтін, диаграмма, қадамдалған шешім, портфолио, журнал, тест парағы, қысқа видео.

Бұл типологияда өзіндік жұмыс тек үй тапсырмасы емес, «оқу дәлелі» рөлін атқарады: мұғалім оқушының ойлауын тікелей көрмейді, бірақ артефакт арқылы (мәтін, схема, қателер журналы) оқу әрекетінің сапасын бағалай алады. Осыған байланысты кестеде «мұғалім қолдауы» бағаны әдейі енгізілді: толық дербестік мектеп тәжірибесінде жиі формализмге әкеледі, ал шағын, бірақ дәл бағытталған қолдау оқушыны автономияға біртіндеп шығарады.

Кесте 1. Механикадағы өзіндік жұмыстың типологиясы (мақсат-формат-құрал сәйкестігі)

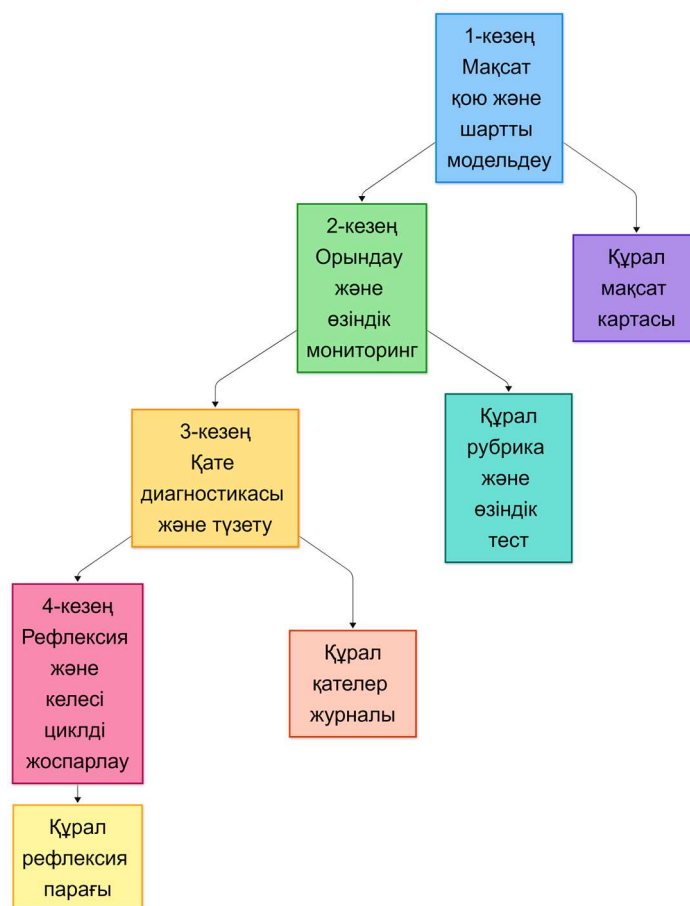
Өлшем	Өзіндік жұмыс түрі	Нысаналы оқу нәтижесі	Мұғалім қолдауы	Оқушы артефакті
Ұғымдық түсіну	Қысқа түсіндірме жазу (100-150 сөз)	Ньютон заңдарын сапалы тілмен түсіндіру	3 сұрақтан тұратын бағыттаушы шаблон	Түсіндірме мәтін
Модельдеу	Еркін дене диаграммасы (FBD)	Күштерді дұрыс бөлу, бағыт таңдау	1 үлгі, 1 қарсы-үлгі	Диаграмма жинағы
Алгоритмдеу	Үлгі есептерді талдау (worked examples)	Шешім қадамдарын құрылымдау	Қадамдық рубрика	Қадамдалған шешім
Дағды қалыптастыру	Деңгейлік есептер (A-B-C)	Есептеу дәлдігі, бірлік тексеру	Деңгей шартын нақтылау	Есептер портфолиосы
Бекіту	Интервалды қайталау	Ұзақ мерзімді сақтау	Апталық кесте	Қайталау журналы
Метатаным	Қате талдауы (error analysis)	Қате себептерін тану, түзету	Қате түрлерінің классификаторы	Қателер журналы
Өзіндік бақылау	Қысқа өзіндік тест (10 сұрақ)	Жылдам диагностика	Тест кілтімен өзіндік тексеру	Нәтиже парағы
Коммуникация	«1 есеп - 1 түсіндіру» видеосы (1-2 мин)	Физикалық мағына айту	Бағалау критерийі	Қысқа түсіндірме

Кесте 1 типологиясы механикадағы оқу әрекетін «шешім шығарма» деген бір өлшемге қыспай, бірнеше өзекті қабатқа бөледі. Бірінші қабат - ұғымдық тіл: Ньютон заңдары жиі формула ретінде жатталып, физикалық мағынасы жоғалып кетеді, сондықтан 100-150 сөздік түсіндіру мәтіні оқушының ұғымды «өз сөзінде» құруына мәжбүрлейді. Екінші қабат - модельдеу: күштер жүйесін дұрыс көрмей тұрып есеп шешу көбіне кездейсоқ алгебраға айналады, сол себепті FBD жеке артефакт ретінде міндеттеледі. Үшінші қабат - алгоритмдеу: оқушының шешімі көбіне қадамдық құрылымға емес, «бірден формула табуға» сүйенеді; ал үлгі есептерді қадамдық рубрикамен талдау жаңадан үйренушілер үшін тиімді тәсіл ретінде когнитивтік жүктемені азайтып, дұрыс схеманы қалыптастыруға мүмкіндік береді [4].

Типологияның практикалық ұтысы - мұғалімнің тексеру жұмысын жеңілдетуі емес, керісінше тексеруді мазмұндандыруы. Мысалы, «есептер портфолиосы» тек есеп саны емес, тұрақты сапа индикаторын береді: бірлік тексеру орындалды ма, шек жағдайы қаралды ма, таңба қайдан шықты. Ал «қателер журналы» оқушыны айыптау құралы емес, рефлексиялық құралға айналады: қате түрі аталады, себебі жазылады, түзету стратегиясы жоспарланады. Бұл жерде маңыздысы - қателердің өзі емес, қателерді ұстау мәдениеті.

FBD бағыты бойынша бөлек атап өтетін нәтиже - диаграмманы «өздігінен құру» арқылы есеп шығару сапасына әсер ететін фактордың педагогикалық маңызы. Механика есептерінде диаграмма сыртқы бейне ғана емес, ішкі модельдің көрінетін формасы. Сондықтан FBD жинағын артефакт ету оқушының «күштерді көру» дағдысын қалыптастырады, әрі есептің шартын дұрыс интерпретациялауға көмектеседі [5].

Өзіндік жұмысты тек түрге бөліп қою жеткіліксіз. Негізгі нәтиже - осы түрлерді басқарудың қайталанатын, өлшенетін циклі. Сол үшін «авторлық 4 кезеңді протокол» ұсынылды: мақсат қоюдан бастап рефлексияға дейінгі тізбек әр аптада қайталанып отырады және әр кезең нақты құралмен бекітіледі. Бұл протоколдың педагогикалық мәні - оқушыға «өзіндік мониторинг» пен «түзету» қадамын міндеттеу. Оқушы көбіне шешімді тоқтатпай, қате кеткен жерді көрмей жүре береді; протокол дәл осы жерге тоқтау нүктесін енгізеді.



Сурет 1. Өзіндік жұмысты басқарудың авторлық 4 кезеңді протоколы

Сурет 1-дегі протоколдың «жұмысқа жарамдылығы» оның қарапайымдылығында емес, кезеңдердің әрқайсысы нақты өнімге тірелуінде. 1-кезеңде мақсат картаға түседі: оқушы «бүгін Ньютонның 2-заңын қолданамын» демейді, «күштерді бөлемін, проекцияны дұрыс аламын, бірлікті тексеремін» деп нақты операцияларды жазады. 2-кезеңде рубрика

мен өзіндік тест мониторинг құралы болады: оқушы шешім барысында рубрикаға қайта оралып, «мен шынымен осьті дұрыс таңдадым ба» деп өзіне сұрақ қояды. 3-кезеңде қателер журналы іске қосылады: қате бір сөзбен емес, типімен жазылады (ось, таңба, шарт оқу, бірлік). 4-кезеңде рефлексия парағы келесі циклдің мақсатын береді - бұл жерде «не үйрендім» деген жалпы сөйлем емес, келесі аптада қай қателікті қысқартатыны жоспарланады.

Протоколдың мұғалімге беретін нәтижесі - кері байланыстың нүктелік, бірақ дәл болуына жағдай жасау. Мұғалім әр оқушыға ұзын түсініктеме жазбайды, 1-2 нақты сәйкессіздікті көрсетеді: мәселе қай кезеңде, қандай құрал жетпеді. Бұл логика кері байланысты «баға» ретінде емес, оқу алшақтығын қысқартатын ақпарат ретінде қарастыратын ғылыми дәстүрмен үйлеседі [6].

Келесі нәтижелік блок - мұғалімге арналған апталық «жобалау матрицасы». Бұл матрица өзіндік жұмысты кездейсоқ тапсырмалар жиынтығынан шығарып, сабақтың тақырып ядросына бекітілген артефакттар жүйесіне айналдырады. Матрицада үш принцип қатар ұсталады: (1) міндетті ядро артефакт, (2) қысқа диагностика, (3) қате талдауы арқылы түзету. Осы үшеуі жоқ жерде үй жұмысы жиі «орындадым-орындамадым» деңгейінде қалып қояды да, оқу механикасының әлсіз буыны күшеймейді.

Кесте 2. Мұғалімге арналған «жобалау матрицасы» (апталық өзіндік жұмысты құрастыру)

Апта	Тақырып ядросы	Міндетті ядро артефакті	Қайталау интервалы	Қысқа диагностика	Қате талдауы	Үй тапсырмасы сапасының шарты
1	Кинематика	График интерпретациясы	2 күн, 6 күн	10 сұрақ	2 қате	Тапсырма түсіндірумен аяқталсын
2	Ньютон заңдары	FBD жинағы	2 күн, 7 күн	10 сұрақ	3 қате	Есеп саны емес, қадам сапасы бағалансын
3	Импульс	Соқтығыс модельдері	3 күн, 8 күн	8 сұрақ	2 қате	Қате журналын міндетті ету
4	Энергия	Энергетикалық баланс	3 күн, 10 күн	10 сұрақ	3 қате	Тексеру қадамы (бірлік, шек) енгізілсін

Кесте 2 матрицасының мәні - «артефакт арқылы оқыту». Мысалы, кинематикада график интерпретациясы міндетті артефакт болғанда оқушы формуладан бұрын қозғалыстың бейнесін оқуға үйренеді. Ньютон заңдары аптасында FBD жинағы міндетті болғанда әр есеп «күштер тілін» үйрететін микро-зертханаға айналады. Импульс тақырыбында соқтығыс модельдері міндеттелсе, оқушы оқиғаға физикалық сценарий ретінде қарайды: оқшауланған жүйе бар ма, импульс сақталу шарты орындала ма. Энергия аптасында энергетикалық баланс міндетті болса, механика есептері «қай формула» емес, «қай энергия түрі қайда ауысты» деген қатаң логикаға түседі.

Қайталау интервалы мен қысқа диагностика бағандары өзіндік жұмыстың уақыт құрылымын көрсетеді. Бұл жерде идея өте прагматикалық: оқушыға ұзын тапсырманың орнына жиі, қысқа тексеру нүктесін беру. 5-10 минуттық диагностика қателерді «қатып қалмай» тұрып ұстайды, ал 2-6-7-10 күн сияқты интервалдар оқу мазмұнын ұмытылудан қорғауға бағытталған. Ең маңыздысы - матрица «үй жұмысы көп болсын» демейді; «үй жұмысы сапа шартымен аяқталсын» дейді. Бұл тәсіл үй жұмысының тиімділігі оны қалай жобалауға тәуелді екенін көрсететін синтездік зерттеулердің жалпы логикасымен сәйкес келеді, әсіресе жоғары сыныпта [3].

Үшінші нәтижелік блок - қателердің типологиясы және өзіндік түзету тапсырмалары. Бұл бөлім механикада ең жиі кездесетін «инерциялы» қателерді жүйелейді: күш пен үдеуді шатастыру, ось таңдаудағы қате, таңбаны жоғалту, шартты дұрыс оқымау. Нәтиже ретінде қате жай ғана аталып қоймай, әр қате үшін түзету әрекеті берілді. Педагогикалық тұрғыда бұл «қателермен жұмыс» бөлігін бағалау мәдениетінен ажыратып, оқу құралына айналдырады: қателіктің себебі оқушының назарын қайда бұру кергін көрсетеді.

Кесте 3. Механикадағы типтік қателер және өзіндік түзету тапсырмасы

Қате	Белгісі	Түзету әрекеті
Күш пен үдеуді шатастыру	« $F=ma$ » механикалық қолдану	3 жағдайға FBD сызу, әрқайсысын сөзбен түсіндіру
Бірліктерді тексермеу	Нәтиже «мәнсіз»	Әр есепте соңында өлшем талдауы
Ось таңдау қателігі	Проекция қате	Бір есепті 2 түрлі осьпен шешіп салыстыру
Векторлық бағытты жоғалту	Минус таңба жоғалады	5 қысқа жаттығу: бағыт және таңба
Шартты дұрыс оқымау	Артық формула	«Берілгені-табылатынды» қайта жазу және модельдеу

Кесте 3-тің әдістемелік жаңалығы - «түзету әрекетінің» нақты, шағын және қайталанатын болуында. Оқушыға «мұқият бол» деудің орнына, бір қателікті 2-3 микро-жаттығумен қайта құру ұсынылады. Мысалы, ось таңдау қателігі жиі «бір ғана дұрыс ось бар» деген қате интуициядан туады; бір есепті екі түрлі осьпен шешіп салыстыру осы интуицияны бұзады да, оқушыны модельдеу еркіндігіне шығарады. Сол сияқты таңбаны жоғалту қателігі көбіне векторлық бағыттың тілін жоғалтудан болады; бағыт және таңбаға арналған қысқа жаттығулар мәселені локальды түрде емдейді.

Бұл блок өзіндік реттелген оқу стратегияларын қалыптастыруға бағытталған интервенциялар туралы мета-талдауларда көрсетілетін ортақ оймен үйлеседі: стратегия үйрету тек «айтумен» емес, тапсырма құрылымына кіріктірілген нақты әрекеттермен іске асады [7].

Соңғы нәтижелік элемент - сабақтан тыс циклдің коммуникациялық картасы. Бұл сызба өзіндік жұмыстың апталық «жабық циклі» қалай жұмыс істейтінін көрсетеді: қысқа оқу, деңгейлік есеп, өзіндік тест, қате журналы, артефакт тапсыру, мұғалімнің қысқа кері байланысы, кейін интервалды қайталау. Мұнда басты тетік - мұғалімнің кері байланысы ұзақ емес, дәл болуы және оқушының келесі қадамын анықтауы. Оқушы алдымен үлгі есеп арқылы қадам құрылымын көреді, кейін деңгейлік есептер арқылы сол құрылымды қолданады, кейін өзіндік тест арқылы әлсіз жерін табады, соңында қате журналы арқылы әлсіз жерді мақсатқа айналдырады. Апта соңындағы артефакт тапсыру мұғалімге «оқушы не істеді» деген есеп үшін емес, «оқушы қай кезеңде қиналды» деген диагностикалық ақпарат үшін керек.

Қорытынды

Ұсынылған протоколдың ғылыми қисыны үш дәлелді арнаға тіреледі. Біріншісі - өзін-өзі реттеу: механикада нәтиже көбіне «қай есеп шықты» емес, «оқушы өз қателігін қалай ұстайды және қалай түзетеді» арқылы анықталады. Екіншісі - уақыт факторын басқару: бір реттік қарқынды дайындық орнына, интервалды қайталау арқылы ұғымдық тіректер тұрақтанады, бұл әсіресе күш, энергия, импульс сияқты өзара байланысқан ұғымдарда маңызды. Үшіншісі - үй тапсырмасының сапасы: зерттеулер оның әсері тапсырманың жасқа сәйкестігі мен құрастырылуына тәуелді екенін көрсетеді, сондықтан механикада «аз, бірақ құрылымды» қағидасы әдістемелік тұрғыда ақылға қонымды. Шектеу де бар: ұсынылған матрица нақты бір мектептің бағдарламасына, уақыттық жүктемесіне және оқушының бастапқы дайындығына бейімделуі тиіс. Әсіресе жоғары сыныпта уақыт тапшылығы өзекті, сондықтан өзіндік жұмыстың бір бөлігі қысқа, бірақ жиі диагностикаға (5-10 минут) ауысқаны дұрыс.

Механика бөліміндегі өзіндік жұмысты ұйымдастырудың тиімділігі тапсырма санына емес, оқу-әрекетті басқарудың сапасына, уақыт бойынша бөлінген қайталауға және қателерді жүйелі өңдеуге тәуелді. Авторлық 4 кезеңді протокол механикадағы күрделі ұғымдарды тұрақтандыруға, оқушының автономды оқу құзыретін дамытуға және мұғалім кері байланысын нысаналы етуге мүмкіндік береді. Болашақта осы протоколды нақты сыныптарда апробациялап, қате құрылымының өзгерісін және рубрика деңгейлерінің динамикасын эмпирикалық өлшеу - ең табиғи келесі қадам.

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